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Letter of Concurrence - U.S. Fish and Wildlife Service (USFWS)

MATERIALS INFORMATION

Foundation Report for the Soldier Pile Ground Anchor Wall at DN 101 PM 22.9, dated January 21, 2015

Addendum for the Foundation Report for the Soldier Pile Ground Anchor Wall at DN 101 PM 22.9, dated January 8, 2016

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Arcata Fish and Wildlife Office
1655 Heindon Road
Arcata, California 95521
Phone: (707) 822-7201 FAX: (707) 822-8411

In Reply Refer To:
AFWO-12B0001-12I0001

Tim Ash
California Department of Transportation
Division of Environmental Analysis, MS 27
1120 N Street
P. O. Box 942874
Sacramento, California 94274-001

APR 0 9 2014

Paula Gill, Caltrans Liaison
United State Army Corps of Engineers
San Francisco District Headquarters
1455 Market Street
San Francisco, California 94103

Subject: Programmatic informal consultation for the California Department of Transportation's Routine Maintenance and Repair Activities, and Small Projects Program for Districts 1 and 2

Dear Mr. Ash and Ms. Gill:

We have reviewed your request, dated March 9, 2011, and received March 29, 2011, for programmatic informal consultation with the U. S. Fish and Wildlife Service (Service) for the proposed California Department of Transportation's (Caltrans) Routine Maintenance and Repair Activities, and Small Projects Program for Districts 1 and 2. This response is prepared in accordance with section 7(a)(2) of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 *et seq.*), and its implementing regulations (50 CFR § 402). The United States Army Corps of Engineers (Corps) proposes to permit a subset of these activities and thus will be a co-lead action agency for this consultation. As co-lead Federal action agencies for the proposed activities, Caltrans and the Corps are seeking programmatic concurrence for proposed maintenance and repair activities, small projects and geotechnical drilling activities that *may affect, but are not likely to adversely affect*, one or more of six federally threatened or endangered species (see **Covered Species** section below) that may occur within the action area[1] of the proposed activities. Caltrans and the Corps are also seeking concurrence that their proposed activities will not result in adverse effects to designated critical habitat for the covered species. Although Caltrans and the Corps are co-lead Federal action agencies for this consultation, for simplicity, hereafter we refer to the co-lead agencies as "Caltrans".

[1]Defined as the area potentially impacted directly or indirectly by the proposed action

On July 1, 2007, the Federal Highway Administration (FHWA) assigned, and Caltrans assumed, the designation as lead Federal action agency for projects funded by the FHWA, but designed and built by Caltrans. Therefore, as the lead Federal action agency, Caltrans is responsible for conducting section 7 consultations with the Service. This letter transmits the Service's concurrence with Caltran's determination of potential impacts to six federally listed species and designated critical habitat within the jurisdiction of the Arcata Fish and Wildlife Office. This programmatic letter of concurrence was prepared with information from a Caltrans' biological assessment, information in the Service's files, and correspondence between Caltrans and Service staff. A complete decision record for this consultation is on file at the Arcata Fish and Wildlife Office.

I. Covered Species

This consultation applies to the following species and designated critical habitat:

A. AMPHIBIANS

California Red-legged Frog (*Rana draytonii*)
Federal Listing Status: Threatened (05/23/1996, 61 FR 25813 25833)
Critical Habitat Designation: Original 03/13/2001 (66 FR 14626 14674); Current 03/17/2010 (75 FR 12816 12959)

B. BIRDS

Marbled Murrelet (*Brachyramphus marmoratus*)
Federal Listing Status: Threatened (10/01/1992, 57 FR 45328 45337)
Critical Habitat Designation: Original 05/24/1996 (61 FR 26257 26320); Current 10/05/2011 (76 FR 61599 61621)

Northern Spotted Owl (*Strix occidentalis caurina*)
Federal Listing Status: Threatened (6/26/1990, 55 FR 26114 26194)
Critical Habitat Designation: Original 01/15/1992 (57 FR 1796 1838); Current 12/04/2012 (77 FR 71875 72068)

Western Snowy Plover (*Charadrius alexandrinus nivosus*)
Federal Listing Status: Threatened (03/05/1993, 58 FR 12864 12874)
Critical Habitat Designation: Original 12/07/1999 (64 FR 68508 68544); Current 06/19/2012 (77 FR 36727 36869)

C. FISHES

Tidewater Goby (*Eucyclogobius newberryi*)
Federal Listing Status: Endangered (02/04/1994, 59 FR 5494 5499)
Critical Habitat Designation: Original 11/20/2000 (65 FR 69693 69717); Current 02/06/2013 (78 FR 8745 8819)

D. MAMMALS

Point Arena Mountain Beaver (*Aplodontia rufa nigra*)
Federal Listing Status: Endangered (12/12/1991, 56 FR 64716 64723)
Critical Habitat: Not designated.

II. Consultation History

Since 2007, Caltrans have consulted with the Service's Arcata Fish and Wildlife Office on proposed projects for the species listed above on numerous occasions. During that time, the Arcata Fish and Wildlife Office and Caltrans recognized that many of these projects resulted in no adverse effects to federally listed species and to their designated critical habitat. Furthermore, we recognized that the individual project letters of concurrence included many of the same avoidance and minimization measures. Consequently, the Arcata Fish and Wildlife Office and Caltrans decided that a programmatic approach to the section 7 consultation process was appropriate for some listed species and agreed to initially include only those projects that resulted in a *may affect, but not likely to adversely affect* determination for one or more of these listed species. Once this programmatic letter of concurrence has been implemented by Caltrans, the Arcata Fish and Wildlife Office will determine whether a similar programmatic approach for projects with a *may affect, likely to adversely affect* determination for one or more of the covered species, resulting in a programmatic biological opinion, would be appropriate.

III. Covered Area

The geographic area covered by this programmatic letter of concurrence consists primarily of Humboldt County, the majority of Del Norte and Mendocino counties, and portions of Siskiyou, Trinity, Tehama, Glenn, Colusa, and Lake counties (Figure 1). However, coastal portions of the Sacramento Fish and Wildlife Field Office's jurisdictional area and western portions of the Yreka Fish and Wildlife Field Office's jurisdictional area will be covered by this programmatic letter of concurrence if a project falls within the range and suitable habitat of any of the covered species listed above.

IV. Description of Proposed Activities

Caltrans proposes to conduct the following routine maintenance and repair activities, and small construction projects within the covered area. These projects and proposed activities are described below, and in detail in Caltrans' programmatic biological assessment (Caltrans 2010) and may be eligible for coverage under the programmatic letter of concurrence. Proposed activities represent actual work on the ground that could potentially impact listed species covered under this consultation. A proposed activity will be covered for one or more listed species provided Caltrans adheres to all applicable avoidance and minimization measures, and all applicable Best Management Practices (BMPs) for all covered species that Caltrans has determined may occur within the action area. Proposed activities may be implemented on all

local, State and Federal highway infrastructures, including, but not limited to, roads, bridges, culverts, rights-of-ways, and other Caltrans-owned and locally-owned (*e.g.*, cities, counties) areas adjacent to existing facilities.

For a project to be covered by this programmatic consultation, the potential impacts to one or more of the covered species or their designated critical habitat from the proposed activities must be: (1) insignificant; (2) discountable (*i.e.*, a very low probability of occurrence); or (3) wholly beneficial. Therefore, if Caltrans is unable to meet the required avoidance and minimization measures for one or more of their proposed activities, for one or more covered species, the project would be consulted on using the standard provisions for section 7 consultation (*i.e.*, a project specific consultation). However, for any given project it is possible that one or more species and one or more of the proposed activities may be covered, while others may not. In this case, a separate project specific consultation would only be required for those species and activities that do not meet the requirements of this programmatic consultation.

A. ROUTINE MAINTENANCE ACTIVITIES INCLUDING RESURFACING, INSTALLATION OF GUARD RAILS, SHOULDER WIDENING, AND STRIPING

Caltrans proposes to conduct routine maintenance activities that are not necessarily associated with any other group of proposed activities. Caltrans currently conducts these routine maintenance activities throughout Districts 1 and 2 along many miles of highway. The list of proposed activities below represent the most common routine maintenance activities, but other activities not on this list may occur periodically and will be covered by this consultation provided Caltrans adheres to all applicable avoidance and minimization measures listed below for the six covered species.

Caltrans is proposing to perform the following routine maintenance activities:

1. Asphalt overlay (resurfacing)
2. Guard rail installation, repair, or replacement
3. Widening of road shoulders
4. Seal coat overlay
5. Road striping
6. Rumble strip installation (preferably using modified rumble [aka “mumble”] strips)
7. Minor road curve corrections

B. CLEANING ACTIVITIES

Caltrans proposes to clean water conveyance structures of sediment and debris in order to ensure proper functioning, accommodate passage of aquatic organisms, and avert failure. Types of infrastructure that may require regular cleaning include: culverts, drainage ditches, bridge abutments, and piers. Cleaning may require the use of shovels, rakes, other hand tools, a vactor, or heavy equipment such as a backhoe or excavator, and may require minutes to several hours or

days to complete. For a complete list of potential cleaning activities see the Caltrans Maintenance Manual Volume I (Caltrans 2006).

Caltrans is proposing to perform the following cleaning activities:

1. Cleaning of sediment and debris in a dry or wetted channel, from culverts, stream channels, ditches, drainage channels, bridge abutments, and other infrastructure.
2. Cleaning of sediment and debris with heavy equipment from any infrastructure, including culverts, drainage channels, and bridge abutments. Heavy equipment includes vactoring power heads, winches, backhoes, and excavators.

C. SLIDE AND SLIPOUT ABATEMENT AND REPAIR

Caltrans proposes to implement slide and slipout abatement and repair activities that involve the repair of damaged infrastructure, and the removal of sediment and debris from roadsides, rights-of-way, stream banks, bridges, piers and abutments. Equipment may include, but is not limited to: shovels, excavators, bulldozers, backhoes, drill rigs, graders, dump trucks and hand tools. Repair activities will typically occur once all debris has been removed.

Caltrans is proposing to perform the following activities as part of slide abatement and slipout repair projects:

1. Paving
2. Asphalt overlay
3. Placement of cement or fill material
4. Striping
5. Road improvement activities necessary to refurbish damaged roadways
6. Excavation
7. Culvert repair and replacement
8. Drainage pipe installation
9. Temporary road building
10. Drilling
11. Backfilling
12. Installation of guard rails
13. Stabilization of road cuts and upslope areas
14. Weed abatement
15. Construction of retaining walls and other slope stabilization structures, such as rock slope protection (RSP).
16. Slide abatement and repair activities using hand tools.

17. Slide abatement and repair activities using heavy equipment.
18. All other abatement and repair activities related to landslides and infrastructure failure, such as transport of equipment, development of Storm Water Pollution Prevention Plans, implementation of BMPs, and fueling and maintenance of vehicles and equipment.
19. Rock control structures (*e.g.*, wire mesh/cable net drapes)

D. DRAINAGE SYSTEM MAINTENANCE, REPAIR, AND REPLACEMENT

Caltrans proposes to implement drainage system maintenance, repair, and replacement activities that involve the rehabilitation, repair, retrofitting, and replacement of culverts to maintain function, and where practicable, improve flow condition.

Caltrans is proposing to perform the following activities as part of drainage system maintenance, repair, and replacement projects:

1. Rehabilitation of culverts
2. Replacement, repair, and retrofitting of culverts

E. BRIDGE REPAIR, MAINTENANCE, AND NEW CONSTRUCTION

Caltrans is proposing to perform the following bridge maintenance and repair activities:

1. Repairing damage or deterioration or correcting bridge deficiencies in various bridge components
2. Removing debris and drift from bridge piers
3. Fixing bearing seats
4. Cleaning abutments
5. Cleaning drains
6. Repairing expansion joints
7. Cleaning and painting structural steel
8. Sealing concrete surfaces
9. Maintenance and repair of electrical and mechanical equipment on moveable span bridges
10. Widening and replacement of bridge components (*e.g.*, railings, wing walls)
11. Maintenance and repair activities associated with the operation of the moveable spans
12. All other non-construction related activities that are required to complete bridge maintenance and repair activities, such as transport of equipment, development of Storm Water Pollution Prevention Plans, implementation of BMPs, and fueling and maintenance of vehicles and equipment.

13. Construction and installation of new bridges

F. VEGETATION MANAGEMENT

Caltrans proposes to employ appropriate management *(i.e.,* maintenance) of vegetation on roadsides using an Integrated Vegetation Management (NM) program. This program consists of using permanent vegetation control techniques that reduce the need for ongoing vegetation management. These techniques can include, but are not limited to, the following treatments: (1) concrete or asphalt application, (2) fiber or rubber weed control mat application, (3) stamped asphalt application, (4) irrigation, (5) mulch application, (6) rock blanket or rock slope protection installation in upland areas, (7) plant removal and replacement, (8) fertilization, weed and pest control, (9) growth retardant application, (10) pruning, (11) washing, (12) planting, (13) herbicidal fabric application, and (14) roadside mowing. Vegetation that cannot be controlled using these techniques will be managed and removed by cutting, mowing, bulldozing, or burning, using equipment such as backhoes, front-end loaders, torches, and/or chainsaws. For a complete list of potential maintenance activities relating to vegetation management see Caltrans (2006).

Caltrans is proposing to perform the following vegetation management activities:

1. Removal of riparian or upland vegetation.

2. All other activities required for the management, maintenance and control of vegetation, such as transport of equipment, development of Storm Water Pollution Prevention Plans, implementation of BMPs, and fueling and maintenance of vehicles and equipment.

G. GRADING AND ESTABLISHMENT OF STAGING AND STORAGE AREAS

A staging area is a designated area where vehicles, supplies, and construction equipment are positioned for access and use at a construction or maintenance site. Storage areas are used to store materials, construction waste, water, wood, soil, or rock by the roadside, and are often necessary for highway maintenance and construction activities. Staging and storage areas may be temporary (life of the project) or permanent.

Caltrans is proposing to perform the following activities:

1. Installation of new staging or storage areas.

2. Grading and leveling of existing staging and storage areas.

3. Vegetation removal

4. Ground leveling and grading

5. Storage of vehicles and equipment

6. Fueling of vehicles

7. Installation of artificial lighting sources.

8. Any other activities required for the maintenance or establishment of staging and storage areas, such as transport of equipment, development of Storm Water Pollution Prevention Plans, and implementation of BMPs.
9. Recontouring and revegetation of staging and storage areas upon project completion.

H. GEOTECHNICAL DRILLING

Caltrans proposes to use geotechnical drilling for a variety of projects including, but not limited to: (1) building of retaining walls, (2) geotechnical investigations for bridge and culvert replacements or retrofits, (3) installation of piles and other support structures and slope stabilizations. Geotechnical drilling typically consists of using a crane-deployed-platform to drill holes; smaller wheeled drill rigs are employed as well. The drill rig typically accesses the area using existing roads or barge. Where access roads need to be developed, the road will typically be restored to the original topography and re-vegetated upon completion of geotechnical investigations. However, in some instances the road may be retained for construction access and future maintenance of the constructed facilities. See below for further information regarding grading and establishment of temporary access roads. Geotechnical drilling may require: (1) drilling with or without a platform, (2) craning in equipment, (3) construction of access roads and drilling pads, (4) removal of trees, shrubs, and other vegetation, and (5) intermittent lane closures with traffic control.

Caltrans is proposing to perform the following geotechnical drilling activities:

1. Geotechnical drilling.
2. All other non-drilling activities related to and necessary to complete these types of projects, such as transport of equipment, development of Storm Water Pollution Prevention Plans, implementation of BMPs, and fueling and maintenance of vehicles and equipment.

I. GRADING OF EXISTING PERMANENT, AND ESTABLISHMENT OF NEW TEMPORARY ACCESS ROADS AND TRAFFIC DETOURS

Caltrans proposes to establish new temporary roads, traffic detours and the grading of existing roads where construction activities necessitate the closure of an existing road or when access to infrastructure is required but cannot be achieved using existing roads. Typical grading and road construction activities include: (1) the disturbance of existing soil and debris using a shovel, dozer or grader, (2) the movement of gravel and debris from the areas, and (3) leveling, reshaping, and smoothing of the road surface. These activities are typically accomplished using heavy equipment with an attached bucket or blade. Temporary roads are typically comprised of crushed rock or concrete and are outsloped for maximum water drainage. Crushed rock or concrete is typically used as an overlay as well to provide a smooth road surface and minimize dust. Road construction may also involve the building of water bars, temporary culverts, ditches, deflectors and drainage dips to assist in drainage and maintain road integrity. When temporary roads are no longer needed, they are typically seeded with a mix of native plants and returned to their pre- project contour wherever possible.

Caltrans is proposing to perform the following road grading and building activities:

1. Grading of permanent access roads and construction of temporary access roads and traffic detours.
2. All other activities related to establishment and maintenance of temporary access roads and traffic detours, such as transport of equipment, development of Storm Water Pollution Prevention Plans, implementation of BMPs, and fueling and maintenance of vehicles and equipment.

J. CONSTRUCTION OF SETTLING BASINS

Caltrans proposes to construct settling basins, where necessary, to provide on-site water and pollution management during and after construction activities. A settling basin is a temporary or permanent basin formed by excavating and/or constructing an embankment so that sediment laden runoff is temporarily detained, allowing sediment to settle out before the runoff is discharged into watercourses. Typically, settling basins are considered for use on projects: (1) with disturbed areas during the rainy season, (2) where sediment-laden water may enter the drainage system or watercourses, (3) where post construction detention basins are required, (4) associated with dikes, temporary channels, and pipes to convey runoff from disturbed areas; or at outlets of disturbed soil areas. A typical temporary settling basin has a design life of 12 to 28 months and will be maintained until the site is permanently protected against erosion or a permanent detention basin is constructed.

Caltrans is proposing to perform the following settling basin activities:

1. Construction and maintenance of settling basins.
2. All other activities related to the construction of settling basins, such as transport of equipment, development of Storm Water Pollution Prevention Plans, implementation of BMPs, and fueling and maintenance of vehicles and equipment.
3. Decommissioning of sedimentation basin once it is no longer being used or effective.

K. INSTALLATION OF ROCK SLOPE PROTECTION/EROSION CONTROL MATERIALS

Caltrans is proposing to perform the following activities:

1. Installation of rock slope protection or erosion control materials at the outlet or wing walls of existing and new culverts, on stream banks, and bridge abutments and piers.

V. Protective Measures

A. SPECIES-SPECIFIC AVOIDANCE AND MINIMIZATION MEASURES

The following species-specific avoidance and minimization measures must be implemented to avoid or minimize adverse effects to federally listed species and their habitat, including designated critical habitat. Proposed projects and activities that cannot adhere to one or more of the measures for the species that may occur within the action area will not be covered by this programmatic consultation and would require a separate project-specific consultation. Most or all of these species-specific protective measures have been recommended by the Service to avoid or minimize potential impacts to listed species, and implemented by Caltrans, for many past projects with similar or identical proposed activities.

The first steps in determining whether a proposed project could be covered under this programmatic letter of concurrence for a species is to determine whether the action area is: (1) within the known range of the listed species, and (2) within suitable habitat or (3) within designated critical habitat that is currently not suitable. The range and habitat suitability questions will quickly include or exclude certain listed species from consideration for coverage. This process is identical to technical assistance regularly provided to Caltrans biologists via phone or email correspondence. If one or more covered species may occur within the action area of a proposed project, the next step is to determine whether presence\absence surveys for the species, using Service-recommended survey protocol, have been conducted. Finally, if no surveys have been conducted, then Caltrans will presume occupancy of the listed species within the action area and adhere to all avoidance and minimization measures listed below to avoid adverse effects to listed species, suitable habitat, or designated critical habitat.

1. Northern Spotted Owl

a) Occupied Habitat

If northern spotted owl surveys (using the Service's 2012 survey protocol; Service 2012; Attachment A) determine that the action area is occupied **or** the lead Federal action agency presumes spotted owl occupancy without conducting surveys, Caltrans will adhere to the following avoidance and minimization measures:

i. Vegetation Removal or Alteration:

a. No suitable northern spotted owl nest trees[2] will be removed during the nesting season (1 February to 15 September).

b. Suitable habitat may be removed or altered outside the nesting season provided "no take" guidelines are adhered to for all known spotted owl home ranges within 0.7 mile of the action area in coastal [redwood] forests (Service 2011; Attachment B) or within 1.3 miles of the action area in interior forests

[2]In Northwestern California, Lahaye and Gutierrez (1999) found that northern spotted owls nest primarily in the broken tops, cavities, or on platforms (*e.g.*, mistletoe brooms) of Douglas-fir (83%; *Pseudotsuga menziesii*) and redwoods (9%; *Sequoia sempervirens*), with a mean minimum diameter-at-breast height (dbh) of 46.9 in (SD = 3.7 in). It is important to note, however, that northern spotted owls in northwestern California have nested in smaller diameter trees that contain the proper structural elements.

(Service 2008; Attachment C).

c. Caltrans must ensure that there are no "adverse effects" to designated northern spotted owl critical habitat within the action area. However, because the Service has no specific quantitative thresholds, above which there would likely be an adverse effect to critical habitat, Caltrans must contact the Service to determine whether the proposed habitat removal within designated critical habitat would constitute an adverse effect.

ii. Auditory or Visual Disturbance:

a. No proposed activity generating sound levels 20 or more decibels above ambient sound levels **or** with maximum sound levels (ambient sound level plus activity-generated sound level) above 90 decibels (excluding vehicle back-up alarms) may occur within 0.25 mile (1320 feet) of suitable spotted owl nesting\roosting habitat during the majority of the nesting season (*i.e.,* 1 February to 09 July; Service 2006; Attachment D). These above-ambient sound level restrictions will be lifted after 31 July; after which the Service considers the above-ambient sound levels as having "no effect" on nesting spotted owls and dependent young.

b. No human activities shall occur within a visual line-of-sight of 40 m (131 feet) or less from any known nest locations within the action area (Service 2006; Attachment D).

b) Unoccupied Habitat

a. If northern spotted owl surveys (using the Service's 2012 survey protocol; Service 2012; Attachment A) determine that all suitable spotted owl habitat within 0.7 mile of the action area in coastal [redwood] forests or within 1.3 miles of the action area in interior forests, is unoccupied, suitable habitat may be removed or altered without seasonal restrictions, provided "no take" guidelines are adhered to for all known spotted owl home ranges within 0.7 mile of the action area in coastal [redwood] forests (Service 2011; Attachment B) or within 1.3 miles of the action area in interior forests (Service 2008; Attachment C). The Service considers previously occupied habitat as essentially "occupied" in perpetuity. Therefore, adequate (based on the "no take" guidelines mentioned above) suitable nesting\roosting and foraging habitat must be maintained within all historical northern spotted owl territories within the action area.

b. Caltrans must ensure that there are no "adverse effects" to designated northern spotted owl critical habitat within the action area. Because the Service has no specific quantitative thresholds, above which there would likely be an adverse effect to critical habitat, Caltrans must contact the Service to determine whether the proposed habitat removal would constitute an adverse effect to designated critical habitat.

2. Marbled Murrelet

a) Occupied Habitat

If marbled murrelet surveys (using the Service's 2003 survey protocol; Evans Mack *et al.* 2003; Attachment E) determine that the action area is occupied **or** the lead Federal action agency presumes marbled murrelet occupancy without conducting surveys, Caltrans shall adhere to the following avoidance and minimization measures:

i. Vegetation Removal or Alteration:

a. No potential marbled murrelet nest trees[3] will be removed during the nesting season (24 March to 15 September).

b. Potential suitable nesting habitat may be removed or altered outside the nesting season (16 September to 23 March).

c. Caltrans must ensure that there are no "adverse effects" to designated marbled murrelet critical habitat within the action area. However, because the Service has no specific quantitative thresholds, above which there would likely be an adverse effect to critical habitat, Caltrans must contact the Service to determine whether proposed habitat removal within designated critical habitat would constitute an adverse effect.

ii. Auditory or Visual Disturbance:

a. No proposed activity generating sound levels 20 or more decibels above ambient sound levels **or** with maximum sound levels (ambient sound levels plus activity-generated sound levels) above 90 decibels (excluding vehicle back-up alarms) may occur within 0.25 mile (1320 feet) of suitable marbled murrelet nesting habitat during the majority of the murrelet nesting season (*i.e.*, 24 March to 19 August)(Service 2006; Attachment D).

b. Between August 20 (date when most marbled murrelets have fledged in coastal northern California) and September 15 (end of marbled murrelet nesting season) of any year, project activities, with adjacent suitable nesting habitat, that will generate sound levels ≥10 dB above ambient sound levels will observe a daily work window beginning 2 hours post-sunrise and ending 2 hours pre-sunset. However, prep work that does not generate sound levels above ambient sound levels, including street sweeping and manual removal of pavement markers, can occur during all hours. The need for this daily work window depends on the distance between suitable nesting habitat and the above-ambient sound generating activity following the Service's guidelines (Service 2006; Attachment D). For example, if above-ambient sound levels generated by proposed activities will become attenuated back down to ambient sound levels prior to reaching suitable nesting habitat, the daily work window would not be necessary.

[3]Potential habitat that should be surveyed for nesting murrelets was defined by Nelson *et al.* (2003) as: (1) mature (with or without an old-growth component) and old-growth coniferous forests; and (2) younger coniferous forests that have platforms (relatively flat, at least 4-inch diameter and 33 feet high in the live crown of a coniferous tree). Platform presence is more important than tree size.

c. No human activities shall occur within visual line-of-sight of 40 m (131 feet) or less from a nest (Service 2006; Attachment D).

b) Unoccupied Habitat

a. If protocol surveys determine that all suitable marbled murrelet nesting habitat within the action area is considered unoccupied, suitable nesting habitat may be removed or altered without seasonal restrictions.

b. Caltrans must ensure that there are no "adverse effects" to designated marbled murrelet critical habitat within the action area. Because the Service has no specific quantitative thresholds, above which there would likely be an adverse effect to critical habitat, Caltrans must contact the Service to determine whether the proposed habitat removal would constitute an adverse effect to designated critical habitat. However, the removal of a few small trees and shrubs would be exempt from this requirement.

3. California Red-legged Frog

The California red-legged frog occurs in only the extreme southern portion of the covered area within the southern half of Mendocino County. The avoidance and minimization measures below apply to project action areas that contain potentially suitable California red-legged frog habitat.

a) A qualified biologist (*i.e.*, certified by the Service) will conduct Worker Environmental Awareness Training for the construction workers prior to the start of construction activities. Awareness training will include a brief review of the biology of the California red-legged frog and guidelines that must be followed by all construction personnel to avoid take of California red-legged frogs.

b) The qualified biologist will appoint a biological monitor (*e.g.*, the crew foreman) who will be responsible for ensuring that all crewmembers comply with the guidelines. Awareness Training will be conducted for new personnel before they can participate in construction activities. The qualified biologist will notify the Resident Engineer who will address any work stoppage, and the Service will be contacted if a California red-legged frog at any life stage (*i.e.*, adults, sub-adults, tadpoles, eggs) is encountered during project activities.

c) Within 24 hours prior to the onset of ground disturbance activities, the qualified biologist will survey the project area for all life stages of the California red-legged frog. Surveys must be conducted immediately prior to ground-disturbing activities to lower the probability of one or more adult or sub-adult frogs moving into or laying eggs within the project area after a survey has already been conducted.

d) If California red-legged frogs (including eggs and tadpoles) are encountered at any time during project activities, construction activities will cease in the area and the Service will be notified to determine how to proceed.

e) Water pumps will be screened with wire mesh screens no larger than 0.2 inch to prevent California red-legged frog tadpoles, sub-adults, and adults from entering the pump system. Although pre-activity surveys may have detected no California red-legged frogs, this measure is to ensure that frogs that were missed during the survey are not harmed or killed by water pumps.

f) All food-related trash will be disposed of in closed containers and removed from the project area at least twice per week during the construction period. Food may attract frog predators such as raccoons to the action area.

g) The contractor will implement a toxic materials control and spill response plan. Equipment refueling will only occur at staging areas where fuel will not enter the floodplain.

h) All vegetation removal activities will be done with the use of hand tools only (including chainsaws).

i) The number of access routes, numbers and sizes of staging areas, and the total area of the activity will be limited to the minimum necessary to achieve the project goal. Routes and boundaries will be clearly demarcated.

4. Tidewater Goby

The following avoidance and minimization measures apply to action areas where tidewater gobies have been detected using the Service's recommended presence\absence survey protocol (Service 2005a: Appendix F; Attachment F), when water samples taken from the water body detect tidewater goby DNA, or when Caltrans presumes goby presence. For ground-disturbing activities conducted within unoccupied (based on the aforementioned surveys) suitable habitat within designated tidewater goby critical habitat, Caltrans must ensure that the primary constituent elements (Service 2005a) of goby critical habitat are maintained.

a) To avoid crushing adult gobies and their breeding burrows, no construction equipment will work within the active, wetted channel and no workers shall walk within the wetted channel.

b) To avoid barotrauma injury to gobies or damage to breeding burrows, no impact or vibratory equipment shall be used within an active, wetted channel or in any location where it could have an adverse effect on breeding burrows and gobies. In addition, heavy equipment used outside the wetted channel, must be operated at a distance as far as possible from suitable breeding habitat to avoid barotrauma injury and/or damage to goby breeding burrows.

c) For long-term work conducted immediately adjacent to suitable breeding habitat, a visual barrier shall be used to avoid visual disturbance by workers and equipment.

d) No geotechnical drilling is permitted in the wetted channel.

e) New access roads must not enter a wetted channel or watercourse.

5. Point Arena Mountain Beaver

a) Prior to implementing proposed vegetation-altering or ground-disturbing activities, habitat assessments and surveys for Point Arena mountain beaver must be conducted using Service-approved protocol (Service 2005b). Survey and habitat assessment results are valid for 2 years; if conducted within 500 feet of the impact area. Therefore, if proposed activities do not begin within 2 years of surveys, additional surveys will need to be conducted prior to conducting the work.

b) No vegetation removal or ground disturbance in occupied habitat or within unoccupied suitable habitat. However, roadside mowing along State Route 1, in occupied habitat or unoccupied suitable habitat using motorized equipment is allowed between July 1 and November 30 (*i.e.*, the non-breeding season), provided a maximum 4-foot horizontal strip of vegetation will be mowed, to a minimum height of 2 feet.

c) No vibrator equipment will be used within 500 feet of occupied suitable habitat during the breeding season (December 1 to June 30), and within 250 feet of occupied suitable habitat during the non-breeding season (July 1 to November 30).

d) Night lights should be at least 250 feet from occupied suitable habitat.

e) Heavy equipment must remain on the road prism in areas with evidence of Point Arena mountain beaver burrowing or within unoccupied suitable habitat.

f) Staging areas will be placed in unsuitable habitat areas only or on the road prism to avoid habitat disturbance. No staging areas are allowed within occupied or unoccupied suitable habitat.

6. Western Snowy Plover

The following avoidance and minimization measures apply to action areas within suitable snowy plover nesting habitat regardless of whether snowy plovers have been detected during Service approved protocol surveys.

a) From February 15 through September 30, daily pre-activity surveys by an authorized snowy plover monitor out to 325 feet from the action area will take place. An authorized snowy plover monitor will also remain on-site during all activities within suitable nesting habitat (coastal beaches; gravel bars on the lower Eel River). If the authorized snowy plover monitor determines that operations are resulting in a behavioral disturbance to existing snowy plovers, or if one or more snowy plovers move into the action area, work will stop immediately. The Service believes that a one-time, short-term behavioral disturbance (*e.g.*, flushing) would not result in adverse effects to the species, provided the work stops immediately and workers and equipment leave the vicinity of the snowy plover(s) that exhibited the behavioral response.

b) If a project activity requires vehicles above the wave slope (*i.e.*, sand wetted by the last tidal cycle) on any occupied beach, vehicles will only access the beach during daylight hours, and be limited to 5 mph or the minimal speed required to prevent becoming stuck in the sand, but never to exceed a speed of 15 mph. An authorized snowy plover monitor will be present in vehicles or walking in front of the vehicles to ensure that no snowy plovers are adversely affected. As mentioned in measure "a" above, a short-term behavioral disturbance such as flushing would likely not result in an adverse effect to snowy plovers, however, repeated behavioral disturbances to the same birds may result in an adverse effect. Therefore, the authorized snowy plover monitor must ensure that any given snowy plover is not repeatedly exposed to activities that may result in adverse effects; which may require suspension of work activities until after the nesting season.

c) Heavy equipment will be walked to the work site along the wave slope and will remain on-site until the project is completed. When work is conducted on the beach above the wave slope, workers will approach the beach from the wave slope using the shortest route possible.

d) Trash and food will be contained in predator-proof containers and transported off of the site each day.

e) Pets will not be allowed at beach or gravel bar work sites.

B. BEST MANAGEMENT PRACTICES

In addition to the species-specific avoidance and minimization measures listed above, Caltrans will implement appropriate Best Management Practices (BMPs) at all project sites. BMPs are effective, practical, structural or nonstructural methods that prevent or reduce the movement of sediment, nutrients, pesticides and other pollutants from the land to surface or ground water, or that otherwise protect water quality and beneficial uses from potential degradation. BMPs will be applied to projects involving: (1) erosion control, (2) waste, water or material management; (3) water conveyance, (4) hydroseeding and hand seeding, (5) material delivery, storage, and use; (6) paving operations, (7) vegetation management and preservation, (8) spill prevention and control, (9) stockpile management, (10) streambank stabilization, (11) structure demolition, (12) vehicle and equipment cleaning, maintenance, and refueling, and (13) water conservation practices.

A complete list of potential BMPs are listed in Appendix C of Caltrans programmatic biological assessment (Caltrans 2010), the Caltrans Storm Water Quality Handbook: Maintenance Staff Guide (Caltrans 2003), and the Caltrans Storm Water Quality Handbook: Construction Site Best Management Practices Manual (Caltrans 2003a). Caltrans has the flexibility to choose the most appropriate BMP for each site and will maintain all BMPs to function in their intended manner. Additional Best Management Practices (ABMPs) as described in the Programmatic Biological Assessment (Caltrans 2010) will be implemented where necessary, as determined by Caltrans staff. Refer to Appendix C of Caltrans Programmatic Biological Assessment (Caltrans 2010) for a complete list of ABMPs.

VI. Administration of the Letter of Concurrence

Implementation of this programmatic letter of concurrence requires a step-wise approach by Caltrans environmental staff to determine whether a proposed activity is appropriate for coverage for one or more of the federally threatened or endangered species (see section **I. Covered Species**). For all intents and purposes, ANY project could be covered under this programmatic letter of concurrence (*i.e.*, a "*may affect, but not likely to adversely affect*" [NLAA] determination for the species) provided Caltrans adheres to all avoidance and minimization measures for the covered species that may occur in the action area. For example, proposed blasting would generally result in a "*may affect, likely to adversely affect*" (LAA) determination for the northern spotted owl and marbled murrelet if conducted during the nesting season in or near occupied suitable habitat. However, if blasting is conducted outside the nesting season, or is muffled to minimize sound levels to at or near ambient levels, then it could be covered under this programmatic letter of concurrence for the northern spotted owl and marbled murrelet. In contrast, if Caltrans can't guarantee adherence to seasonal restrictions or reduce elevated sound levels, blasting would not be covered under this programmatic letter of concurrence and would require a separate project-specific consultation.

Because most Caltrans road projects the Service consults on in Caltrans Districts 1 and 2, are for potential auditory and visual impacts (with little or no vegetation removal as a general rule) to the northern spotted owl or marbled murrelet, it doesn't really matter what particular construction equipment or techniques are employed to complete the proposed projects as long as they adhere to seasonal restrictions for noise generation and minor vegetation removal and\or can minimize noise levels to at or below ambient levels. This all assumes that suitable occupied or unoccupied habitat occurs within the action area (including habitat that is exposed to above ambient sound levels and the actual project footprint). If no suitable habitat for a particular species occurs within the action area of a project, then no avoidance and minimization measures for that species would need to be implemented.

The Service and Caltrans will meet annually, at a minimum, to: (1) review covered projects and activities; (2) evaluate and discuss the effectiveness of the program; (3) review the list of covered activities and species; (4) update procedures, avoidance and minimization measures, BMPs, and project criteria, if necessary; and (5) ensure that avoidance and minimization measures and BMPs are effective at maintaining potential impacts of proposed activities at less than significant levels for all covered species and critical habitat. Modifications to the programmatic letter of concurrence will be discussed and developed during these meetings. In addition to the annual meeting, items (1) through (5) above may also be discussed during monthly Level 1\2 project meetings or during quarterly video conferences, both of which are attended by the Service's transportation liaison and Caltrans environmental staff.

At any time, the Service or Caltrans may revoke or revise this programmatic letter of concurrence if it is determined that it is not being implemented as intended, or if reinitiation of consultation is required or desirable it is expected that after a period of implementation, both parties are likely to identify measures that will provide additional efficiencies while at the same time maintaining or improving species conservation and recovery.

To assist Caltrans with achieving consistent administration and implementation of the programmatic letter of concurrence, Caltrans will provide annual training to maintenance and environmental staff that describes the activities covered by the consultation, proper implementation of required avoidance and minimization measures, and project data management. The Caltrans environmental senior and district maintenance manager (or designee) in each district are responsible for coordinating and implementing the annual training. The training will be presented by Caltrans staff, with Service staff in attendance to provide support.

If an issue cannot be resolved between Caltrans and Service staff, the issue will be elevated to the management level. Managers and staff will then meet to discuss the issues, and will work together to come to an agreement. Issues should be elevated when consensus cannot be reached regarding the determination of effects severity; adequacy of avoidance and minimization measures; or issues related to the applicability and administration of the programmatic letter of concurrence. In addition, questions about relevant laws, regulations, or policy may be elevated. If managers and staff cannot resolve the issue, then it will be raised to the next higher level (*i.e.*, the policy level).

VII. Concurrence

The Service concurs with Caltrans' determination that the above described portions of Caltrans' routine maintenance and repair program "*may affect, but are not likely to adversely affect*" the covered listed species or designated critical habitat identified in Section I, provided Caltrans implements the avoidance and minimization measures listed above. The Service concurs with Caltrans determinations based on information provided in a biological assessment, email and phone correspondence, and meetings with Caltrans environmental staff.

VIII. Conclusion

This concludes informal consultation for the proposed California Department of Transportation's (Caltrans) Routine Maintenance and Repair Activities, and Small Projects Program for Districts 1 and 2. However, obligations under section 7 of the Act, as amended, should be reconsidered if: (1) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not previously considered; (2) proposed actions are subsequently modified in a manner that was not considered; (3) a new species is listed or critical habitat designated that may be affected by the proposed activities; or (4) Caltrans is unable to implement all of the avoidance and minimization measures described above.

Thank you for your coordination on this project. Please contact fish and wildlife biologist Gregory Schmidt at (707) 825–5103 should you have further questions regarding this consultation.

Sincerely,

Bruce Bingham
Field Supervisor

cc:
Caltrans, Eureka (Attn: Dana York, Sandra Rosas, Steve Croteau)
Caltrans, Redding (Attn: Amber Kelley, Chris Quiney, Keith Pelfrey)
CDFW (Attn: JoAnn Dunn)
NMFS (Shari Witmore, Chuck Glasgow)
Caltrans (Amy Golden, James Henke)

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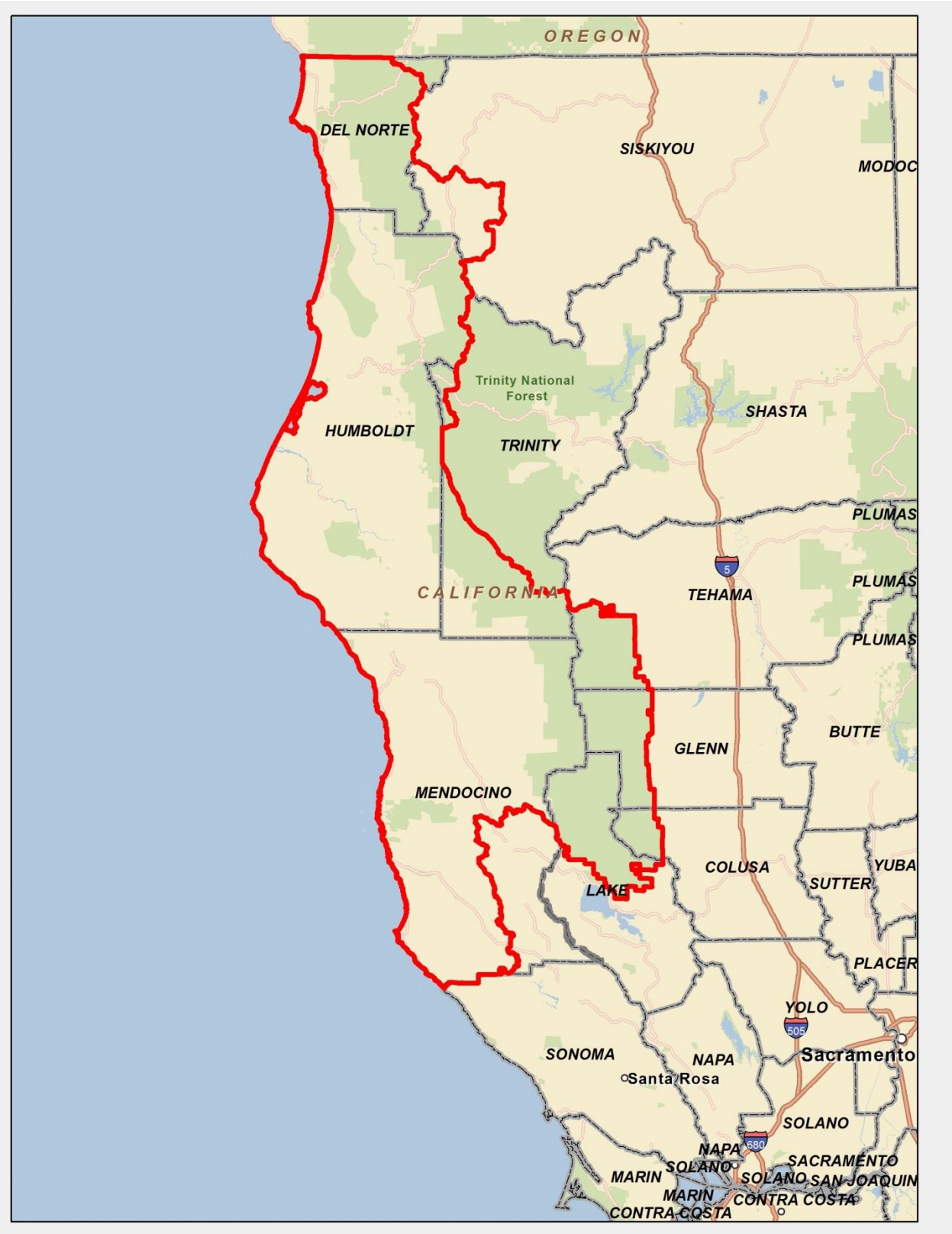

FIGURE 1. Approximate geographic area (red border represents the jurisdiction of the USFWS-Arcata Field Office) covered by the programmatic letter of concurrence.

ATTACHMENT A

PROTOCOL FOR SURVEYING PROPOSED MANAGEMENT ACTIVITIES THAT MAY IMPACT NORTHERN SPOTTED OWLS

Endorsed by the
U.S. Fish and Wildlife Service

February 2, 2011

Revised January 9, 2012

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PROTOCOL FOR SURVEYING PROPOSED MANAGEMENT ACTIVITIES THAT MAY IMPACT NORTHERN SPOTTED OWLS
(2011 Protocol)

1.0 INTRODUCTION

The U.S. Fish and Wildlife Service (Service) developed this 2011 NSO Survey Protocol (2011 Protocol) to promote consistent and scientifically rigorous procedures to survey for northern spotted owls (*Strix occidentalis caurina*; spotted owl) in areas where management activities may remove or modify spotted owl nesting, roosting or foraging habitat (excluding areas defined as dispersal habitat). This protocol should also be applied to activities that disrupt essential breeding activities and to activities that may injure or otherwise harm spotted owl other than through habitat modification (e.g., noise disturbance, smoke from prescribed fire). This 2011 version of the survey protocol builds upon the 1992 Protocol and incorporates changes made to the Draft 2010 Protocol.

In recent years, research on spotted owls provided insights that raised concerns regarding the effectiveness of surveys, particularly those which do not result in spotted owl detections. Specifically, the invasion of the Pacific Northwest by the barred owl (*Strix varia*), an aggressive and potentially significant competitor of the spotted owl, has resulted in a suppression effect on spotted owl response rates (Olson et al. 2005, Crozier et al. 2006). Therefore, survey results that do not account for barred owl effects on spotted owl detection rates may provide false or insufficient information about spotted owl presence in the survey area, and lead to forest management activities that may impact spotted owls and be in conflict with the Endangered Species Act.

To address this concern, the Service and cooperators (see list below) conducted analyses of historical survey data during 2009 and 2010, leading to estimates of detection rates for spotted owls that account for the effects of barred owl presence. Information utilized to generate the detection rates came from long-term spotted owl demography studies (Anthony et al. 2006, Olson et al 2005, Dugger et al. 2009, Bailey et al. 2009, Kroll et al. 2010) and spotted owl site and timber-harvest related surveys on private industrial forest lands in Oregon and California (Kroll et al. 2009). These detection rates, along with data on spotted owl site colonization and extinction probabilities, and empirical analysis of spotted owl site occupancy (Olson et al. 2005, Dugger et al. 2009, Kroll et al. 2010a), were utilized in developing this protocol. These analyses provided strong evidence that the 2-year, 3-visits-per-year requirement, as described in the 1992 protocol, was no longer sufficient to provide a reasonable likelihood of detecting territorial spotted owls where barred owls occur. Lastly, to improve the efficiency and practicality of this protocol, the professional opinion of researchers, survey practitioners, and regulators were integrated into this product.

Use of the 2011 Protocol should serve two primary purposes: (1) provide a methodology that results in adequate coverage and assessment of an area for the presence of spotted owls, and (2) ensure a high probability of locating resident spotted owls and identifying owl territories that

may be affected by a proposed management activity, thereby minimizing the potential for unauthorized incidental take. While this protocol utilizes the best available information for conducting project-level surveys, the protocol is not designed to monitor yearly trends of spotted owls or for many other research applications.

This protocol should be implemented across the northern spotted owl's range. However, in some areas local conditions, particularly when supported by appropriate data, may warrant deviations from this protocol. These deviations may occur through mutual cooperation between the landowner or their representative and the appropriate regulatory agency. Spotted owl surveys that are conducted as part of demographic long-term monitoring programs (see areas described in Forsman et al. 2011) can be considered reasonable alternatives to implementation of this protocol.

This document describes the methodology for surveying for spotted owls. It is the Service's expectation that practitioners should read and fully understand the details of the 2011 Protocol as described herein. The development of the Protocol has benefitted from data analysis, input, and reviews by the interagency Barred Owl Work Group (organizations listed below), established pursuant to 16 U.S.C. 1533(f)(2) to assist in implementing recovery plan actions.

Bureau of Land Management
California Department of Fish and Game
Green Diamond Resource Company
Hancock Forest Management
National Audubon Society, Seattle Chapter
National Council for Air and Stream Improvement
Oregon Department of Fish and Wildlife
Oregon Department of Forestry
Oregon State University
Plum Creek Timber Company
Raedeke Associates, Inc.
The Campbell Group
U.S. Fish and Wildlife Service
U.S. Forest Service
Washington Department of Fish and Wildlife
Weyerhaeuser Company

2.0 COORDINATION AND SHARING OF INFORMATION

Spotted owl survey crews, consultants, and their clients are strongly encouraged to coordinate with others doing similar surveys in nearby areas, during all phases of the survey effort. Appropriate coordination involves:

- pre-season planning, including coordination of commitments by adjacent land managers on the areas to be surveyed by each party in the event that multiple parties are working in the same landscape; this limits unnecessary calling of owls and is a cost-savings for landowners;
- immediate communication of results, positive or negative, that may affect other land managers or regulatory actions; and
- exchange of post-survey season information summaries.

Common inefficiencies, such as overlapping or excessive known spotted owl site visits by more than one survey group, can be avoided through coordinated pre-planning. It is also advisable to inform adjacent land managers of all surveys near their ownership because new survey results may affect their management activities.

To enhance coordination efforts, the Service, through its local field offices, will participate in and, if needed, initiate pre-survey coordination meetings. The purpose of the meetings will be to:

- allow representatives from land management agencies and organizations conducting surveys to share information on the approximate extent of planned survey areas,
- look for ways to reduce potential survey overlap to avoid and minimize harassment of spotted owls,
- discuss opportunities for sharing information throughout the field season,
- provide discussion opportunities related to implementation of the survey protocol, and
- share information on techniques used in surveying spotted owls that will enhance the likelihood of obtaining responses.

The Service *strongly recommends* entities or their representatives conducting spotted owl surveys attend these coordination meetings. Local meeting coordinators should distribute information related to these meetings prior to the breeding season to federal, state, tribal and private landowner organizations. The Service also recommends that both federal and non-federal entities conducting spotted owl surveys provide frequent updates of new data to the state and federal agencies responsible for maintaining spotted owl databases as the information informs evaluation of potential impacts to spotted owls from forest management practices. In addition, the Service recommends that barred owl data also be reported to appropriate state and federal database managers.

3.0 ESTABLISHING THE AREA TO BE SURVEYED

Prior to doing any field survey, the appropriate area to be surveyed should be identified from maps, aerial photos, GIS, or other resources.

3.1 Identifying the Project Area

The first step in conducting surveys for spotted owls is to identify the *PROJECT AREA*[1]. This area includes all lands delineated for the proposed project that may be subject to activities potentially impacting spotted owls through habitat modification, direct injury, noise disturbance, or any other means. For the purposes of this protocol, the project area is the polygon (or multiple polygons) that forms the footprint of the proposed project. Examples of project areas include timber harvest units, prescribed fire areas, disposal sites, road rights-of-way, etc. (Figure 1.).

3.2 Delineating the Survey Area

Once the project area is determined, the *SURVEY AREA* can be established and mapped. The survey area is defined as the area extending one provincial median annual home range radius from the perimeter of the project area for projects that will remove or modify nesting, roosting, or foraging habitat (see Section 9.0 for guidelines for disturbance-only projects). Table 1 indicates appropriate home range radii to use for projects within each physiographic Province. Figure 1 provides a hypothetical example of a survey area established around a multi-unit project area, based on a provincial home range radius area established surrounding the multiple project units.

Table 1. Provincial survey radius to apply when determining the survey area around proposed projects that may impact northern spotted owls, by Physiographic Province[2].

Physiographic Province	Provincial Survey Radius (mi.)
Olympic Peninsula	2.7
Washington Cascades	1.8
Oregon Coast Ranges	1.5
Oregon Klamath	1.3
Oregon Cascades	1.2
California Klamath	1.3
California Cascades	1.3
California Coast Range (Douglas-fir/mixed conifer zone	1.3
California Coast Range (redwood zone)[3]	0.7

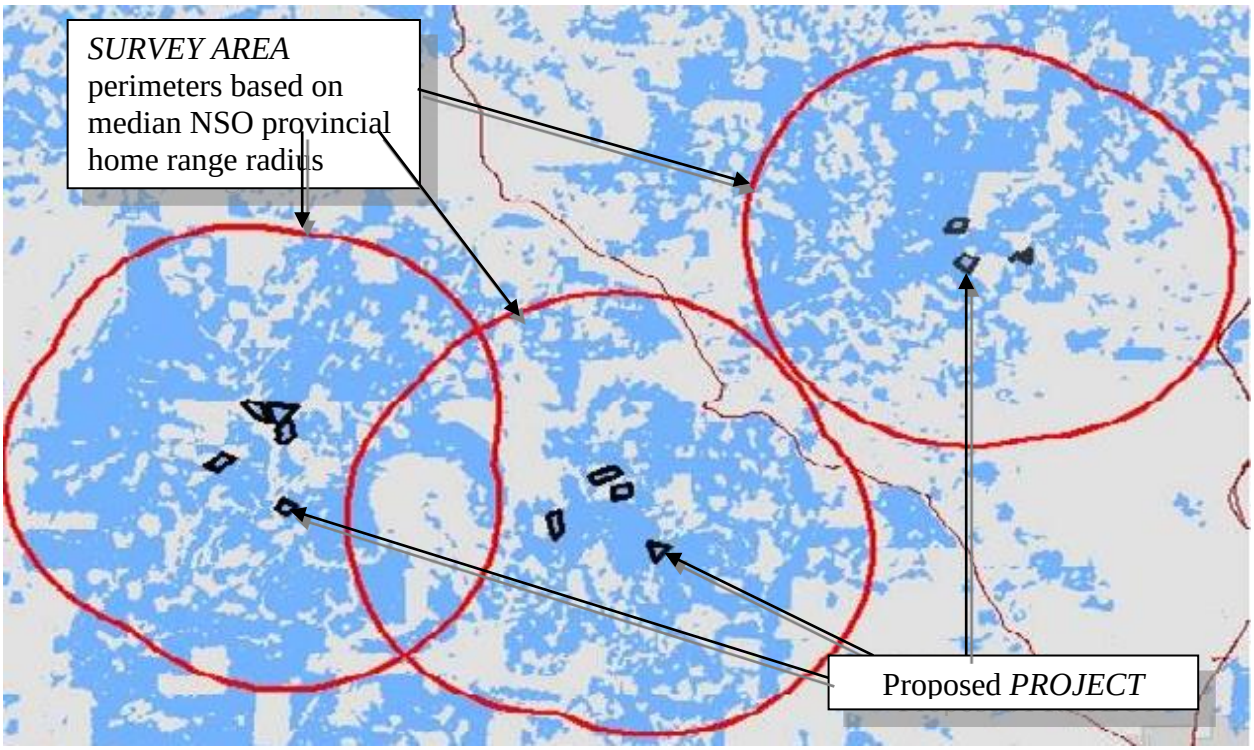
3.3 Habitat to Survey

For the purposes of this protocol, the *HABITAT TO SURVEY* includes any habitat within the survey area where protocol surveys may elicit a response from a resident owl or pair of owls (i.e., nesting, roosting, or foraging habitat). The survey effort need not include stands typically characterized as spotted owl dispersal habitat that does not normally function as

[1] Terms specific to this document appear in *ITALIC CAPITALS* in their first use, and are defined in the Glossary of Terms (Appendix 1). These terms appear in normal font in subsequent use in this document.
[2] Appendix 7 provides a map of the Physiographic Provinces.
[3] The Arcata Fish and Wildlife Office will provide further guidance delineating the "redwood zone"

nesting, roosting, or foraging habitat for territorial spotted owls. Descriptions of spotted owl habitat specific to various regions may be available from state wildlife or forestry agencies, or local Service Field Offices[4]. Habitat descriptions can also be found in these references: Thomas et al. 1990, Courtney et al. 2004, USDI Draft Revised 2010 Northern Spotted Owl Recovery Plan. Regulatory definitions may be of use where appropriate (e.g., definitions within state forest practices regulations; however, recognize that in some areas the Service does not support definitions of habitat used in current state forest practice regulations.) Surveyors should seek out this information from the appropriate regulatory agency prior to implementing surveys.

Figure 1. Hypothetical landscape with spotted owl habitat (darker color) and proposed project areas (project footprint) with the provincial median survey radius indicated by the three larger circular polygons.



4.0 SURVEY PERIOD

The *SURVEY PERIOD* is the time during which survey visits should occur to be counted toward meeting criteria for complete surveys (defined fully in section 11.0). For purposes of this protocol, the following survey periods are prescribed:

[4] Appendix 2 provides contact information for Fish and Wildlife Service Field Offices within the range of the northern spotted owl.

1. The *general* survey period throughout the range of the northern spotted owl is specified as March 15 through August 31. Forsman et al. (1984) indicate that courtship behavior usually begins in February or March, with the timing of nesting and fledging varying upon elevation and latitude. April 1 coincides with incubation in most areas (exceptions addressed below). Appendix 3 provides a generalized spotted owl breeding chronology.

2. In the Oregon and California Coast Ranges, local information suggests that spotted owls defend established territories as early as March 1. Therefore, in the Oregon Coast Range Province and California Coast Range Province, the survey period can be initiated on March 1, and survey conducted at that time (and otherwise consistent with this protocol) may be counted toward a complete survey. Please recognize that determinations for nesting and non-nesting status are to be conducted during specific periods of the survey season (Section 17.0). To maximize efficiency, occupancy and nesting status surveys should coincide.

3. Specific to the western Washington Cascades, the fledgling period can extend to September 15. Here, local information has shown that spotted owls return to their established territories later and defend their territory well into September (D. Herter pers. comm. and unpublished data October 2009; R. Pearson pers. comm. and unpublished data, November 2009). Therefore, within the Western Washington Cascades Province, surveys may continue as late as September 15 and count toward meeting a complete survey.

There may be cases where positive responses occur outside the above survey periods. These responses may provide important information, but will require closer evaluation to determine if the responses represent core use areas. Surveys outside the above dates do not count towards the number of visits required for completing the year's survey without seeking concurrence from the Service.

5.0 GENERAL SURVEY DESIGN

The intent of any survey is to obtain complete coverage of spotted owl habitat within the survey area, and in a manner in which spotted owls will be able to hear the surveyor and the surveyor will be able to hear responding owl vocalizations.

5.1 Calling Routes

Establish calling stations and survey routes to achieve complete coverage of all habitat within the survey area. Spacing of calling stations can be determined by the topography and acoustical characteristics (e.g., background noise such as creeks) of the area; stations are typically spaced between 0.25 and 0.5 mile apart. Surveyors should take advantage of prominent points within the survey area when establishing calling stations. Use of prominent points should not be at the cost of not being able to hear distant responding owls. Tips on

placing call stations to maximize acoustical coverage can be found on the Service's website (http://www.fws.gov/species/nso).

5.2 Known Spotted Owl Sites

Where *KNOWN SPOTTED OWL SITES* exist within the survey area, surveys should be initiated at the *ACTIVITY CENTER* (see section 8.0). Once the occupancy and/or reproductive status (per your management need) for the year is determined, spotted owl habitat within a 0.5 mile radius of the site center can be excluded from further surveying for the remainder of the season. Adjustments beyond the 0.5 mile area can be made to avoid unnecessary or excessive calling of spotted owls depending on topography. Rationale for this type of exception should be provided on field survey forms.

5.3 Survey Procedures

Both nighttime and daytime surveys are recommended. Research data indicate that nighttime calling remains an efficient way of detecting spotted owls. In addition, some recent research data along with professional opinion by research personnel suggest that strategic daytime surveys are also an effective way for locating spotted owls. Thus, this protocol advises the use of both under certain situations, as described in "Daytime Stand Searches" (see section 13.0) below. Three types of surveys are accepted: spot calling, continuous walking and calling, and leapfrog surveys. Each is described below. Spot calling is the recommended method. Whatever method you use, be sure you cover all spotted owl habitat within the survey area.

5.3.1 Nighttime Spot Calling

Set up a series of fixed calling points approximately 0.25 to 0.5 mile apart or as needed to account for local acoustical conditions, along road, trails and/or transects. When possible, pick prominent points which allow coverage of large areas. Spend at least 10 minutes at each point. Topography with prominent features (e.g., high ridges, road landings situated above large drainages, etc.) may lend itself to more effective coverage. Whatever the topographic situation, be sure that you have sufficient overlap in calling coverage from point to point, whereby you are able to hear responding owls and that all spotted owl habitat within the entire survey area is adequately covered.

5.3.2 Continuous Walking Surveys

Continuous walking surveys occur during the night or day and are utilized when nighttime spot calling from roads or trails cannot be accomplished. Walk the designated route playing the electronic caller and pause at prominent points and at regular intervals throughout the area to conduct informal stations that are at least 3 minutes in duration.

5.3.3 Leapfrog Surveys (Nighttime)

If two people are involved, you may use a leapfrog method along roads (see Forsman 1983).

5.4 Survey Components

Regardless of the procedures used above, implementation of the following components will meet the objectives of the protocol.

5.4.1 Qualifications of Crew Leaders and Surveyors

Information regarding the qualifications, training, and experience of surveyors and crew leaders is presented in Appendix 4.

5.4.2 Digital Wildlife Callers

As of 2011, the Service advises use of high quality digital callers with well recorded spotted owl calls, and **strongly discourages** human mimicking of spotted owls calls. Increasing evidence suggests that use of human mimicking calls has a lower response rate than do quality digital devices, resulting in territorial spotted owls not being detected despite a complete protocol survey. The use of the digital caller ensures more consistent and equitable calling methods. The amplified sound generally should be about as loud as a spotted owl, but must be audible to the distance of 0.25 – 0.5 mile depending on topography. While playing calls and listening for a response, surveyors must be stationed outside their vehicle. In areas of high densities of spotted owls (e.g., California coastal areas), over-amplification may confound survey results by eliciting simultaneous responses from spotted owls representing multiple territories.

1. ***Digital Callers.*** As policy, the Service cannot recommend or endorse a specific company or device for digital callers. Surveyors are encouraged to use digital callers with quality speakers and digital recordings of high fidelity, as these devices and recordings are more likely to elicit a spotted owl response. Quality devices may also prove to be cost-effective, by reducing the number of survey visits to detect spotted owls, as well as being more durable in typical field conditions. The Service encourages surveyors to seek out others in the surveying business for suggested devices.

2. ***Bionic Ears.*** Hearing enabling devices such as “bionic ears” should not be used, as these devices generally only “listen” in one direction and may impeded determining response locations.

5.4.3 Spotted Owl Calling Procedures

1. ***Calling Methods and Sequencing.*** Start the caller and let it run for 3-4 complete calls, listen for 1 to 2 minutes, then play another set of calls. A recommended call sequence includes: standard 4-note hoot, barking calls, contact whistle both normal and agitated, and agitated call (also referred to as the monkey call). Use both male and female examples of all these calls as available but use of calls from both sexes is best. Recorded spotted owl calls can be downloaded from the following website: www.fws.gov/species/nso. These same calls may come with commercial calling devices.

2. ***Call Variation.*** When conducting the daytime stand searches or activity center searches, use a variety of calls, with some emphasis on the female whistle. Do not

broadcast loudly and do not use agitated or barking calls near a potentially active nest – this could agitate the female more than necessary or draw females off the nest.

3. ***Varying Call Patterns Between Visits.*** If several visits to the area have used the same set of spotted owl calls, the surveyor should consider switching to a different set of calls/recordings of a different individual that had not been used previously at the site or survey area (http://www.fws.gov/species/nso). This "new" spotted owl may elicit a stronger reaction (e.g., because it is considered a "stranger" rather than a known "neighbor") from a resident but relatively non-vocal spotted owl. It is recommended that surveyors always hold in reserve such calls until late in the survey, as they may be more effective at eliciting a response if the owl has become habituated to the calls earlier in the season. **Optional:** If spotted owls have not been detected in visits 1-4, use barred owl calls for five minutes following the 10-minute calling period on visits 5 and 6. Please note these efforts on your field forms.

4. ***Duration of Calling Effort.*** Continue this process for at least 10 minutes at each calling station. **Discontinue calling once a spotted owl responds.** Allow the spotted owl to respond and listen for the remainder of the 10 minutes to determine if there is more than one spotted owl. See section 14.0 RECORDING DATA for recommendations on recording data and triangulation procedure. Prompt triangulation should occur soon after the first owl starts responding.

5. ***Daily Timing of Surveys.*** Conduct night surveys between official apparent sunset and sunrise (see the NOAA website for area and times: http://www.srrb.noaa.gov/highlights/sunrise/sunrise.html).
Be sure not to call the same section of a survey route at the same time on each survey effort, that is, vary the time you start and the section of the route from which you start.

6. ***Acceptable Weather Conditions.*** Do not survey under inclement weather conditions, such as high wind speed (e.g. > 15 mph), rain, heavy fog, or at high noise levels which would prevent hearing of responses (e.g., stream noise, continuous tree drip after a rain event, machine noise, etc.). If weather conditions or noise levels are in doubt, be conservative. Consider placing call stations away from streams to reduce noise interference. Surveys conducted under marginal conditions will reduce quality of the overall survey effort. Negative results collected under inclement weather conditions may not be adequate for evaluating spotted owl presence/absence. Generally, surveys should be conducted under conditions described as a gentle breeze (wind speed 8-11 mph, or less. Under such conditions, flags may extend, and leaves move. As wind levels reach >12mph (small branches move, dust begins to blow) conditions are not acceptable as background sound level substantially reduces ability of the owl to hear the caller, and vice versa. For additional information, see:

http://www.unc.edu/~rowlett/units/scales/beaufort.html.

7. ***Systematically survey all spotted owl habitat*** within each survey area until an owl responds or if no response is heard, until the recommended number of survey visits have been completed.

8. ***Characterize and document behavioral observations.*** Make note of agitated calls, continuous responses, movement (toward or away the calling stations), or situations such as when one response is received and the owl is quiet thereafter. Recording this type of information may assist with the identification of activity centers.

5.5 Complete Visits

The objective of a complete visit is to conduct a thorough survey of the entire area in one field outing; however, in some cases this may not be possible. A complete visit may be a combination of day and night surveys and may include a daytime *FOLLOW-UP* OUTING. If reasonable effort was made to cover the survey area in one outing, but this was not accomplished, then the remaining unsurveyed area should be surveyed as soon as possible but within 7 days for the entire survey area. To reduce the chance of spotted owls moving between portions of the Survey Area and not being detected, complete the visit on consecutive days as much as possible. The entire area should be covered within 7 days to be considered one complete visit.

1. ***Subdividing Survey Areas.*** If the project area is too large to be surveyed in 7 days, it should be divided into smaller areas based on habitat distribution, topography, road networks, and/or drainages. Survey areas need to be small enough to be completely surveyed within the specified time period.

2. ***Daytime Follow-up to a Spotted Owl or Unidentified Strix.*** If a surveyor detects a spotted owl or unidentified *Strix* species (including owls that fly-in without calling) at night and conducts a daytime follow-up, the combination of the night outing and the daytime follow-up would be counted toward one complete visit. If a surveyor does not obtain a response during a survey, a daytime follow-up would not be necessary. In that case, the night outing alone would be considered as one complete visit provided all remaining spotted owl habitat within the Survey Area has been called (See section 6.0 for Follow-up visits).

3. ***Temporal Spacing of Visits.*** Complete visits must be spaced at least 7 calendar days apart. For example, assume a complete visit ends May 1. Using a proper 7 day spacing, the next possible visit date would be begun on May 8.

4. ***Three Visits by June 30.*** At least 3 of the complete visits should be conducted before 30 June; this includes at least one visit in April, one in May and one in June. Ideally, the survey effort should be spread out over the entire survey season. Concentrating surveys too early or late in the survey season may result in inaccurate conclusions for the survey area.

5. ***Documenting Unavoidable Operational Conditions.*** Where survey seasons or individual visits are restricted due to snow, landslides, mandatory road closure, or other unavoidable operational and access conditions, the survey period may be adjusted to accommodate such restrictions; documentation should be provided to explain the causes of the modified survey period.

6. ***Safety and Night Surveys.*** Surveys may be conducted during the day where there are no roads or foot trails to traverse at night, or where there are other safety concerns. Documentation should be provided for specific safety concerns as to why night surveys could not be conducted. Note: while the protocol provides some flexibility to account for field conditions, it is recommended that adequacy of survey effort be discussed with the appropriate regulatory office.

7. ***Number of Complete Visits.*** To meet the objectives of this protocol, 2-year surveys with 6 complete visits per year are required to determine the presence or absence of spotted owls.

5.6 Additional Visits

If a single spotted owl responds, and after 6 complete visits resident status has not been determined, then up to 2 additional visits may be necessary in that year. Additional visits are visits conducted beyond six complete visits and are conducted only in the general area of the response (a 0.5-mile radius around the detection location). If resident status is determined at any point during the additional visits, no more visits to that particular site are required that year.

For additional visits, maintain the standards (timing, temporal spacing of visits, weather condition limitations, etc.) outlined elsewhere in this document. If additional visits cannot be completed prior to the end of the survey season (while still maintaining intervals required between visits), they may be conducted as soon as necessary to stay within the normal survey season, or up to as late as September 30.

If the last response occurs on:

- Visits 1 through 4 - no additional visits are required
- Visit 5 - conduct 1 additional visit
- Visit 6 - conduct 2 additional visits

6.0 FOLLOW-UP OUTINGS

The objective of the daytime follow-up outing is to locate spotted owls by conducting an intensive daytime search of spotted owl habitat within the general vicinity (approximately a 0.5-mile radius) of the response location that prompted the follow-up. Daytime locations are very important in determining key nesting and roosting sites, which in turn provides more precise information for management. All spotted owl and barred owl detections should be recorded to the Township, Range, Section, 1/4 and 1/16, and appropriate UTM datum when possible. Daytime follow-up surveys consist of both active calling with a digital device and visual

searching.

A review of aerial photos is suggested to assist surveyors in identifying the available habitat in which to focus a search. *Searches should start as close as possible to the owl's mapped response.* Surveys may begin from the road closest to the response area. If owls do not respond to vocalizations given from road survey stations nearest the detection, surveyors should conduct daytime stand searches throughout the 0.5 mile area around the detection. This may take several hours, depending on the terrain. *Do not conduct your follow-up entirely from the road* – spotted owls may be using a patch of habitat at a distance from the road and may not respond unless surveyors are close in proximity. Observers should watch for owls approaching without responding and other evidence of occupancy, such as pellets, whitewash, and molted feathers. Pellets, whitewash, or feathers alone may not be sufficient to document spotted owl presence or residency. Mobbing jays and other birds may alert the observer to the presence of a spotted owl or other *Strix* species. The follow-up should be completed as soon as possible after presence was detected, as owls are more apt to be located near the previous night's location. A daytime follow-up is the second part of a complete visit if a spotted owl is detected. The follow-up route must be delineated on a map and accompanying outing form and should include the start, end, and total survey time.

Do not hoot any more than is necessary; hoot only as much as needed to identify *Strix* species and determine status. Excessive surveyor vocalization may modify spotted owl behavior and stimulate them to move around more than is typical and possibly increase their risk of predation. Excessive calling near a nest site may cause harassment by bringing the female off the nest. Limit the use of calling, in particular higher stress calls, when calling near a known nest site. Soft contact whistles and "mouse squeaks" sometimes works to elicit responses near nests.

7.0 WHEN BARRED OWLS or *STRIX* UNKNOWN SPECIES ARE DETECTED

Because barred owls now completely overlap the distribution of northern spotted owls in Oregon and Washington and substantially overlap the species in California, and have reduced detection rates (response behavior) of spotted owls, it is important to properly ascertain the species of *Strix* owls detected, either visually or auditory, during the survey.

7.1 When Barred Owls Are Detected

If a barred owl is heard or seen:

1. Continue to call for spotted owls for the entire 10-minute period, or until a spotted owl responds,

2. If a spotted owl responds and the barred owl is in close proximity and/or acting aggressively toward the responding spotted owl, **discontinue calling at that station immediately**. Continue to listen at that station for at least the entire 10-minute period so that any spotted owl or additional barred owl responses will be heard and recorded. Complete the rest of the survey beyond hearing distance to continue calling the route (generally at least 0.5 mi.). This guidance applies to other owls and raptors *that may*

be acting aggressively toward (or represent a capable predator of) spotted owls.

7.2 When *Strix* Unknown Species Are Detected

If a *Strix* Unknown Species is heard or seen:

1. Continue to call using spotted owl calls for the entire 10-minute duration, or until the spotted owl or barred owl identification is confirmed.

2. Wait silently for 5 additional minutes after the 10-minute calling period while listening and watching for owls.

3. If the unidentified *Strix* owl detections cannot be identified to species by spending extra time at the station where it was originally detected, a follow-up should be conducted to increase the probability of identifying which species is present.

4. If follow ups are unsuccessful in establishing the species identity of the owl, additional visits should be conducted. The same procedures as used to determine resident status should be used; up to two additional visits should be conducted (see section 5.6 Additional Visits).

5. If all parameters of the protocol are met and the *Strix* species detection is either attributed to a barred owl or remains uncertain, do not "guess" on the species determinations without reasonably confident visual or audio information; simply record the species as Strix unknown. All field observations need to be well documented so that all information associated with the survey can be taken into consideration during technical assistance or consultations with the state and federal regulatory agencies.

8.0 ACTIVITY CENTER SEARCHES WITHIN SURVEY AREA[5]

Objective: *To search habitat and locate spotted owls in known core areas used in previous years for nesting and roosting.*

A minimum of one daytime stand search "Activity Center Search" is to be completed for each activity center within the survey area, each year, as a component of the 2-year survey. This is important because spotted owls commonly utilize the same, or nearby nest and roost stands year after year and searching the activity center and core use area during the day may increase the likelihood of detecting a spotted owl. Research has shown that this is still the case for some spotted owls even with barred owls present.

Use aerial photographs and delineate stands of spotted owl habitat with the likelihood of containing nesting and roosting owls within 0.5 mile of the activity center to focus a thorough visual and auditory search of the identified stands. Similar to follow-up surveys, these searches may take up to several hours to thoroughly search the habitat. In conducting these surveys, the

[5] Please see Glossary (Appendix 1) for definitions of "known/historical" sites.

broadcast calling will be at a lower volume than used for nighttime station calling (approximating the volume of an actual spotted owl hoot). Avoid the heat of the day to increase the chances of finding spotted owls. During the daytime search, be sure to look for incidental signs of whitewash, pellets, and feathers indicating potential presence of spotted owls. Also, keep your eyes to the forest canopy because owls may fly in to the surveyor without responding. Investigate jays or other birds giving scolding calls because they often mob roosting owls.

These daytime searches to known spotted owl sites ("Activity Center Search") should be conducted as part of the initial visit to the survey area (generally late March or early April), prior to the initiation of nighttime routes. If it is possible to locate resident spotted owls without doing station visits, time and effort may be saved because portions of the survey area within hearing distance of that known spotted owl site (generally 0.5-mile radius) can be omitted from surveys to avoid unnecessarily interacting with those owls. If the pair or resident single is located, record the location and go to Section 17, Determining Reproductive Success, if this level of information is needed.

This search area may be included as part a complete visit if the daytime search is conducted during the seven days required for a complete visit (Ex: if daytime stand search occurs within the 0.5 mile area on visit one, nighttime calling of that same habitat will not be necessary for that visit). Please note that on subsequent visits, nighttime calling of this 0.5 mile circle should be included in the overall survey area for the remainder of the complete visits if owls were not detected during the Activity Center Search.

IF Activity Center Searches are being conducted to locate NSOs adjacent to project activities and determine nesting status for projects operating in the breeding season of years 3 and 4, follow methodology for determining nesting status (this may include more than one visit).

9.0 SURVEYS FOR DISTURBANCE-ONLY PROJECTS

Activities that do not modify spotted owl habitat but will result in disturbance to spotted owls usually represent short-term effects compared to the long-term effects of habitat modification, especially when such projects are limited to one season. Therefore, a one-year six visit survey can apply to smoke or noise-disturbance only actions. Six visits that cover all spotted owl habitat within 0.25 mile from the project area will be effective until the beginning of the following breeding season. If operations are not completed by year two, three spot check survey visits each year should occur in years two and three OR project proponents can choose to utilize the 2-year, six visit survey protocol. Field forms should indicate that these are disturbance-only projects.

10.0 SPOT CHECK SURVEYS

With the invasion of the barred owl, spotted owls have shown increasing tendency to move from established, activity centers and establish, or attempt to establish, alternate activity centers or core use areas to avoid agonistic encounters with barred owls. Spotted owls establish activity centers in stands that have not previously been documented more frequently than typically

occurred prior to the barred owl invasion. Because of this movement, there is an increased risk that spotted owls may establish activity centers and core use areas within or near project areas subsequent to completion of protocol surveys. If gone undetected, spotted owls at these new site centers are at risk of direct harm, injury, or harassment from project activities that result in direct physical modification (e.g., tree felling, prescribed fire, cable yarding, helicopter downdraft, etc.) or biological modification (e.g., noise exceeding ambient conditions).

The 2-year, 6-visits per year, surveys establish a reasonably high likelihood of detecting spotted owls in occupied activity centers within the survey area. However, the Service believes it prudent that project proponents to do *SPOT CHECK SURVEYS* of the project area and immediate vicinity (i.e., within 0.25 mile) prior to conducting activities in years 3 and 4. Spot checks are prescribed to detect spotted owls that may have moved into the project area subsequent to completion of general surveys. A new site center could be established in the project area by (a) known territorial individuals within the survey area; (b) undetected spotted owls from known sites within the survey area; or (c) dispersing juveniles, floaters, or territorial spotted owls displaced from outside the survey area. These factors, plus the history of barred owl detections in the survey area, are taken into account when determining the need for spot checks. Spot checks are intended to supplement the general project-level surveys and avoid the potential direct take of spotted owls from project implementation.

Adjustments to project timing or other project modifications may be required under some circumstances where spotted owls initiate breeding activities within or immediately adjacent to a project area (See 10.3 below).

10.1 Design of Spot Check Surveys

Spot check surveys include the following components:

1. Spot checks supplement the full 2-year, 6 visits-per-year protocol surveys and are conducted during years 3 and/or 4 of the survey cycle.

2. Spot check surveys will cover all spotted owl habitat within the project footprint and within 0.25 mile of the project footprint (hereafter referred to as the *SPOT CHECK AREA*).

3. Spot check surveys consist of three nighttime surveys spaced a minimum of 7 days apart.

4. Spot checks may begin on the appropriate Survey Period date for the physiographic province (see section 4.0), and should be completed prior to or concurrent with project activities (see conditions described in10.2.2. below) on or before April 15, or as soon as feasible during the early portion of the breeding season (See Appendix 4) if there are conditions of limited accessibility, such as due to snow or seasonal road closures. If spot checks cannot be completed by April 15, reasons for delayed completion should be documented in the survey record.

5. Should the project continue into the year 4 breeding season, spot checks should be repeated, with similar consideration of spotted owl nesting status and consideration of take avoidance measures.

6. Any detection of spotted owls during a spot check survey should be followed up as soon as possible, but not later than 7 days after the nighttime detection, by a daytime follow-up visit to confirm the location and status of detected owls.

10.2 Circumstances Establishing the Need for Spot Checks.

Not all projects need spot check surveys. The surveyor should apply the circumstance that best describes actual history of known spotted owl sites and survey data for the project and survey area, as described below. Figure 2 provides a flow chart to assist in determining cases where spot checks are needed.

10.2.1 Circumstances Precluding the Need to Conduct Spot Check Surveys

For project areas meeting ***ALL*** of the following conditions, the likelihood of territorial spotted owls occupying the project area is discountable. The action may occur in years 3 and 4 without additional surveys.

1. No resident single owls, territorial owl pairs, or pairs/two owls of unknown status are detected during protocol survey visits, including any additional visits, in the survey area (i.e., survey area not occupied by a territorial pair or single detected during year 1 and/or year 2 surveys); and

2. No activity centers are known to occur in the survey area; and

3. No barred owls are detected in the survey area during protocol surveys or are otherwise known to occur in the survey area; and

4. All spotted owl habitat within the survey area has been **completely** covered during protocol surveys (i.e. there is no habitat that was omitted due to inaccessibility, landowner restrictions, incomplete surveys, or other constraints).

10.2.2 Situations Where Spot Checks Are Necessary

The following bullets describe situations when spot check surveys **are** necessary. The project proponent should complete spot checks and schedule/implement projects as appropriate:

1. If no resident single owls, territorial owl pairs, or pairs/two owls of unknown status are detected within the survey area (project footprint plus one home range for projects that will modify habitat; 0.25 mile footprint for disturbance-only surveys) during year 1 or 2 of protocol surveys, and no known spotted owl sites are known from the survey area, BUT barred owls are known to occur within the survey area (through project surveys or other scientifically credible methods), spot checks are necessary. In this case, projects may be initiated during the breeding season (or

continue if ongoing) concurrent with spot checks.

2. If no resident single owls, territorial owl pairs, or pairs/two owls of unknown status are detected within the survey area during year 1 or 2 protocol surveys, but known spotted owl sites are known to occur in the survey area, spot checks are necessary. In this case, projects may be initiated during the breeding season (or continue if ongoing) concurrent with spot checks.

3. If no resident single owls, territorial owl pairs, or pairs/two owls of unknown status are detected within the survey area during year 1 or 2 protocol surveys, and no known spotted owl sites are known to occur in the survey area, BUT portions of spotted owl habitat within the survey area is unsurveyed during protocol surveys due to inaccessibility, landowner restrictions, or other constraints, spot checks are necessary. Under these circumstances, spot checks must be completed prior to operations occurring after February 1.

4. If resident single owls, territorial owl pairs, or pairs/two owls of unknown status are detected within the survey area during years 1 and/or 2 protocol surveys, spot checks are necessary. Under these circumstances, spot checks must be completed prior to operations occurring after February 1**.**

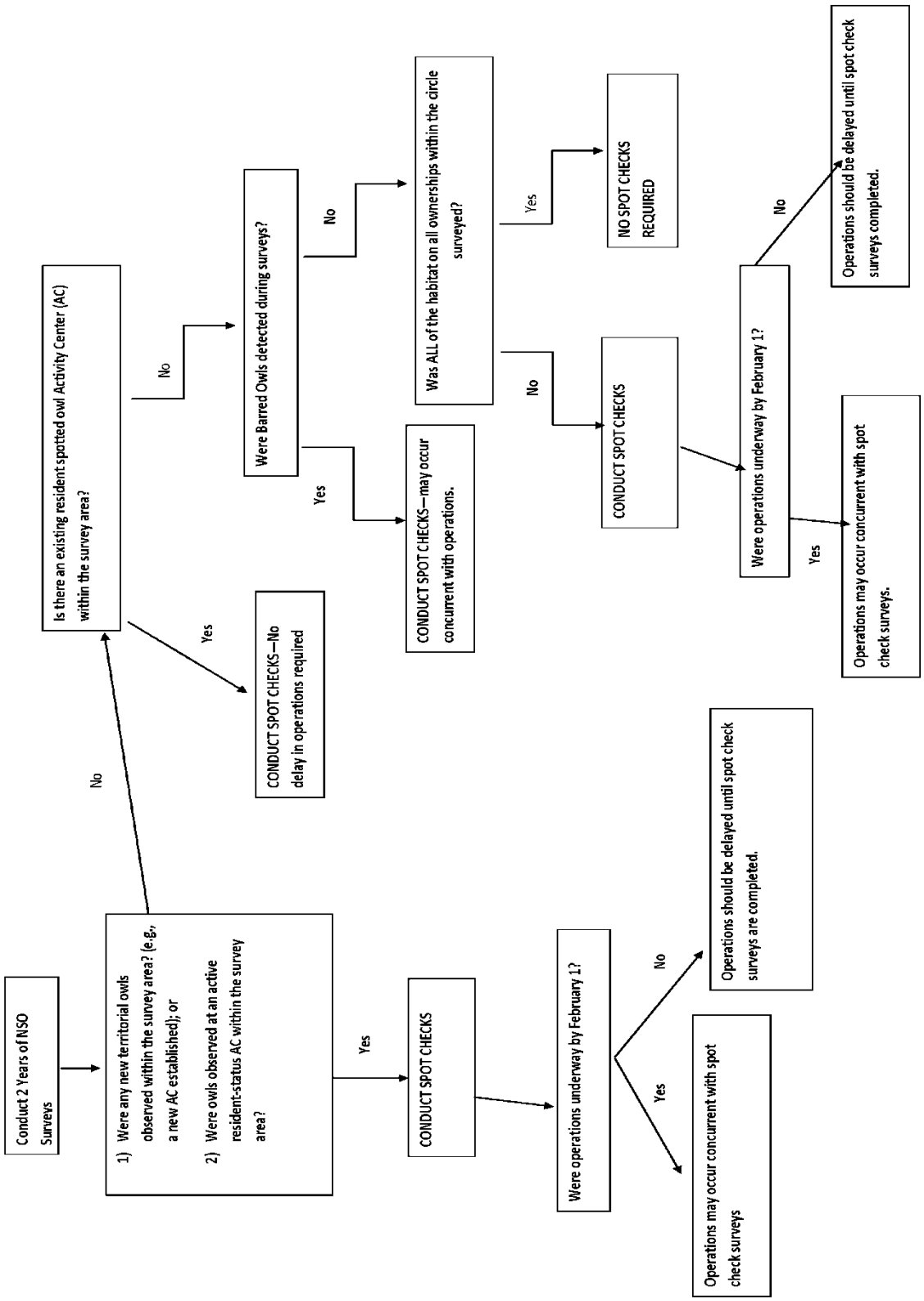
10.3 If Spotted Owls Are Detected in the Spot Check Area

If spotted owls are detected in the spot check area, ALL ongoing operations that have a likelihood of direct harm to a spotted owl and/or creating above-ambient noise shall be postponed. Conduct follow-up outings to determine location and pair/nesting status, as described in Section 16.0-17.0 of this document. Location data should be reviewed by the appropriate regulatory office to ensure that appropriate protection measures that avoid incidental take are implemented.

10.4 If Spotted Owls Are Not Detected in the Spot Check Area

If spotted owls are not detected, the project may continue through that breeding season. Should the project continue into the following breeding season, spot checks should be repeated.

Figure 2. Flow Chart to determine when spot check surveys are required.



11.0 COMPLETE SURVEY

A COMPLETE SURVEY includes:

- Two years of six visits per year, including activity center searches, and, if appropriate;
- Spot Checks and activity center searches, as described in section 10.0 and 8.0 respectively.

12.0 DURATION AND EXPIRATION OF SURVEYS

Based on the data analyzed and professional opinion, 2-year surveys are expected to provide more accurate results for a survey area because of annual variation in occupancy and detection probabilities between years across most of the range of the spotted owl. As described above, two years of spot checks may be necessary in years 3 and 4 depending on the results of two years of survey. If spot checks have not been completed, full protocol surveys are recommended beginning in year 5. If spot checks have been completed in years 3 and 4, technical assistance with appropriate regulatory agency will be required to evaluate scope of remaining harvest and appropriate survey needs in year 5 for remaining harvest areas.

13.0 DAYTIME STAND SEARCHES (OPTIONAL)

Objective: *To search habitats most likely to contain roosting or nesting spotted owls.* Optional daytime stand searches are intended to provide an extra level of assurance that non-responsive spotted owls are not residing in a project area by searching nesting/roosting habitat within the project area using methodologies used for follow-up surveys. Examples of situations when daytime stands searches might be warranted include projects near known activity centers without recent verified owl use, projects near activity centers that have been taken over by barred owls, or project areas proposed in high-quality nesting or roosting habitat.

14.0 RECORDING DATA

For each visit, whether results are positive or negative, record the following information on the survey form:

- Brief description of survey route, with accompanying topographic map of route.
- Survey start and stop time at stations (total amount of time spent calling) and total time of survey if calling between stations.
- Weather conditions (including estimated wind speed and precipitation). Note stop and restart times if weather during your survey momentarily exceeds recommended conditions.
- Clearly document areas of overlap on survey area maps indicating years of surveys for each area.

If raptors are detected during a survey, all sightings or responses by spotted owls, barred owls, spotted-barred owl hybrids, great horned owls, northern goshawks, or any other large raptor species should be recorded. The presence of barred owls, great horned owls, goshawks, or other large raptors may affect spotted owl responses.

Note on map and on data form (both should have survey date recorded):

- Compass bearing and approximate distance to spotted owl or other raptor;
- Sex and age if known (adult and subadult spotted owls cannot be distinguished based solely on vocals);
- Time of first response;
- Type of detection (e.g., audio, visual or both). For multiple or moving owls, map and list information and number of each response or observation. This will allow for more accurate determination of activity centers.

Estimate and indicate on a map the bird's original and final location. One method is to triangulate on the location from which the owl's call originated, taking compass bearings from 2-3 identifiable positions (e.g., at road junctions; or record GPS coordinates at each triangulation point) along the road or trail. Make sure compass bearings are taken in as short a time-frame as possible and recorded on the survey form. Do not force the spotted owl to call again if bearings cannot be completed before the spotted owl stops calling. Simply use the best compass bearing(s) you have. The intent of the triangulation and mapping is to provide a means to find the location in a subsequent survey effort (e.g., follow-up; see below). Triangulation efforts should begin soon after the owl's first response.

Once a spotted owl responds at night, discontinue calling at the station, but keep listening for the remainder of the station visit; consider listening for a few minutes beyond the 10 minutes to ascertain if other owls are present. Once the station visit at which the detection was obtained has been completed, continue to survey the remainder of the survey route. However, to avoid 'leading' a spotted owl across the survey area through continued calling nearby, we recommend that once an owl responds, the surveyor should go to other parts of the survey route and complete the rest of the survey visit, omitting the area within 0.5 mile around the detection location. If that is not practical, survey only the remaining points that are *beyond hearing distance of the responding bird*. The range of hearing distance is generally any distance beyond a ridge or about 0.5 mile straight-line distance from the owl. Completing the route will provide an opportunity to detect other owls that may be present.

If no response is heard, proceed to the next calling point. Continue until the survey area is completely covered.

If a spotted owl (or an unidentified *Strix* owl) is detected during the survey, return to the area during the day as soon as possible (preferably within 48 hours) and conduct a follow-up outing to verify status as needed, unless reproductive status has already been determined. Diurnal surveys should be interrupted to accomplish the follow-up immediately after the detection.

15.0 MOUSING

The purpose of mousing is to determine if spotted owls are nesting and reproducing. By offering one or more mice to spotted owls, their nesting status can be determined based on the behavior of the adult. Mousing will also be used to locate nests (and brooding females) by inducing the male to lead the surveyor to the nest tree and, later in the nesting season, can be used to locate and count young recently out of the nest. Mousing consists of the following steps.

1. Locate one or both members of a pair during the day and offer to them at least two mice or other small prey items.

2. Once the owl(s) take prey, or are found with natural prey, record the 'fate' of each prey item (e.g., eaten, cached, given to female or young) along with the sex of the owl that captured the prey. The fate of the prey is used to classify nesting status.

3. If the owl eats the prey item, continue to offer additional prey items until the owl caches the prey, sits on it for an extended period of time (30-60 minutes), refuses to take additional prey, or carries the prey away. If the bird flies with the prey, follow and try to determine the final disposition of the prey. For more details on mousing procedures, see Forsman (1983) Methods and Materials for Locating and Studying Spotted Owls. USDA Forest Service, Gen. Tech Rept. PNW-162.

4. Field personnel should make a concerted effort to get the owl(s) to take mice. Be creative in placing a mouse where the owl can easily see and capture it and offer mice to the mate of an owl that has refused mice on that visit. A long pole or stick can be used to place mice higher in a tree where an owl may more likely take it.

The known spotted owl site will be classified as nesting, non-nesting, or unknown nesting status (see section17. Determining Nesting & Reproductive Status) based on your observations.

16.0. DETERMINING ACTIVITY CENTER STATUS

Depending on the use for which the survey data will be applied, determining the occupancy/reproductive status of sites may be necessary. This section provides guidance on the appropriate techniques to collect necessary information, and in correctly interpreting that information, to make the relevant determination. Verify the activity center status according to the following definitions (status visits can be day or night). The definitions may be somewhat different from the status definitions outlined in the density/demography survey guidelines, due to the different objectives of the guidelines for surveying proposed management activities.

16.1 Determining Resident/Territorial Spotted Owl Pairs or Singles

The following subsections for determining if an activity center is occupied by a territorial pair, and pair with status unknown, a resident single, or status unknown.

16.1.1 Territorial Pair Status.

Any one of the following criteria establishes *TERRITORIAL PAIR* status:

1. A male and female are heard and/or observed (either initially or through their movement) in close proximity (< ¼ mile apart) to each other on the same visit; or
2. A male takes a mouse to a female (see "mousing" clarification under section 15.0 or REPRODUCTIVE SUCCESS SURVEYS 17.5); or
3. A female is detected (seen or heard) on a nest; or
4. One or both adults are observed with young; or
5. Young identifiable based on plumage characteristics observed late in the season by knowledgeable surveyors or young identifiable based on molecular data.

16.1.2 Two Birds/Pair Status Unknown.

The presence or response of 2 birds of the opposite sex where pair status cannot be determined and where at least 1 of the owls meets the resident single requirements establishes *TWO BIRDS, PAIR STATUS UNKNOWN*.

16.1.3 Resident Single Status

RESIDENT SINGLE STATUS is established by any one of the following criteria:

1. The presence or response of a single owl within the same general area on 3 or more occasions within the breeding season, with no response by an owl of the opposite sex after a complete survey; or
2. Multiple responses over several years (e.g., 2 responses in year 1 and 1 response in year 2) from the same general area.

A resident single may represent a succession of single owls of either sex within the same general area in a single or multiple years. Determining if the responses occur within the same general area should be based on topography and the location of any other owls known for the surrounding area. This should be determined by the wildlife biologist for the particular area.

16.1.4 Status Unknown

STATUS UNKNOWN is the appropriate determination, following a complete survey, whenever the response of a male and/or female does not meet any of the above site status definitions.

17.0 DETERMINING NESTING & REPRODUCTIVE STATUS

Reproductive surveys are usually conducted to determine if breeding season restrictions intended to protect nesting owls can be lifted.

Reproduction surveys include two stages: nesting status and reproductive success. The following is the recommended protocol for determining reproductive status of spotted owls. Reproduction surveys may provide information on nest tree locations which provide the most relevant management (activity) center locations.

17.1 Nesting Status Surveys

Nesting Status Surveys should be done whenever it is necessary to determine if spotted owl may be nesting. The following criteria determine appropriate timing and procedures for conducting such surveys:

1. Conduct nesting status surveys between 1 April and 1 June. The start date is based on nest initiation dates. If local data suggests a different date for nest initiation, adjust the start date accordingly. Young identified after 1 June would still confirm nesting.

2. Spread the surveys throughout the months of April and May. Avoid collecting all nesting status surveys early in the breeding season.

3. Use a standard "mousing" procedure as described above to determine nesting status. However, do not mouse birds any more than is necessary to determine nesting status. Stimulating the owl to move around excessively during the day, may increase their risk of predation. Similarly, excessive calling near a nest site may cause harassment and endanger eggs or young by bringing the female off the nest. Also, do not cause owls to unnecessarily become more habituated to humans by using more mice than necessary.

4. Two observations, at least one week apart, are required to determine nesting status if the first observation occurs before 1 May. This is necessary because the owls may show signs of initiating nesting early in the season without actually laying eggs and their behavior could easily be mistaken for nesting behavior. After 1 May, a single observation is sufficient.

17.2 Determining Nesting Status

Nesting is confirmed if, on 2 visits before 1 May, or 1 visit after 1 May, any of the following conditions are observed:

1. The female is detected (seen) on the nest; or

2. Either member of a pair carries natural or observer-provided prey to the nest; or

3. A female possesses a brood patch when examined in hand during mid-April to mid-June (only one observation is required). Dates may vary with the particular areas. Be careful not to confuse the normal small area of bare skin (i.e., apteria) on the abdomen with the much larger brood patch. A fully developed brood patch covers most of the lower abdomen, extending to the base of the wings. Describe the brood patch on the field form. including length, width, color, and texture of the skin, and any evidence of regenerating feathers around the edge (NOTE - while a scientific research permit is not required by the Service for calling spotted owls, any capture or handling of spotted owls requires such a permit); or

4. Young identifiable as spotted owls or young detected in the presence of one or both adults.

17.3 Non-Nesting Status

The activity center is classified as non-nesting if any of the following are observed. Again, *except for brood patch information*, two observations are required during the nest survey period (April 1-June 1), with at least 3 weeks separating these observations to ensure that late nesting attempts are not missed. The second observation should occur after 1 May. Because nesting attempts may fail before surveys are conducted, the non-nesting status includes owls that did not attempt to nest as well as those that have failed. Non-nesting is inferred if any of the following conditions is met:

1. The female is observed roosting and away from the nest for at least 60 minutes on two occasions, more than 3 weeks apart between 1 April and 1 May. (Be aware that nesting females with large nestlings often roost outside the nest during warm weather. If in doubt, be sure to schedule one or more visits in mid-June to check for fledglings);

2. The female does not possess a brood patch when examined in-hand between mid-April and mid-June; or

3. Prey is offered to 1 or both members of the pair and they cache the prey, sit with prey for an extended period of time (60 minutes), or refuse to take additional prey beyond the minimum of 2 prey items. To be considered a valid nesting survey, an owl must take at least 2 prey items.

Surveys where the bird(s) leaves the area with prey and it is not possible to determine the fate of the prey do not count toward the required 2 visits because nesting status could not be classified. Some spotted owls may be reluctant to take prey at all. If in doubt, be sure to schedule 1 or more visits in mid-June to check for fledglings.

17.4 Nesting Status Unknown

If nesting status is not determined before 1 June, it is not possible to classify the owls as non-nesting using the criteria listed above.

1. If owls are found after 1 June, without young, nesting status is unknown.

2. If no owls are found after 1 June (at those sites where owls were present prior to 1 June), nesting status is unknown.

17.5 Reproductive Success Surveys (Number of Young Fledged)

Once a pair is classified as nesting, conduct reproductive success surveys after the time the young leave the nest (fledge), usually from late May to late June depending on latitude or elevation. If local fledging times are available you may adjust the dates accordingly. The following methods should be adopted to detect fledged young.

1. Schedule at least 2 visits to the site to locate and count fledged young, timing the visits so that the fledged young are observed as soon after leaving the nest as possible to avoid missing young that may be lost to predation later in the season.

2. Attempt to locate fledged young. Use visual searches and/or mousing of adults. If young are present, the adults should take at least some of the prey to the young. The sight of an adult with prey will usually stimulate the young to beg, revealing their number and location.

3. If the birds take at least 2 prey items and eventually cache, sit with, or refuse further prey without ever taking prey to fledged young; on at least 2 occasions, separated by at least 3 days, 0 young are recorded.

To determine the true number of fledged young, do the following:

4. On the first reproductive success visit, count the number of fledged young seen or heard.

5. Conduct a minimum of 1 additional visit, 3 to 10 days after the first fledged young is seen. This is necessary because it is possible to miss some owlets on a single visit.

6. If no response is elicited on a minimum of 2 visits, separated by at least 1 week during the fledging period, then classify the production of young as unknown.

7. If young are counted on 1 visit but a second visit is not conducted, or find no owls were found on the second visit, classify the number of young as 1+ or 2+ etc., based on the results of the initial visit.

8. Opportunistic mousing late in the season (after July 30) may be useful for providing supplemental information about site productivity.

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Appendix 1. Glossary of Terms

Many of these terms have a long history and various meanings in regard to spotted owl biology and management. This glossary defines the context in which they are used in this document.

Abandoned Activity Centers: Activity centers that have been determined through appropriate analyses with state or federal agencies, as no longer likely to be supporting territorial owls due to habitat changes and/or long-term surveys with negative responses. Synonymous with abandoned historical spotted owl site.

Activity Center: Spotted owls have been characterized as central-place foragers, where individuals forage over a wide area and subsequently return to a nest or roost location that is often centrally-located within the home range (Rosenberg and McKelvey 1999). Activity centers are a location or point representing 'the best of" detections" such as nest stands, stands used by roosting pairs or territorial singles, or concentrated nighttime detections. Activity centers are within the core use area and are represented by this central location.

Activity Center Search: Stand searches of any known or historical core use areas that are within the survey area perimeter. (See Section 8.0 for specific guidance on methods to conduct these searches).

Additional Visits: Supplemental visits needed to locate and determine spotted owl pair status or reproductive status. May also be necessary to determine species of unknown Strix owl responses.

Adult: A northern spotted owl $\geq$ 2 years old.

Breeding Season: The time period from 1 February through 31 August that includes courtships, nesting, nestling and fledgling dependency periods. This time period may vary by geographic locale.

Calling Route: An established route within a survey area where recorded calls of northern spotted owls are used to elicit a response.

Calling Stations: Point locations used to conduct surveys, distributed throughout an area so as to attain complete coverage of spotted owl habitat within the survey area.

Complete Coverage: Complete coverage of suitable owl habitat is obtained when the calling stations have been located within a survey area so that a northern spotted owl anywhere in the survey area would be able to hear surveyors and vice-versa.

Complete Visit: A complete visit occurs when all calling stations or calling routes within a survey area have been called with the seven day period, including daytime follow-up surveys for all spotted owl responses. See Section 5.5 for specifics.

Complete Survey: Complete coverage of suitable habitat throughout the survey area that consists of two years of six visits per year, including activity center searches, and, if appropriate, spot checks and additional activity center searches in years 3 and 4, as described in section 10.0 and 8.0 respectively.

Core Use Area: An area of concentrated use within a home range that receives disproportionally high use (Bingham and Noon 1993), and commonly includes nest sites, roost sites, and foraging areas close to the activity center. Core use areas vary geographically, and in relation to habitat conditions. This is a biological definition of core use area and is not the same as a 70-acre core as defined by the Oregon Forest Practices Act nor is it equivalent to the 100acre LSRs referred to as NSO cores on federal lands.

Daytime Stand Searches: Optional. *The objective is to search habitats most likely to contain roosting or nesting spotted owls.* A daytime stand search should cover nesting/roosting habitat within the project area.

Dispersal Habitat: Juvenile owls often must disperse through a range of forest types prior to finding habitat on which to establish a territory. These forest types include nesting, roosting, and foraging habitat in addition to other forest stand types that provide minimum diameter and canopy closure of trees. Definition of this habitat type vary by physiographic province.

Fledgling: Young of the year that are off of the nest.

Follow-up Outing: Follow-ups are conducted with an intensive search of spotted owl habitat within the general vicinity (approximately a 0.5-mile radius) of the response location -that prompted the follow-up. (See Section 6.0 for recommended methodology for conducting these searches).

Foraging Habitat: Foraging habitat is defined as habitat that provides foraging opportunities for spotted owls, but without the structure to support nesting and roosting (USFWS 1992*b*). Owls often forage in forest conditions that meet the definition of nesting/roosting habitat, but also use a broader range of forest types for foraging. This definition identifies habitat that functions as foraging habitat, but does not meet requirements for nesting /roosting

Habitat-capable area: Forests below the elevation limits of occupancy by territorial spotted owls that are capable of growing and sustaining structural (Davis and Lint 2005:30) and ecological conditions of spotted owl habitat.

Habitat Modification: Activities that occur in spotted owl nesting, roosting, or foraging habitat that reduce the canopy or other elements of spotted owl habitat at the stand-level. Wildlife biologists with the appropriate federal and state agencies may be able to provide technical assistance assessing these types of effects.

Historical Site: Spotted owl sites that contained territorial spotted owls in the past. For the purposes of this protocol, these spotted owl sites are considered a subset of known spotted owl

sites (see glossary below).

Home Range: The area in which a spotted owl conducts its activities during a defined period of time (USFWS 1992b) that provides important habitat elements for nesting, roosting, and foraging. Home range sizes vary generally increase from south to north and vary in relation to habitat conditions and prey availability and composition

Juvenile: A northern spotted owl is considered as juvenile age class in the first 5 months after hatching. Juveniles 1 to 3 months old are very white with downy plumage over all of the body or evident on breast and head; at 4 to 5 months old, juvenile begin losing downing plumage.

Known Spotted Owl Site: Includes both owl sites found during the current survey period and owl sites identified in previous years ('historical site). Known spotted owl sites include both the activity center and the area surrounding concentrations of 'the best of' detections such as nest stands, stands used by roosting pairs or territorial singles, or areas of concentrated nighttime detections.

Mousing: Mousing describes the act of offering prey items to spotted owls. The purpose of mousing spotted owls is to determine pair status and/or reproductive status. A male spotted owl may take a prey item to an unseen female; likewise, adult owls may take prey items to unseen young.

Nest: Northern spotted owls use broken-topped trees, old raptor nests, witches brooms, cliff ledges, mistletoe brooms, and tree cavities for nests. A spotted owl must be observed using the structure or have mice taken to a nesting female positively identified in the structure to designate a nest tree.

Nesting and Roosting Habitat: Habitat that provides nesting and roosting opportunities for spotted owls. Important stand elements may include high canopy closure, a multi-layered, multi-species canopy with large overstory trees and a presence of broken-topped trees or other nesting platforms (*e.g.*, mistletoe clumps (USFWS 1992*b*). The appearance and structure of these forests will vary across the range of the spotted owl, particularly in the dry-forest provinces.

Nestling: A young owl that is still in the nest.

Northern Spotted Owl (*Strix occidentals caurina*): One of three subspecies of spotted owl that ranges from southern British Columbia, Canada, through western Washington and Oregon, and into northwestern California. Listed as a threatened species by the U.S. Fish and Wildlife Service.

Physiographic Province: a geographic area having a similar set of biophysical characteristics and processes because of the effects of climate and geology that result in patterns of soils and broad-scale plant communities. Habitat patterns, wildlife distributions, and historical land use patterns may differ significantly from adjacent provinces.

Project Area: The polygon that forms the perimeter (footprint) of the proposed project. (Refer to Section 3.1 for specifics on determining the polygon).

Provincial: This is a qualifying term used with home range and core use area to reflect the fact that both vary in size according to latitude, amount of available habitat, prey availability, and forest structure and composition. Typically, home range and core use area sizes increase from south to north, and decrease as amount of high quality habitat available to owls increases.

Roost: Typically a tree used by a spotted owl for extended daytime rest periods. A roost site consists of the roost itself and the immediate vicinity. Roost areas are identified by observations of spotted owls, and/or the presence of pellets, white-wash and other evidence.

Spot Check Area: All suitable spotted owl habitat within the project area, plus suitable spotted owl habitat within 0.25 mile of the perimeter of the project area.

Spot Check Surveys: Conducted in years 3 and 4, consisting of 3 nighttime surveys spaced a minimum of 7 days apart, covering the spot check area (see section 10.0).

Spotted Owl Habitat: For purposes of surveying, spotted owl habitat is any habitat (i.e., nesting, roosting or foraging quality) where you may expect to elicit a response from a resident owl or pair of owls. This does not include younger or more open stands typically characterized as spotted owl dispersal habitat. Descriptions of spotted owl habitat for the various areas may be available from state wildlife and forestry agencies, or through technical assistance with local Service Field Offices (Appendix 3). Habitat descriptions can also be found in these references: Thomas et al. 1990, Courtney et al. 2004, USDI 2008. Regulatory definitions should be used where appropriate (e.g., definitions embedded within state forest practices regulations).

Subadult: A spotted owl in the first or second years of life. Identified by characteristic tail feathers with white tips tapering to sharp points (i.e., triangular shape). For more information on identifying subadult spotted owls, please see Moen et. al. 1991.

Survey Area: All suitable spotted owl habitat within one spotted owl provincial median home range radius from the perimeter of the proposed project area should be surveyed for projects that will modify spotted owl nesting, roosting, or foraging habitat. Table 1 provides appropriate survey area radius values, by physiographic province. (See Section 3.2 for additional specific guidance). For disturbance-only projects that will not modify habitat but will result in disturbance to spotted owls (short-term effects compared to the long-term effects of habitat modification), surveys should be conducted within 0.25 miles of the project area (see Section 9.0 for specific guidance).

Survey Period: All surveys of proposed project areas must take place between March 15 and August 31, with some exceptions. (See Section 4.0 for specifics related to province differences and weather related exceptions).

Appendix 2: U.S. Fish & Wildlife Service Field Office Contact Information.

U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, 2800 Cottage Way, Room W-2605, Sacramento, CA 95825-1846. Telephone: 916-414-6000.

U.S. Fish and Wildlife Service, Arcata Fish and Wildlife Office, 1655 Heindon Road, Arcata, CA 95521-5582. Telephone: 707-822-7201.

U.S. Fish and Wildlife Service, Red Bluff Fish and Wildlife Office, 10950 Tyler Road, Red Bluff, CA 96080. Telephone: 530-527-3043.

U.S. Fish and Wildlife Service, Yreka Fish and Wildlife Office, 1829 South Oregon Street, Yreka, CA 96097. Telephone: 530-842-5763.

U.S. Fish and Wildlife Service, Klamath Falls Office, 1936 California Ave, Klamath Falls, OR 97601. Telephone: 541 885-2525

U.S. Fish and Wildlife Service, Roseburg Field Office, 2900 NW Stewart Parkway, Roseburg, OR 97471. Telephone: 541-957-3470.

U.S. Fish and Wildlife Service, Bend Field Office, 20310 Empire Avenue, Suite A100, Bend, OR 97701. Telephone: 541-383-7146.

U.S. Fish and Wildlife Service, Oregon Fish and Wildlife Office, 2600 SE 98th Avenue, Suite 100, Portland, OR 97266. Telephone: 503-231-6179.

U.S. Fish and Wildlife Service, Washington Fish and Wildlife Office, 510 Desmond Drive, SE, Suite 102, Lacey, WA 98503. Telephone: 360-753-9440.

U.S. Fish and Wildlife Service, Central Washington Field Office, 215 Melody Lane, Suite 119, Wenatchee, WA 98801. Telephone: 509-665-3508.

Appendix 3. Generalized Northern Spotted owl Breeding Season Chronology[6].

Prelaying												
Laying												
Incubation												
Nestling												
Fledgling												
Initial dispersal												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

Prelaying Stage (duration variable)
Beginning about a week before laying, the female spends most of her time near the nest. Because the prelaying stage has no clearly definable beginning, we have arbitrarily designated the first several weeks prior to laying of the first age as the prelaying stage.

Laying Stage (1-6 days; Forsman et al. 1984)
When egg laying begins, the female spotted owl typically spends almost all of her time in the nest, her mate provides nearly all of her food. Copulation continues on a daily basis throughout the egg-laying stage and for up to about 4 days after incubation begins.

Incubation Stage (30 plus or minus 2 day; Forsman et al. 1984)
Incubation begins shortly after laying of the first egg and is done solely by the female, who may leave the nest at night for up to 2 hours during the first couple of days of incubation. Thereafter, she only occasionally leaves the nest for periods of 10 to 20 minutes at night to regurgitate pellets, defecate, preen, or accept food from her mate.

Nestling Stage (normally 34-36 days; Forsman et al. 1984)
The female broods the new hatchlings almost continuously for 8-10 days, still depending on her mate to provide food for herself, and now for the young. By the time her young are 2-3 weeks old, the female begins to forage for increasingly longer periods at night, typically 1-4 hours. The male continues to bring food to the nest, but the female passes the food to the young. Most young observed by Forsman et al. (1984) fledged (left the nest) when 34-36 days old, occasionally moving off the nest to perch on nearby limbs for a few days before leaving the nest permanently. Occasionally young leave their nest earlier than normal. Because such young are less developed physically, they may spend more time on the ground than young that remain in the nest for the full nestling period. This may increase their mortality rate compared to that of

[6] This information is intended to depict the generalized breeding chronology, recognizing slight variations in all stages may occur depending on individual owls, elevation, in-season weather conditions, and/or latitude.

later-fledged young.

Fledgling Stage (80-120 days; Forsman et al. 1984)
The fledgling stage covers the period after the young leave the nest until they become independent of their parents. Within about 3 days after fledging (assuming a normal nestling period of 34-36 days), most young can flutter or climb to elevated perches; usually in a week they can fly clumsily between trees. Within about 3 weeks after fledging, they can hold and tear meat from prey brought by their parents. Both parents regularly bring food to the fledgling and generally continue to do so until mid- to late September, apparently regardless of the age or capabilities of the young. Because of this, the fledgling stage may be relatively long or short, depending upon when a given nest was begun and on variations in the age of the young at fledging.

Appendix 4. Recommended Credentials and Qualifications for Crew Leaders and Surveyors.

RECOMMENDATIONS FOR SPOTTED OWL SURVEYORS CREDENTIALS and QUALIFICATIONS

Surveyor qualifications are provided as recommendations for evaluation of personnel that are proposed to be involved in spotted owl surveys. *These recommendations are advisory but highly encouraged.*

Crew Leader:

- Responsibilities: Supervises survey crew, data collection, prepares basic data summary, and coordinates with other surveyors. Additional responsibilities include supervision of: 1) survey route layout, and 2) determination of area coverage requirements.

- Minimum requirements:
    - Normal hearing abilities are requisite. A crew leader must be able to hear the owl(s) if they were calling (a hearing test is advised); AND
        - One year (one field season) of spotted owl survey experience, plus training in spotted owl survey techniques, including identifying the various calls of northern spotted owls, barred owls, and NSO-barred owl hybrids as attested to by letters of reference;
          -OR-
        - At least 2 field seasons conducting spotted owl calling surveys, preferably under the guidance of another biologist with experience in conducting successful spotted owl surveys.

Owl Caller or Surveyor:

- Responsibilities: conducts owl surveys and collects data.

- Minimum requirements:
    - Normal hearing abilities are requisite (a hearing test is advised). An owl caller must be able to hear the owl(s) if they were calling; AND
        - Training in spotted owl survey techniques, including identifying the various calls of northern spotted owls, barred owls, and NSO-barred owl hybrids as attested to by letters of reference;
          -OR-
        - At least one field season of spotted owl survey experience, preferably working closely with other biologists experienced in conducting successful spotted owl surveys.

Both Crew Leader and Owl Surveyor must have the physical ability to work in mountainous terrain and willingness to work during nighttime conditions. In some cases, Crews Leads and Surveyors may be asked to conduct both day and nighttime work. Orienting skills, including the use of map and compass is essential. Surveyor safety should be of primary importance.

Appendix 5. Suggested but Necessary Equipment to Conduct Surveys

- **Digital caller.** An example of this would be an MP3 player and a chip containing the spotted owl calls identified for use in this protocol (page XX).
- **Call recordings of other owl species.** This would include the range of barred owl calls along with other owl species from the Pacific Northwest. Surveyors should become familiar with the vocalizations of all of the owls they might hear. Part of this familiarization is to distinguish the difference between spotted owl and barred owl female contact calls or whistles. Identification of unknown calls should be attempted to in the field with the recorded calls on hand.
- **Binoculars.** Many times, spotted and barred owls fly in to surveyors and will not vocalize. The potential of identification increases with the use of binoculars with sufficient magnification.
- **Lighting.** Have a good flashlight to help with spotlighting and identification of individuals at night. Owls may perch for only a short time and having this lighting available will increase your chances of positive identification and save on subsequent survey effort. Have a good headlamp to assist with getting around. For safety, as well as to avoid wasted surveys, remember to carry spare, fully charged batteries in your vehicle.

Appendix 6: Template Field Data Collection Form

SITE VISIT FORM

SITE ID NUMBER: _____ SITE NAME_____STATE: _____

VISIT #: _____ OUTING #**:** _____ YEAR: _____ OUTING DATE: _____

LANDOWNER: _____ PHYSIOGRAPHIC PROVINCE_____

COMPLETE VISIT: (Y/N) _____OBSERVERS:_____

TYPE OF SURVEY: _ACS__ _SC_ CC __FO___ RV_____AV_____OPP_____

ACS=Activity Center Search **SC**=Station Calling **CC**= Continuous Calling **FO**=Follow Up Outing **RV**=Reproductive Visit
AV=Additional Visit **OPP**=Opportunistic Siting

HISTORICAL SITE CENTER LOCATION (use if historical site center is being surveyed)
T_____R_____Sec_____1/4_____1/16_____ WEATHER:_____

OWLS DETECTED: (Y/N) _____

Station	Start	End	SPP	Obs Type[1]	Sex	Bearing/ Distance	T / R / Sec	¼	1/16	UTM East	UTM North

[1]**ObsType** = V=Visual A=Audio S=Sign

Field Data Form - Data Dictionary

Age – Age is verifiable only upon visual detections.

AD=Adult
IMM = Immature (adult plumage but white tipped tail feathers observed)
F1=young; all downy **F2** = young, partial adult/partial down feathers **F3** = Young of the year with almost all adult feathers; may see a few downy feathers sticking through
UNK=Age unknown

Detection Time – Record in military time

Location Name – Enter name of survey area (i.e., Jackson Timber Sale)

Master Site Number - Enter state-identified activity center number

Physiographic Province – e.g., CA or OR Klamath, OR Coast, WA Cascades, etc.

SEX – M= Male **F=**Female **Unk =** Unknown**.** Contact whistles can be made by male or female**.**

SPP – **NSO** = Northern spotted owl **BAOW** – Barred Owl

Appendix 7. Physiographic Provinces Within the Range of the Northern Spotted Owl

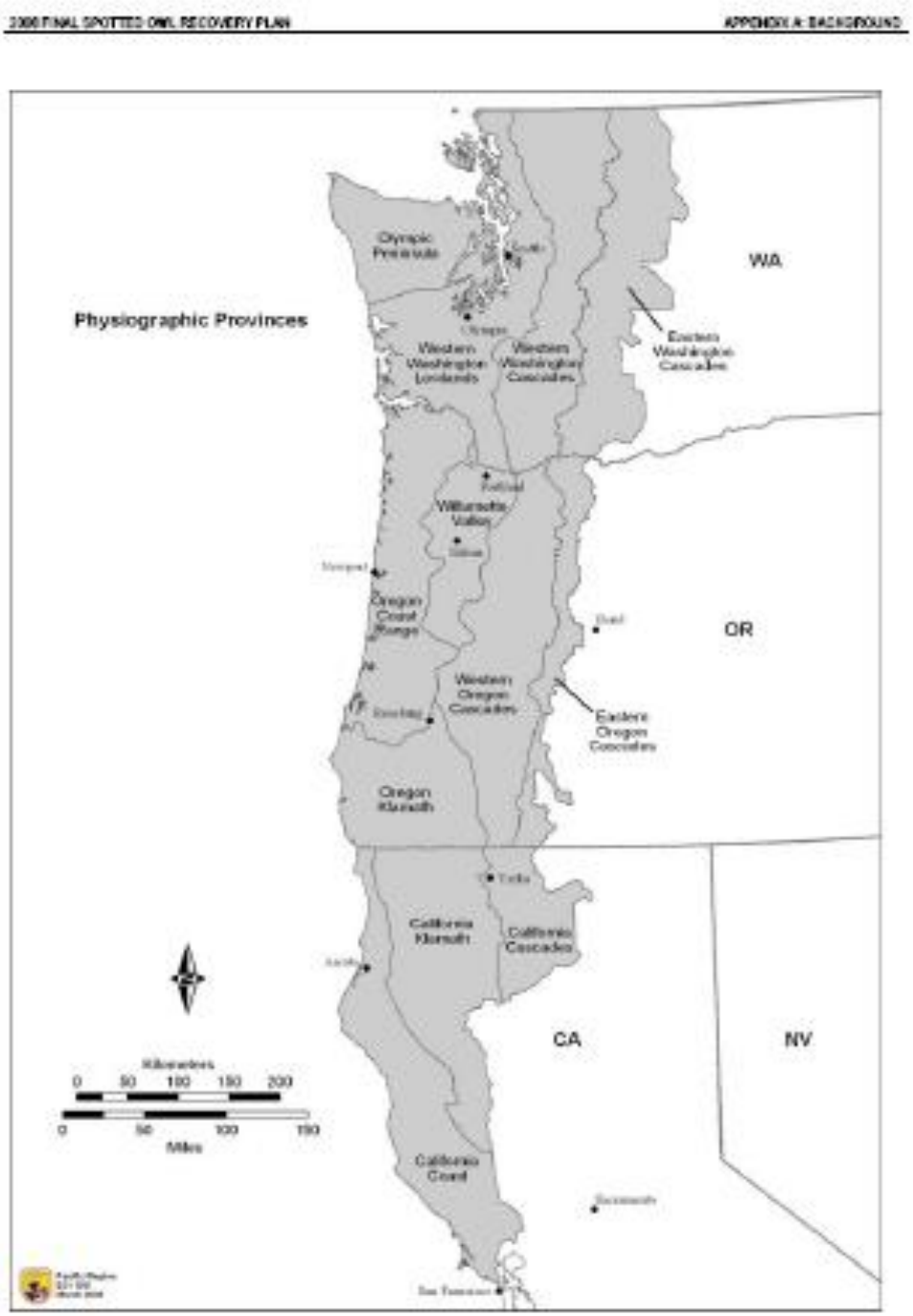


Figure A1. Physiographic Provinces in the range of the spotted owl in the United States.

ATTACHMENT B

U.S. Fish and Wildlife Service
Guidance for Evaluation of Take for Northern Spotted Owls on Private Timberlands in California's Northern Interior Region

I. Accuracy of NSO activity center location and status

1) Location
    a. Confirm plotted activity center location accuracy
        i. CDFG Reports 2 and 3
        ii. Data from adjacent landowners
        iii. Recent surveys
    b. Document deviations from CDFG locations
    c. Update habitat analysis maps as necessary
2) Status
    a. Valid site
        i. Review page 11 of protocol to determine
        ii. If not valid, report to CDFG for inclusion in next database update
    b. Current occupancy status
    c. Current reproductive status, if determined

II. Survey Effort

1) Coverage
    a. Surveys of nesting/roosting habitat out to 0.7 miles from THP boundary
        i. Use THP habitat map(s) to verify
2) Protocol survey
    a. Time of day
    b. Spacing between visits
    c. Number of surveys
    d. Survey dates
    e. Time spent at each call point
3) Follow up visit(s)
    a. Confirm that the area searched covers suitable habitat within response location/last known location within a logical distance.
    b. Time of follow up and duration of follow up
    c. Additional night surveys
        i. Review page 10 of protocol

III. Habitat

1) Typing
    a. Verify habitat typing with aerial photos, equivalent imagery, or field visits
    b. Changes to typing need to be reflected in the NSO habitat acres table and habitat analysis maps
    c. Post harvest typing
        i. Post-harvest habitat typing must agree with the silviculture prescription
2) Definitions
    a. Nesting/roosting
        i. High Quality Nesting/roosting Habitat
            1. Basal Area = 210+ square feet, **and**
            2. ≥ 15" quadratic mean diameter (QMD) , **and**
            3. ≥ 8 trees per acre (TPA) of trees ≥ 26" in diameter at breast height (DBH) , **and**
            4. ≥ 60% canopy closure
        ii. Nesting/roosting Habitat
            1. A mix of basal areas ranging from 150-180+ square feet, **and**
            2. ≥ 15" QMD, **and**
            3. ≥ 8 TPA of trees ≥ 26" DBH, **and**
            4. ≥ 60% canopy closure
    b. Foraging
        i. Foraging Habitat
            1. A mix of basal areas ranging from 120-180+ square feet, **and**
            2. ≥ 13" QMD, **and**
            3. ≥ 5 TPA of trees ≥ 26" DBH, **and**
            4. A mix of ≥ 40%-100% canopy closure
        ii. Low Quality Foraging Habitat
            1. A mix of basal areas ranging from 80-120+ square feet, **and**
            2. ≥ 11" QMD, **and**
            3. ≥ 40% canopy closure
3) Quantities
    a. Within 1000 feet of activity center
        i. Outside breeding season (September 1 through January 31): no timber operations other than use of existing roads
        ii. During the breeding season (February 1 through August 31): no timber operations other than the use of existing, permanent, year-round roads

    b. Within 0.5 mile radius (502 acres) centered on activity center
        i. Retention of habitat should follow Section III. 4 of this document
        ii. At least 250 acres nesting/roosting habitat present, as follows:
            1. 100 acres High Quality Nesting/roosting Habitat, **and**
            2. 150 acres Nesting/roosting Habitat

        –AND–

        iii. At least 150 acres foraging habitat must be present, as follows:
            1. 100 acres Foraging Habitat, **and**

2. 50 acres Low Quality Foraging Habitat

iv. No more than 1/3 of the remaining suitable habitat may be harvested during the life of the THP

c. Between 0.5 mile radius and 1.3 miles radius circles centered on activity center

i. Retention of habitat should follow Section III. 4 of this document

ii. ≥935 acres suitable habitat must be present, as follows:

1. At least 655 acres Foraging Habitat, **and**
2. At least 280 acres Low Quality Foraging, **and**
3. No more than 1/3 of the remaining suitable habitat may be harvested during the life of the THP

4) Priority Ranking of Habitat Retention Acres

a. Tree species composition

i. Mixed conifer stands should be selected over pine dominated stands

b. Abiotic considerations

i. Distance to nest

1. Nesting/roosting and foraging habitat closest to identified nest trees, or roosting trees if no nest trees identified

ii. Contiguous

1. Nesting/roosting habitat within the 0.5 mile radius must be as contiguous as possible
2. Minimize fragmentation of foraging habitat as much as possible

iii. Slope position

1. Habitats located on the lower 1/3 of slopes provide optimal micro-climate conditions and an increased potential for intermittent or year-round water sources

iv. Aspect

1. Habitats located on northerly aspects provide optimal vegetation composition and cooler site conditions

v. Elevation

1. Habitat should be at elevations of less than 6000 feet, though the elevation of some activity centers (primarily east of Interstate 5) may necessitate inclusion of habitat at elevations greater than 6000 feet.

IV. Determination

1) If surveys are inadequate or do not meet the intent of protocol, take determination may not be possible.
2) If habitat typing is inadequate, take determination may not be possible.
3) If NSO home range habitat acres are below desired conditions (Section III. 2, 3, and 4), additional loss of suitable habitat can lead to take.

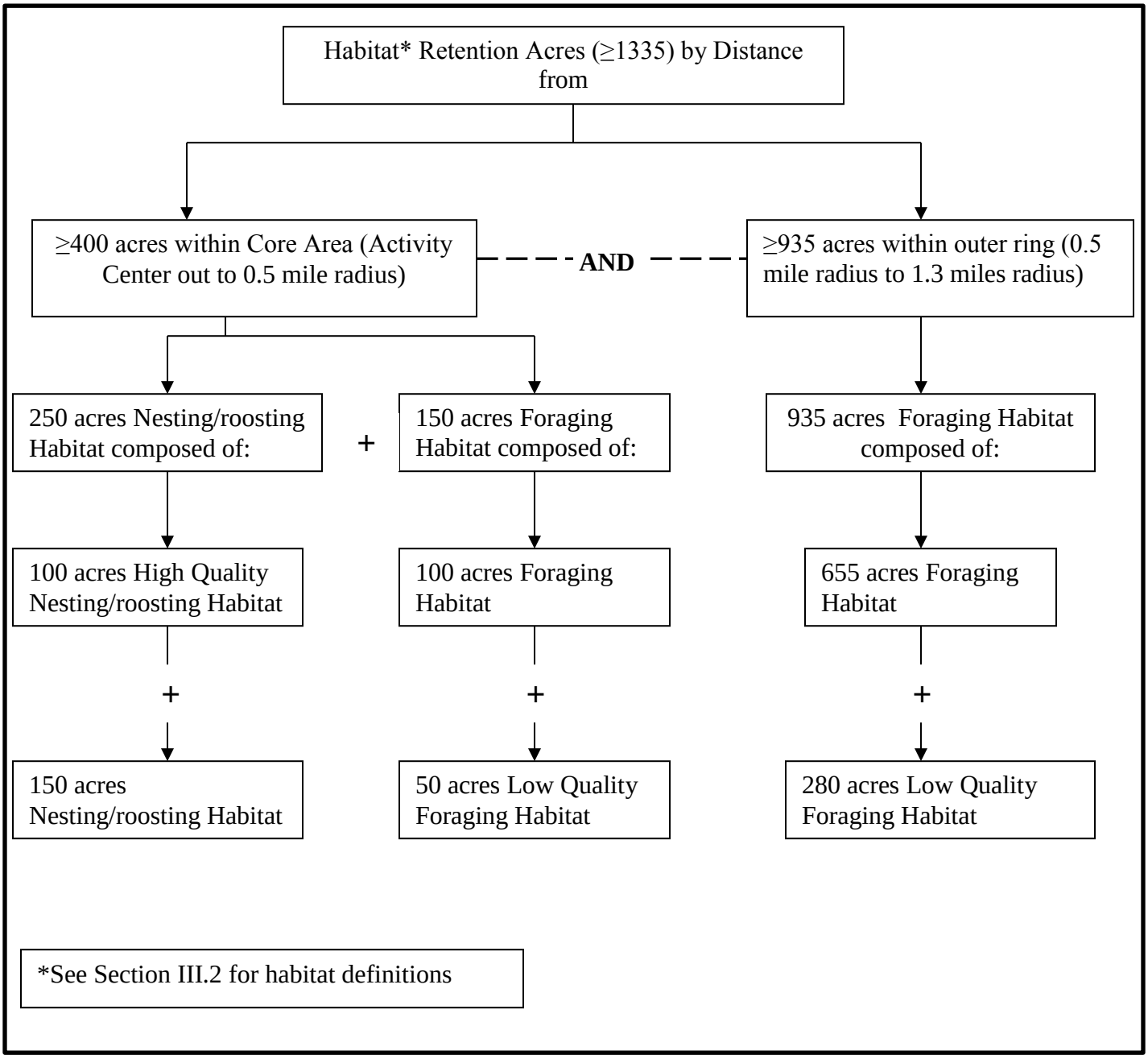
4) If NSOs are nesting, utilize seasonal restriction within 0.25 mile of nest (February 1 through August 31).
5) If effects are limited to noise disturbance, a modified seasonal restriction may be used from February 1 through July 9
    a. Harvest of unsuitable habitat, with unsurveyed suitable within 0.25 of unit boundary
6) Multiple THPs located within a given NSO territory need to be considered collectively or a take determination may not be possible.

V. TA Letter Contents

1) Date of written TA request
2) Date request received
3) Note if previous TA(s) provided in past
4) Number of acres within THP units
5) Amounts and types of silviculture prescriptions
6) Location of THP
    a. Township, Range, and Section
    b. Meridian
    c. County
7) Identify NSO activity centers returned by CDFG reports
8) Surveys conducted and activity center status
9) Logic behind take determination
    a. Habitat considerations
        i. Acres, quality, and location of suitable habitat pre- and post-harvest
        ii. Effects of timber operations on suitable habitat
            1. Degrade: suitable habitat is harvested but still functions in the capacity it did pre-harvest (i.e. Foraging habitat before harvest functions as foraging habitat post-harvest, nesting/roosting habitat pre-harvest functions as nesting/roosting habitat post-harvest)
            2. Downgrade: pre-harvest nesting/roosting habitat becomes foraging habitat post-harvest
            3. Remove: nesting/roosting or foraging habitat is harvested such that it no longer functions as habitat post-harvest
    b. Proximity of activity center to operations
    c. Survey data
10) Sunset date and seasonal restrictions
    a. If 2 year protocol and surveys are current and negative, additional TA needed if operations not completed by February 1, *YEAR* (review protocol page 3).
    b. If 1 year protocol and surveys are current and negative, additional TA needed if operations not completed by February 1, *YEAR* (review protocol page 3).
    c. If NSOs detected in previous surveys and operations are not complete before February 1, surveys are required to determine location and status of NSOs prior to operations during each breeding season that operations are ongoing.

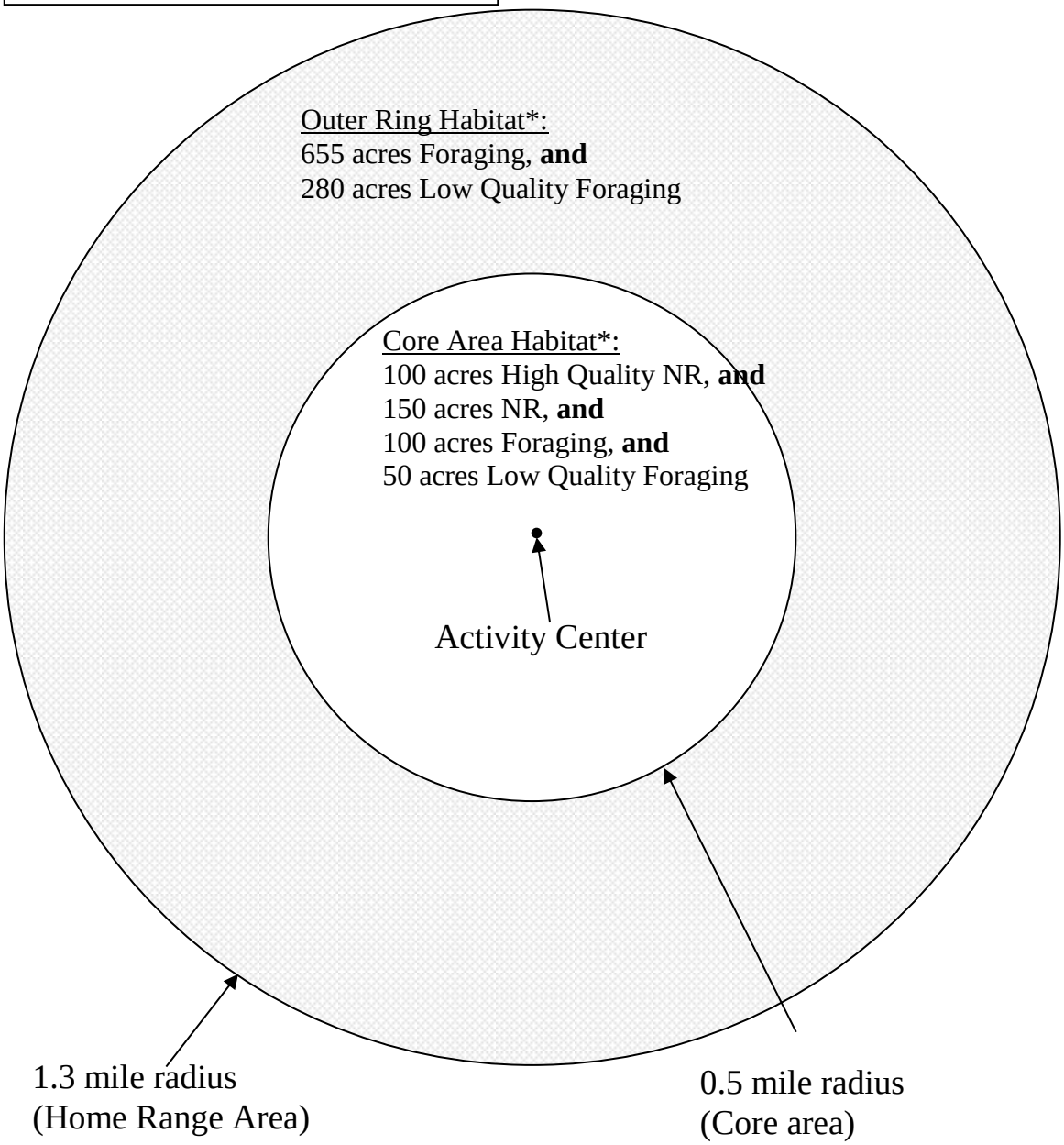
d. If no owls within 1.3 miles of THP (CDFG reports) and no suitable habitat within units or 1.3 miles of units, additional technical assistance may not be required.

11) Name of agency person to contact if there questions regarding TA



Habitat Retention within 0.5 mile Core Area and 1.3 mile Home Range–Interior

*See Section III.2 for habitat definitions



ATTACHMENT C

U.S. Fish and Wildlife Service
Northern Spotted Owl Take Avoidance Analysis and Guidance
For California Coast Forest District

March 15, 2011

Through this document, the Fish and Wildlife Service's (Service) Arcata Office (AFWO) establishes guidelines to avoid the incidental take[1] of the federally listed as threatened northern spotted owl (*Strix occidentalis caurina*, NSO), that may result from timber operations occurring within the range of the coast redwood (*Sequoia sempervirens*) ecotype, in the Coast Forest District (Coast District) of the California Department of Forestry and Fire Protection (CAL FIRE). This document will be referred to hereafter as "Attachment A." The eastern portion of the Coast District is outside of the range of the coast redwood. In these eastern areas, the Revised USFWS Attachment B: Take Avoidance Analysis-Interior ("Attachment B") applies to proposed timber operations where no redwoods are present in the timber harvest plan area.

This document (Attachment A) applies to Timber Harvest Plans (THPs) and to Non-industrial Timber Management Plans (NTMPs). This Northern Spotted Owl Take Avoidance Analysis and Guidance (Attachment A), dated March 14, 2011, replaces, in full, all prior versions of this guidance, and remains in effect until replaced or voided.

I. Background

On February 7, 2011, the Service released the *2011 Protocol for Surveying Proposed Management Activities That May Impact Northern Spotted Owls* (hereafter referred to as the 2011 NSO Survey Protocol), its associated transmittal memorandum (2011 transmittal memo) from Region 8 of the Service, and the transition matrix entitled *NSO Protocol Transition Guidance* for surveys initiated in 2009 through 2011. The 2011 transmittal memo and associated transition matrix provide additional details and clarification for surveys conducted within California (a similar memorandum has been prepared for distribution in Oregon and Washington). The transition matrix clarifies how past surveys would be appropriately credited toward meeting current protocol needs. Those documents are included herein by reference; the reader should consult those documents for details regarding survey methods and interpretation of survey data.

This document provides guidance on the application of survey results to evaluation of specific projects that may impact NSO and provides NSO habitat protection measures and operational procedures specifically recommended for the coast redwood ecotype.

[1]**incidental take -** take that is incidental to, but not the purpose of, carrying out an otherwise lawful activity.

In addition, this revision of Attachment A crosswalks the pertinent issues addressed in previous AFWO Technical Assistance, previous versions of Attachment A, and the 2011 NSO Survey Protocol.

II. Definitions

This section defines several terms used in the analysis of take avoidance of the NSO within the coast redwood ecotype of the Coast District (additional terms are defined within the protocol guidance documents, referenced above):

Activity Center (AC): Area of concentrated activity of either a pair of NSO or a single territorial NSO, represented by a mapped location (e.g., usually a nest tree) that occurs within, but not necessarily in the exact center of, the "Core Area," defined below[2].

Core Area: 100 acres of the 200 acres of Nesting/Roosting habitat retained within a 0.7 mile radius contiguous with the Activity Center. If 100 acres of contiguous Nesting/Roosting is not available, then the highest quality habitat available shall be included.

Foraging Habitat: Habitat that contains ≥40% canopy cover of trees that are ≥ 11" DBH (diameter at breast height), and have a basal area ≥75 square feet per acre of trees ≥ 11" DBH. Trees may be conifer or hardwood.

Nesting/Roosting Habitat: Forested habitat that supports successful nesting and associated roosting behavior by NSO. Habitat with ≥60% canopy cover of trees that are ≥ 11" DBH, and have a basal area ≥ 100 square feet per acre of trees ≥ 11" DBH. Trees may be conifer or hardwood.

Nesting/Roosting Polygon: All Nesting/Roosting habitat which is contiguous with an NSO Activity Center.

NSO Breeding Season: Defined as February 1 to July 31 within the coast redwood ecotype found in the Coast District of California.

NSO Home Range: Defined as a 0.7 mile radius circle centered on the Activity Center for the coast redwood ecotype found in the Coast District.

Suitable or Functional Habitat: Habitat that meets either Nesting/Roosting or Foraging definitions, or a combination of Nesting/Roosting and Foraging habitat.

Survey Area: All Suitable/Functional NSO habitat within 0.7 mile from the project boundaries; or for disturbance only activities, a 0.25 mile area outside the edge of the project should be surveyed.

[2]NSOs have been characterized as central-place foragers, where individuals forage over a wide area and subsequently return to a nest or roost location that is often centrally-located within the home range (Rosenberg and McKelvey 1999).

Survey-Start Date: In the coast redwood ecotype, Coast District, NSO Surveys should start on or after March 1.

Survey-Last Survey Dates: For years 1 and 2 of the 2011 NSO Survey Protocol, the last survey visit should occur on or after May 15. For "Activity Center Searches" and Spot Check Surveys no fixed date is set, but the 2011 NSO Survey Protocols should be followed.

III. Accuracy of NSO Activity Center Location, Status and Mapping

The initial step in determining if the proposed timber operations may avoid take of NSO is to determine if the proposed operations would likely occur within the home range of a NSO (new or historical). A combination of survey data conducted to current protocol and current NSO California Department of Fish and Game (CDFG) database reports, covering all suitable NSO habitat located within the 0.7 mile radius of the proposed harvest operations, will be necessary to support a conclusion that a proposed timber harvest is not within the home range of a NSO.

Accurately mapping the location of the Activity Center is critical to the protection of Core Area habitat. Because NSOs can move from year to year, Activity Center locations are more accurate when plotted as a result of surveys rather than using the locations found in the CDFG NSO Database. Multiple Activity Centers for a NSO pair are possible. If one Core Area does not encompass all known Activity Centers, multiple Core Areas for a NSO pair, or territorial single NSO may need to be mapped and protected to avoid the likelihood of incidental take.

If some, or all, of the habitat in the survey area cannot be surveyed due to lack of access, the most recent update of the CDFG NSO Database should be consulted for Activity Center information within the 0.7 mile survey area. In addition, landowners that are adjacent to the proposed timber operations should be contacted so that all the known current NSO locations can be identified and mapped. All detections reported to the CDFG NSO Database are assigned to a known site or given a new site number. *CDFG NSO Database Report Number 2* identifies the most important detection locations for each site, and those sites should be included as "known" Activity Centers. The guidance contained herein applies to all sites listed in *CDFG NSO Database Report Number 2*, until such detections are determined by the Service not to qualify for protection (e.g., site abandonment or non-site determination). *CDFG NSO Database Report Number 3* may include more than one nest site location for a pair of NSO.

IV. Current 2011 Surveys, Subsequent Years, and Transition from Past Surveys

The 2011 NSO Survey Protocol replaces all prior versions of the NSO survey protocol. Reference to prior protocols should be limited to confirming compliance with earlier protocols during those survey years, for appropriate crediting of earlier, completed surveys, and should not be used as direction for surveys during 2011 and subsequent years. Please refer to the 2011 NSO Survey Protocol and associated NSO Protocol Transition Guidance documents for complete

details regarding survey area, timing, design, and documentation of conditions necessitating deviation from the 2011 NSO Survey Protocol, with the exception of the deviation outlined below.

Data and information specific to the coast redwood region show that NSO nest slightly earlier in the year than interior areas within California. Furthermore, additional data from this coast redwood region have shown that the high response rates of NSO begin as early as March 1. However, the 2011 NSO Survey Protocol states "At least 3 of the complete visits should be conducted before 30 June; this includes at least one visit in April, one in May and one in June."

To accommodate the earlier breeding season for NSOs in the coast redwood region, survey dates should be moved forward 15 days, as follows:

- At least one survey should occur during the period March 15 to April 14.
- At least one survey should occur during the period April 15 to May 14.
- At least one survey should occur during the period May 15 to June 15.

With the exception of this scheduling of survey visits, all other timing, location, and operability requirements (at least 7 days between complete visits, daytime follow-ups, number of complete visits, etc.) remain consistent with the 2011 NSO Protocol.

V. Survey Area

The 2011 NSO Survey Protocol assumes that the entire survey area (0.7 mile) for the redwood portion of the Coast District will be surveyed prior to management activities that may affect suitable NSO habitat. In some cases, access issues related to private property can prevent surveys from being conducted across the entire survey area. At a minimum, surveys should be conducted on the property within which the proposed timber operations will occur, and on any adjacent accessible private or public land and along appurtenant public roads. Current survey data from adjacent landowners may be used to get information about presence/absence of NSO on portions of the survey area not accessible to the project proponent.

Survey documentation for proposed timber operations should include a description, a map of the 0.7 mile survey boundary and, if less than 0.7 mile, a map of the actual surveyed area, and an explanation of any deviation from complete 2011 NSO Survey Protocol. An explanation is especially important when removal or downgrading of suitable NSO habitat is proposed. It should be noted, however, that surveys not covering the entire survey area may require additional Spot Check Surveys to account for incomplete survey area coverage (see 2011 NSO Survey Protocol).

For operations that are anticipated to result only in disturbance to NSO during the breeding season, all suitable NSO habitat within the proposed timber operation plan area should surveyed, plus an additional 0.25 mile radius outside the plan area.

VI. Post-Harvest Habitat Retention and Typing

Accurate habitat typing is required to determine if habitat quantities will be retained above the habitat thresholds described below. Note that CAL FIRE will need habitat typing to verify that pre-harvest typing is correct and post-harvest retention is feasible.

Inventory data provides the best support for accurate habitat typing. When inventory data is not available, habitat typing using available satellite or aerial imagery is acceptable, provided harvest histories showing any habitat alterations since the imagery was generated are incorporated into the analysis. Imagery alone can provide reasonably accurate canopy closure estimations, but since stand age and diameter class can be difficult to determine in redwood forests from imagery alone, it is important to conduct ground truthing as well. CAL FIRE maintains timber harvest histories by watershed and that information is available on-line and should be used in conjunction with imagery for off-property habitat typing.

Narrow strips of habitat (retention areas between clearcuts, etc.) may contain the characteristics of Nesting/Roosting habitat. However, when these narrow strips of habitat are surrounded by unsuitable or low quality habitats, they function as Foraging habitat at best.

Watercourse and Lake Protection Zones (WLPZs), typically, have the highest canopy closure and the largest trees on the landscape. However, WLPZs are not wide enough by themselves to provide functional Nesting/Roosting habitat (i.e., not at least 600 feet wide); therefore, if a WLPZ is bordered on both sides by unsuitable habitat, then the WLPZ cannot be typed as Nesting/Roosting habitat, and is functionally Foraging habitat at best. If one or both slopes on either side of a WLPZ can be accurately typed as at least Foraging habitat, then the WLPZ can be functional as Nesting/Roosting habitat if a minimum of 60% canopy closure of trees at least 11” DBH are present.

Priority Ranking of Habitat Retention Acres

1) Tree species composition:
   a) Redwood or mixed conifer stands should be selected over hardwood dominated stands.

2) Abiotic considerations to help with priority determinations:
   a) Distance to nest: Nesting/Roosting and Foraging habitat closest to identified nest trees, or roosting trees if no nest trees identified.
   b) Contiguity: Nesting/Roosting habitat within the 0.7 mile radius should be as contiguous as possible; and minimize fragmentation of Foraging habitat as much as possible.
   c) Slope position: Habitats located on the lower 1/3 of slopes provide better microclimate conditions and an increased potential for intermittent or year-round water sources.

If the proposed timber operations retain at least 66% of the pre-harvest basal area and meet the functional definition of Nesting/Roosting or Foraging habitat post-harvest as described above, off-property habitat typing is not necessary, unless needed to display Core Area protections.

Core Area Habitat Protection

Once an Activity Center has been accurately mapped, a 100-acre Core Area polygon must be identified that contains the highest quality habitat (typically Nesting/Roosting) located contiguous with the Activity Center.

When an Activity Center is surrounded by sufficient Nesting/Roosting habitat, the Core Area polygon is typically mapped starting with a 1,000-foot radius circle (72 acres) centered on the

Activity Center, and is connected on one side to a WLPZ and expanded until the Core Area includes 100 acres. Limited timber operations are allowed within the Core Area polygon (see VIII. Timber Operations).

When an Activity Center is closer than 500 feet to the outside edge of the Nesting/Roosting polygon, the acres of non-Nesting/Roosting habitat within 500 feet of the activity center are included, but should be augmented with additional Nesting/Roosting habitat elsewhere in the Core Area polygon to make a total of 100 acres of the highest quality habitat.

When the Activity Center is closer than 1,000 feet to, but not within 500 of, the outside edge of the Nesting/Roosting polygon, the protected Core Area should extend to that most distant edge of the Nesting/Roosting habitat but shall not be less than a 500-foot radius.

Operations conducted outside the Core Area, but within 1,000 feet of an Activity Center should retain the functionality of any NSO habitat present pre-harvest within this area, i.e., operations do not downgrade habitat.

Polygons of Nesting/Roosting habitat contiguous with the Activity Center, which are larger than 100 acres provide the most operational flexibility. If the Nesting/Roosting polygon is 200 acres or greater, and operations in the polygon outside the Core Area have retained functional Nesting/Roosting habitat (i.e., no more than 33% of the basal area removed retaining a minimum of 100 sq. ft. of basal area per acre of trees greater than 11" DBH), then the 100-acre core area can be redrawn in subsequent entries. However, the 500-foot radius should remain unchanged, and the redrawn core area should not include any acres harvested within the previous 5 years.

Within the 0.7 mile radius (985 acres) of each Activity Center please use the following:

1) Retain habitat to maximize attributes desirable for NSO.

2) Retain at least 500 acres of suitable (Nesting/Roosting/Foraging) NSO habitat, post-harvest, as follows:

    a) Retain 200 acres of Nesting/roosting Habitat within a 0.7 mile radius of the Activity Center consisting of:
        i) 100 acres of the 200 acres of Nesting/Roosting habitat retained should be contiguous, or contiguous as possible with the Activity Center.

ii) An additional 100 acres of Nesting/Roosting with in the 0.7 mile radius:
   (1) If the second 100 acres of Nesting/Roosting habitat is also contiguous with the Activity Center, or within the same drainage, operations should retain a minimum of 66% of the pre-harvest basal area per acre of trees at least 11" DBH.
   (2) If the remaining 100 acres of Nesting/Roosting habitat is not contiguous with the Activity Center, retain at least Nesting/Roosting habitat.

b) Retain at least 300 acres of Suitable NSO habitat, post-harvest, of at least Foraging quality.

3) Remove no more than 1/3 of the remaining suitable habitat in excess of 500 acres within 0.7 mile of an Activity Center during the life of the timber operations.

VII. Road Use

To avoid take of NSO from noise disturbance (see U.S. Fish and Wildlife Service 2006) road use within 0.25 mile (1,320 feet) of a NSO Activity Center during the breeding season is prohibited until July 10, unless:

1) Non-nesting, or nesting failure at the Activity Center has been determined by a Activity Center Search (2011 NSO Protocol) conducted on or after May 15th, or;

2) The Activity Center is within 165 feet of major highway that typically has continuous traffic year around (Hwy 1, 36, 101,128, 299, etc.) and the appurtenant road is not within 165 feet of the Activity Center.

3) After July 9th until the end of the breeding season road use within the 100-acre core is restricted to existing road use, maintenance and map point work.

VIII. Timber Harvest Operations

A 0.25 mile seasonal restriction on timber operations (except for road use after July 9th) applies to every known NSO Activity Center during the breeding season, unless it is determined via a site monitoring visit, "Activity Center Search" (2011 NSO Protocol), that NSO are not nesting, or nesting failure has occurred. If it cannot be determined whether NSO are nesting, or nesting failure cannot be determined, the 0.25 mile seasonal restriction stays in effect for timber operations until after July 31st.

For all known Activity Centers, timber operations should adhere to the following recommendations:

1) Within the 100-acre Core Area polygon of an NSO Activity Center:

   a) Outside the breeding season, limited timber operations (i.e., road use and maintenance, map point work, tail-hold placements, use of existing skid roads, and loading) may be

conducted, provided no trees >11 inches DBH are cut or removed by the operations, and no logs are yarded through the Core Area.

b) During the NSO breeding season, timber operations (including use of roads before July 9th), are not allowed within the 100-acre Core Area polygon, except as allowed in subsections 4 and 5, below.

2) Timber Operations outside the 100-acre Core Area polygon, but within 0.25 mile of an NSO Activity Center:

   a) Outside the breeding season, timber operations may be conducted.
   b) During the breeding season, no timber operations should proceed unless protocol surveys do not detect nesting NSOs.

3) For all NSO Activity Centers, prior to May 15th (until the required May 15 or later survey is completed):

   a) Timber operations (except helicopter yarding or staging) may be conducted only on those THP areas >0.25 mile from the Activity Center.
   b) Helicopter yarding and staging may occur only on those THP areas >0.5 mile from the Activity Center.

4) For NSO Activity Centers where reproductive status has been determined to be non-nesting or failed nesting:

   a) Limited timber operations (road use and maintenance, map point work, use of existing skid roads, tail-hold placements and loading) may be conducted within the 100-acre Core Area polygon of the Activity Center provided no trees >11 inches DBH are cut or removed by the operations, and no logs are yarded through the Core Area.
   b) Full timber operations, including helicopter yarding and staging, may be conducted within 0.25 mile but not within the 100-acre core polygon of the Activity Center. Helicopter fly-overs shall not occur within 1000 ft. of the Activity Center

5) For NSO Activity Centers, where reproductive status has been determined to be nesting:

   a) For Activity Centers where fledging status has not been determined, timber operations may be conducted only on those THP areas that are >0.25 mile from the Activity Center until the end of the breeding season.
   b) Helicopter yarding and staging may occur only on those THP areas >0.5 mile from the Activity Center.

6) For NSO Activity Centers, where fledging status has been determined (either nest failure or fledglings have left the Core Area):

a) Full timber operations, including helicopter yarding and staging, may be conducted within 0.25 mile but not within the 100-acre core polygon of the Activity Center. Helicopter fly-overs shall not occur within 1000 feet of the Activity Center.
b) Limited timber operations (road use and maintenance, map point work, use of existing skid roads, tail-hold placements and loading) may be conducted within the 100-acre core polygon of the Activity Center, provided no trees >11 inches DBH are removed by the operations, and no logs are yarded through the Core Area.

7) For any NSO Activity Center, regardless of reproductive status:

a) If NSO move to a new location (>1000 feet from the historical Activity Center) and reproductive behavior is confirmed at the new site, request technical assistance to evaluate the status of the historical Activity Center.

IX. February Extensions for Timber Operations:

There is no allowance for extending on-going timber operations into the breeding season except, as stipulated in the most current USFWS Survey Protocol Spot Survey procedures.

X. CAL FIRE Review

When reviewing information related to NSO Activity Centers, the following outline should be used to check for adequacy and accuracy:

1) Location
   a) Confirm plotted Activity Center location accuracy.
      i) Review recent surveys.
      ii) Review CDFG Reports 1, 2, 3.
      iii) Review data from adjacent landowners.
   b) Evaluate deviations from CDFG locations.
   c) Determine if habitat maps and tables have been updated.
2) Activity Center and Project Area Habitat Typing.
3) Verify pre-harvest habitat typing of project area, survey area and 0.7 mile radius from each Activity Center using aerial photos, equivalent imagery, or field visits.
4) Determine if any habitat alterations have occurred which should be reflected in current NSO habitat tables and habitat analysis maps.
5) Verify post-harvest habitat typing reflects the silvicultural prescriptions.
6) Determine Activity Center status.
7) Is it a valid site?
      i) Review most current protocol to determine if the location is consistent with definition of a site.
      ii) Report both new sites and non-valid sites (need USFWS approval) to CDFG for next database update.
8) Determine current occupancy status.
9) Determine current reproductive status, if it was determined.

10) Activity Center Habitat and Disturbance Protection Measures.
11) Confirm consistency with Attachment A.

XI. Determination

CAL FIRE should use the following list to help with their take avoidance determinations:

1) If surveys are inadequate or do not meet the intent of the NSO protocol in effect during the year(s) of survey, take avoidance determination may not be possible.

2) If habitat typing is inadequate, incidental take determination may not be possible.

3) If NSO home range habitat acres are below desired conditions (Section III. 2, 3, and 4), additional loss of suitable habitat can lead to take.

4) If NSO are nesting, use seasonal restriction for all timber operations within 0.25 mile of a nest (February 1 through July 31).

5) If effects are limited to noise disturbance (e.g., no suitable habitat in timber harvest units, but suitable habitat within 0.25 mile of units), a modified seasonal restriction may be used from February 1 through July 9, as follows:
    a. Seasonal restriction applies to unsurveyed suitable habitat within 0.25 mile of unit boundary.
    b. If protocol surveys were conducted and did not detect reproductive NSO, or barred owls seasonal restrictions may not warranted.

6) When multiple THPs are located within a given NSO territory, all habitat conditions should be considered collectively a take avoidance determination may not be possible.

XI. Contents of Technical Assistance Requests

Technical assistance (or "TA") requests need to be submitted to AFWO by CAL FIRE. Open "Habitat Retention Agreements," NTMPs, "Spotted Owl Management Plans," Spotted Owl Recovery Plans," and THPs that have received previous technical assistance from the AFWO (i.e., have an AFWO TA correspondence number) will continue to receive additional technical assistance from AFWO. Technical assistance will be provided on a case-by-case basis to CAL FIRE, by AFWO, on complex determinations or on points of clarification.

Information to be submitted to CAL FIRE should include:

1. Date of written TA request.
2. Date request received.
3. Assigned TA number (only if previous technical assistance has been provided by AFWO in the past for this project).

4. Number of acres within the THP boundary.
5. Maps indicating types and locations of units with silviculture prescriptions.
6. Map of any know NSO sites within the survey area.
7. Location of THP, including County(s); Meridian(s); and, Townships, Ranges, and Sections.
8. Identify NSO Activity Centers returned by CDFG reports.
9. Results of all surveys conducted and Activity Center status for any known Activity Center.
10. Logic behind the take determination.
    a. Habitat considerations:
        i. Acres, quality, and location of suitable habitat pre- and post-harvest,
        ii. Effects of timber operations on suitable habitat;
            1. Degrade: suitable habitat is harvested but still functions in the capacity it did pre-harvest (i.e. Foraging habitat before harvest functions as Foraging habitat post-harvest, Nesting/Roosting habitat pre-harvest functions as Nesting/Roosting habitat post-harvest);
            2. Downgrade: pre-harvest Nesting/Roosting habitat becomes Foraging habitat post-harvest;
            3. Remove: Nesting/Roosting or Foraging habitat is harvested, such that it no longer functions as habitat post-harvest;
    b. Proximity of Activity Center to operations, and;
    c. Survey data.
11. Sunset date and seasonal restrictions:
    a. If operations are not complete before February 1, surveys are required to determine location and status of NSO prior to operations during each breeding season that operations are ongoing.
    b. Additional technical assistance may not be required if NSO are not found within 0.7 mile of THP (CDFG reports), if suitable habitat within units are not found within the project area, or if suitable habitat is not identified within 0.25 mile of units.
12. Name of agency person to contact if there questions regarding the technical assistance.

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U.S. Fish & Wildlife Service, July 26, 2006, guidance document "Estimating the Effects of Auditory and Visual Disturbance to Northern Spotted Owls and Marbled Murrelets in Northwestern California."

ATTACHMENT D

U.S. Fish and Wildlife Service
Estimating the Effects of Auditory and Visual Disturbance to Northern Spotted Owls and Marbled Murrelets in Northwestern California.

July 26, 2006

Executive Summary

The issue of project-induced noise disturbance to northern spotted owls and marbled murrelets has drawn increasing attention in recent years, yet remains a complex, controversial, and poorly understood subject. The data available to assess impacts to terrestrial wildlife from these effects are limited, and fewer data yet are specific to these listed species. This guidance document builds upon and consolidates prior efforts (see Appendices) to interpret the limited available data to draw objective conclusions about the potential for these effects to rise to the level of take.

Through this guidance, the US Fish and Wildlife Service (Service) describes behaviors of these two forest species that reasonably characterize when disturbance effects rise to the level of take (i.e., harass), as defined in the implementing regulations of the Endangered Species Act of 1973, as amended (the Act). These behaviors include:

- Flushing an adult or juvenile from an active nest during the reproductive period.
- Precluding adult feeding of the young for a daily feeding cycle.
- Precluding feeding attempts of the young during part of multiple feeding cycles.

We have attempted to provide objective metrics based on a substantial review of the existing literature, as it pertains to these species and appropriate surrogate species. Our recommended methodology relies on a comparison of sound levels generated by the proposed action to pre-project ambient conditions. Disturbance may reach the level of take when at least one of the following conditions is met:

- Project-generated sound exceeds ambient nesting conditions by 20-25 decibels (dB).
- Project-generated sound, when added to existing ambient conditions, exceeds 90 dB.
- Human activities occur within a visual line-of-sight distance of 40 m or less from a nest.

To simplify the analysis of these potential effects, and to promote consistency in interpretation of the analytical results, we established sound level categories of 10-dB increments. The analysis relies on a simple comparison of project-generated sound levels against ambient conditions. Our recommended analysis includes a simple comparison of project and pre-project sound levels within a matrix of estimated distances for which available data support a conclusion of harassment. We provide a real-world example to assist the reader in understanding the correct application of the methodology.

Finally, we provide additional information the analyst should consider in conducting the analysis, as well as guidance on interpretation the final numbers derived from the analysis. We describe site-specific information that is important to include in project analyses, caution against inappropriate inclusion of information and circumstances not relevant to the results, and provide context to the final interpretation.

Introduction

The issue of elevated sound and visual disturbance of forest wildlife species, especially as it affects the northern spotted owl (owl) and the marbled murrelet (murrelet), has received increased attention in recent years, yet remains a complex, controversial, and poorly understood subject. In an effort to provide objective criteria for determining when disturbance of these species might rise to the level of "take", and to promote consistency in the interpretation of analytical results, the Arcata Fish and Wildlife Office (AFWO) developed the following guidance. The purposes of this guidance are (a) to describe the scientific basis for considering the effects of auditory and visual disturbance to owls and murrelets, and (b) to provide a methodology to simplify the analysis of these effects for the large majority of project circumstances typically encountered in or near owl and/or murrelet habitat.

This guidance attempts to quantify the effects of elevated sound levels and visual proximity of human activities to owls and murrelets, and primarily applies to these species within their suitable forest habitats in northwestern California. It may have some applicability to other forest nesting avian species, but was not developed with other species specifically in mind. Future updates of this guidance may address other forest birds.

This guidance has been developed through an extensive consideration of the available literature, incorporating species-specific information as available, but relying substantially on data from a variety of other surrogate avian species and local applications, as appropriate. This guidance is adapted from information compiled and distributed by the Service's Pacific Region, Office of Technical Support, while allowing for local conditions. Appendices A and B of this document include that information. The reader is referred to those documents for important and extensive background information regarding this issue, methods used to estimate the physical attenuation of sound in the forested landscape, and a complete list of cited material supporting our analysis. However, this guidance is intended to stand alone; the user need not read and digest the extensive appended material to fully implement this guidance.

Behaviors Indicating Harassment

The definition of "take" prescribed by the Act includes "harass". The Act's implementing regulations further define harass as "… an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding or sheltering" [50 CFR §17.3]. Activities that create elevated sound levels or result in close visual proximity of

human activities at sensitive locations (e.g., nest trees), have the potential to significantly disrupt normal behavior patterns.

While owls and murrelets may be disturbed by many human activities, we anticipate that such disturbance rises to the level of harassment under a limited range of conditions. For purposes of this guidance, we assume harassment may occur when owls or murrelets demonstrate behavior suggesting that the safety or survival of the individual is at significant risk, or that a reproductive effort is potentially lost or compromised. Examples of this behavior include, but are not limited to:

- An adult or juvenile is flushed from a nest during the incubation, brooding, or fledging period, that potentially results in egg failure or reduced juvenile survival.
- An adult abandons a feeding attempt of a dependent juvenile for an entire daily feeding period, that potentially results in malnutrition or starvation of the young.
- An adult delays feeding attempts of dependent birds on multiple occasions during the breeding season, potentially reducing the growth or likelihood of survival of young.

Other essential behaviors, if disrupted, may also indicate harassment.

We conclude, based on our interpretation of the available literature, that these behaviors may occur when owls or murrelets are subject to elevated sound levels or visual detection of human activities near their active nests or dependent offspring. We interpret the available published data on owls, murrelets and appropriate surrogate species as indicating that the above behaviors may manifest when: (a) the action-generated sound level substantially exceeds (i.e., by 20-25 dB or more as experienced by the animal) ambient conditions existing prior to the project; (b) when the total sound level, including the combined existing ambient and action-generated sound, is very high (i.e., exceeds 90 dB, as experienced by the animal); or (c) when visual proximity of human activities occurs close to (i.e., within 40 m of) an active nest site. Sound levels of lesser amplitude or human presence at farther distances from active nests have the potential to disturb these species, but have not been clearly shown to cause behaviors that meet the definition of harassment. We estimate distances at which conditions (a) and (b) occur by calculating attenuation rates of sound across habitat conditions representative of the forest habitats occupied by owls and murrelets. We describe this calculation in detail in a later section.

These behaviors are difficult to witness or quantify under field conditions. The difficulty associated with documentation of these behaviors, especially in species such as the marbled murrelet that rely on cryptic coloration and behavior to avoid detection, warrants a conservative interpretation of the limited data available on this subject. However, at this time, we have identified only those behaviors associated with active nest sites during the nesting season as potentially indicating harassment.

Sound Level Categories

The analysis of auditory and visual disturbance provided herein relies substantially on a simple comparison of the sound level generated by sources (e.g., chainsaws, dozers, trucks, power tools,

etc.) anticipated for use in a proposed action against ambient sound conditions prevalent in the action area prior to implementing the project. The analysis compares the sound level that a nesting owl or murrelet is likely to be subject to as a result of implementing a proposed action against the sound levels to which the species may be exposed under existing, pre-project conditions.

Note that in this guidance we define the "ambient" sound level as that sound environment in existence prior to the implementation of the proposed action, and may include any and all human-generated sound sources when they constitute a long-term presence in the habitat being analyzed. Temporary, short-term sources, even if in effect during or immediately prior to the proposed action, would generally not be considered as part of the ambient but would instead be considered as a separate effect, or considered in combination with the sources from the proposed action. A special case of ambient is the "natural ambient", which includes sound sources native to the forested habitat being considered, such as wind in trees, bird calls, and distant water flow. Human-generated, "white noise" sources, such as a distant highway, may also be part of the natural ambient if (a) distant to the area being considered, (b) relatively low in volume (i.e., <50 dB), and (c) relatively uniform in sound level over the area of consideration. Ambient sound should be estimated based on typical sources experienced on a daily or more frequent basis. For other than "natural ambient", sources are generally located within or near the footprint of the proposed action.

The analytical comparison is provided graphically in Table 1. However, before discussing the methodology incorporated into this table, and the interpretation of numeric values derived from its use, we define and describe the sound level categories used in this analysis. We created sound level categories of 10-dB increments as a means to simplify the analysis. Each sound level category is described in terms of the conditions, equipment, tools, and other sound sources common to the particular level.

The following subsections provide concise descriptions of sound levels typically encountered under pre-project ambient conditions or during project implementation (including post-project use, if future use of the project area results in a long-term alteration of the sound/visual environment). Each description includes the decibel range, a general description, and examples of equipment or tools that typify that sound environment. Measurements and estimates from a broad range of tools and equipment are provided for reference purposes in Table 2.

It should be noted that many tools and equipment demonstrate a range of sound production substantially wider than the 10-dB sound level categories provided here. That range of sound production represents the inherent variability among similar sources, and the variation that typically occurs among measurements of even identical sources. This can easily be seen in a cursory examination of Table 2. When the range of sound measures for a source exceed the 10-dB range of a single sound level category, the analyst should consider the sound source in the context of other sources typical to the proposed activity. For example, chain saws used in timber harvest operations would include those in the higher sound measures, and would not include lower sound levels more representative of homeowner applications. In a related issue, the sound of small trees being felled is not anticipated to be substantially higher than the sound of the saws

and other activities. However, the felling of larger trees may exceed the sound of the equipment used to fall and yard them; we have addressed this situation in the sound level descriptions.

We have attempted to create categories here that include similar sound sources, and have generally applied more median values (that is, we have discounted outliers) where multiple values for similar sound sources are encountered. While there may be exceptions within and among these categories, we have attempted to address this variability through an otherwise conservative approach to estimating distances at which harassment behaviors may manifest.

Natural Ambient: Refers to ambient sound levels (generally < 50 dB) typically experienced in owl or murrelet habitat not substantially influenced by human activities, and includes sources native to forest habitats. Human-generated "white noise", such as from a *distant* highway, may apply when < 50 dB and relatively uniform across the action area.

Very Low: Typically 50-60 dB, and generally limited to circumstances where human-generated sound would never include amplified or motorized sources. Includes forest habitats close to less-frequently encountered natural sources, such as rapids along large streams, or wind-exposure, and may include quiet human activities such as nature trails and walk-in picnic areas.

Low: Typically 61-70 dB, and generally limited to sound from small power tools, light vehicular traffic at slow speeds on paved surfaces, non-gas-powered recreational activities, and residential activities, such as those associated with small parks, visitor centers, bike paths, and residences. Includes most hand tools and battery operated, hand-held tools.

Moderate: Typically 71-80 dB, generally characterized by the presence of passenger vehicles and street-legal motorcycles, small trail cycles (not racing), small gas-powered engines (e.g., lawn mowers, *small* chain saws, portable generators), and high-tension power lines. Includes electric hand tools (except circular saws, impact wrenches and similar).

High: Typically 81-90 dB, and would include medium- and large-sized construction equipment, such as backhoes, front end loaders, large pumps and generators, road graders, dozers, dump trucks, drill rigs, and other moderate to large diesel engines. Would include high speed highway traffic including RVs, large trucks and buses, large street legal and trail (not racing) motorcycles. Also includes power saws, large chainsaws, pneumatic drills and impact wrenches, and large gasoline-powered tools.

Very High: Typically 91-100 dB, and is generally characterized by impacting devices, jackhammers, racing or Enduro-type motorcycles, compression ("jake") brakes on large trucks, and trains. This category includes both vibratory and impact pile drivers (smaller steel or wood piles) such as used to install piles and guard rails, and large pneumatic tools such as chipping machines. It may also include largest diesel and gasoline engines, especially if in concert with other impacting devices. Felling of large trees (defined as dominant or subdominant trees in mature forests), truck horns, yarding tower whistles, and muffled or underground explosives are also included.

Extreme: Typically 101-110 dB. Generally includes use of ground-level, unmuffled explosives, pile driving of large steel piles, low-level over flights or hovering of helicopters, and heavily amplified music.

Sound Levels Exceeding 110 dB: These sound levels, typified by sources such as jet engines and military over flights, large sirens, open air (e.g., treetop) explosives, and double rotor logging helicopters, are special situations requiring site- and situation-specific analysis, and are not covered by the analytical methods provided herein.

Derivation of Harassment Distances

As indicated earlier, available data suggest that harassment occurs when sound levels resulting from project-based sound sources exceed ambient conditions by relatively substantial levels, or when those sound sources exceed a high absolute threshold. Since sound attenuates as a function of the distance from the source (within typical forest habitat, at a rate of approximately 6 dB per doubling of distance from a point source), the analyst can estimate the distance at which various sound sources exceed ambient conditions by anticipated threshold values. We estimated these distances using a spreadsheet model that simulates sound attenuation in typical forest habitats, reasonably accounting for ambient environmental conditions and sound source characteristics. As a means of simplifying the analysis process, we used reasonable median sound values within the above-described categories for both source and ambient sound conditions. Table 1 reports the distances within which elevated, project-generated sound is reasonably expected to exceed ambient conditions to such a degree as to result in harassment of murrelets or owls. The reader is referred to Appendices 1 and 2 and their references for additional, detailed discussion of sound metrics and the model used to derive these distances.

Time of Day Adjustment for the Marbled Murrelet

The disturbance take threshold distances provided in Table 1 are based on a comparison of project generated sound levels with existing (ambient) sound levels, which themselves represent average daytime sound conditions. We recognize, however, that ambient sound level often has a substantial time-of-day component, with nighttime, dawn and dusk ambient sound levels generally 5-10 dB lower than typical midday levels (see Appendix A *in* EPA 1974). It is also known that murrelet flights into nests to feed nestlings and for nest-tending exchanges are concentrated around dawn and dusk (Nelson and Hamer 1995), during the period when ambient noise levels tend to be lower than average daytime levels (EPA 1974).

Therefore, for marbled murrelets, the harassment threshold distances provided in Table 1 apply to noise-generating activities occurring during the midday period, when the risk of harassment is lower. Specifically, for murrelets, the harassment distances in Table 1 apply to noise-generating activities that are not within 2 hours of sunrise or sunset. If proposed activities will occur within 2 hours of sunrise or sunset, and if the ambient sound environment during the dawn and dusk period can reasonably be expected to be 5 dB or more quieter than the midday sound environment, then the estimated harassment distance threshold should be calculated based on an ambient level 10 dB lower (i.e., one row up in the table) compared to the normal ambient rating

in Table 1. In some cases, this will result in a larger harassment threshold distance. This time-of-day measure provides a more consistent application of the threshold criteria to the known biology of the murrelet and the anticipated sound environment during dawn and dusk periods.

Similar time-of-day considerations and adjustments are not required for the northern spotted owl.

Application of Harassment Distances to Project Conditions

The following methodology may be used to estimate the approximate distance at which project-generated sound exceeds ambient conditions to such an extent that northern spotted owls or marbled murrelets may be subject to harassment due to sound or visual disturbance.

Step 1: The analyst reviews the environment in the action area to determine the existing ambient sound level. The analyst should include any sound sources occurring in the action area, prior to and not part of the proposed action, that create ambient sound levels higher than the "natural" background. For example, if the proposed action would add a passing lane to a high-use major highway, the ambient condition should include the existing traffic and maintenance on the highway itself, in addition to other sounds native to the adjacent forest environment. As a second example, a proposed action to maintain a remote hiking trail would not include sound sources other than the "natural background" and infrequent human use as part of the existing ambient. Based on this review, the analyst assigns a sound level category to the ambient condition (equivalent to a row of Table 1).

Step 2: The analyst reviews the proposed action to determine the types of equipment, tools, etc., anticipated to be used during the project. Based on the descriptions of sound level categories, above, the analyst assigns a sound level category to the action-generated sound sources (corresponding to the columns in Table 1). Action-generated sound sources should include all major sources necessary to complete the proposed action. When project-specific sound measures are not available, the reader should refer to Table 2 for typical values for equipment, tools, and other sound sources. For projects where distinctly different sound environments (for either ambient or action-generated) may occur within the overall action area, the analyst may complete separate analyses for each distinct sound environment.

Step 3: From Table 1, the analyst finds the cell corresponding to the appropriate row and column for existing ambient sound and action-generated sound, respectively. This cell provides an estimate of the distance within which increased sound level may harass an owl or murrelet. The cell values are generally reported as a distance from the outer edge of the project footprint into occupied or presumed occupied suitable habitat, unless site-specific information indicates sound sources may be more localized within the project footprint (see also "Other Considerations", below).

Step 4: When significant topographic features occur within the sound environment, appropriate consideration may be given to their sound attenuating capabilities. However, the analyst should have a full understanding of the effects of topography on sound attenuation, especially when the species involved typically nests at a substantial distance above the ground. That is, topography may substantially attenuate sound between the source and the receiver (i.e., owl or murrelet nest

site) when that topographic barrier is sufficiently high to block line-of-sight transmission between the source and receiver. For species such as owls and murrelets that normally nest high in tall trees, topography or other barriers provide little attenuation unless very close to the sound source, or very high.

Step 5: Consider the potential for human activities within 40 m of nest branches of owls or murrelets. If no known or likely nest tree, or flight path to the nest itself, occurs this close to the visual disturbance sources, there would be no visual disturbance of owls or murrelets anticipated. Otherwise, assume visual harassment for up to 40 m from human activities.

Table 1. Estimated harassment distance due to elevated action-generated sound levels for proposed actions affecting the northern spotted owl and marbled murrelet, by sound level.

Existing (Ambient) Pre-Project Sound Level (dB)[1,2]	Anticipated Action-Generated Sound Level (dB)[2, 3]			
	Moderate (71–80)	High (81–90)	Very High (91–100)	Extreme (101–110)
"Natural Ambient"[4] (≤50)	50 (165)[5,6]	150m (500)	400m (1,320)	400m (1,320)
Very Low (51–60)	0	100 (330)	250 (825)	400 (1,320)
Low (61–70)	0	50 (165)	250 (825)	400 (1,320)
Moderate (71–80)	0	50 (165)	100 (330)	400 (1,320)
High (81–90)	0	50 (165)	50 (165)	150 (500)

[1]Existing (ambient) sound level includes all natural and human-induced sounds occurring at the project site prior to the proposed action, and are not causally related to the proposed action.
[2]See text for full description of sound levels.
[3]Action-generated sound levels are given in decibels (dB) experienced by a receiver, when measured or estimated at 15.2 m (50 ft) from the sound source.
[4]"Natural Ambient" refers to sound levels generally experienced in habitats not substantially influenced by human activities.
[5]All distances are given in meters, with rounded equivalent feet in parentheses.
[6]For murrelets, activities conducted during the dawn and dusk periods have special considerations for ambient sound level. Refer to text for details

Example Analysis

The following example is provided to assist the reader in understanding the application of this recommended methodology to a hypothetical yet typical project circumstance.

Proposed Project: An agency proposes to construct an informational kiosk, restroom, and six graveled parking slots at an existing, undeveloped, trailhead parking area along a low-speed (<45 mph), paved road closed to large trucks and buses. The footprint of the proposed project is a roughly circular area of approximately 75-foot diameter (about 1/10 acre). The surrounding

forest is suitable nesting habitat for marbled murrelets, and the agency proposes to do construction during the nest season. Topography in the action area is low rolling ridges less than 50 feet high. No other sound sources of significance are located nearby. The construction project will not remove any large trees, but requires the use of several pieces of equipment (e.g., backhoe, dump truck), as well as smaller power equipment (e.g., saws, cement mixer, portable generator, small chain saw) and hand tools. No jackhammering, pile driving, or larger diesel equipment is needed. The agency agrees to conduct all on-site activities during the midday time period between 2 hours after sunrise to 2 hours before sunset.

Analysis: The ambient sound level at the proposed kiosk includes the existing passenger vehicle/light truck traffic on a paved surface immediately adjacent to the work area, and existing human presence of hikers. Using the above-described sound level categories, this ambient sound level classifies as "low" (61-70 dB). The large construction equipment (i.e., the backhoe and truck) are the greatest sources of increased sound to be considered here, as they exceed the level of the other tools. From the above-described sound levels, we anticipate that action-generated sound levels will fit into the "high" category (81-90 dB). Choosing the appropriate row (Ambient = Low) and column (Action-generated = High) in Table 1, we estimate that disturbance may rise to the level of harassment over an area within 50 m (165 ft) from the footprint of the project. Since all activities will be conducted during the mid-day period, no further adjustment of the tabled value to account for murrelet activity periods is necessary. This 50-m distance, when used as a buffer around the project footprint, results in an estimate of 2.9 acres (1.2 ha) subject to harassment from auditory disturbance. Large potential nest trees exist immediately adjacent to the work area, so visual harassment may also be a consideration. However, human presence already occurs at the trailhead on a daily basis, and the proposed project will not substantially alter that effect. The topographic features in the action area are unlikely to further attenuate any sound experienced by murrelets, which commonly nest more than 50 feet above ground level. Since construction of the kiosk and restroom would not appreciably change the effects of the existing roadway or parking area, the duration of effects would be for a single breeding season, and would not alter effects already at the site in future years.

Interpretation and Application of the Results

The estimated harassment distance resulting from the analysis of any particular project conditions requires careful interpretation. Although seemingly precise, the reported distance represents a reasonable *approximation* of the distance wherein "the likelihood of injury" occurs, as supported by currently available data. That is, the resultant number estimates the distance within which available disturbance data on owls or murrelets (or surrogate species, as appropriate) show that at least some individuals would demonstrate one or more behaviors indicating harassment as a result of anticipated sound levels or visual detection of human activities near nest sites. Given the many sources of variability in such an analysis, such as differences in individual bird response, variation in actual sound level produced by similar sources, variability in sound transmission during daily weather patterns, and non-standardization

in sound metrics reported in the published literature, exact estimates of harassment distances are currently infeasible, and likely will remain so.

It is reasonable to assume that owls or murrelets closer to sources of disturbance have a higher likelihood of suffering significant disruption of normal behavior patterns than those at the outer limits of the estimated harassment distance, due to louder sound levels or a visually closer perceived threat to the nest. Further, not all owls or murrelets, except those in the very closest proximity to the disturbance source, may respond to a degree indicating harassment. Thus, the likelihood of injury for any particular individual would range from some low proportion to a higher value depending on its actual proximity to a particular sound/visual source. It is neither reasonable nor necessary for purposes of analysis and estimation of take to predict that all (or even a high proportion of) owls or murrelets within this distance show harassment behaviors. Conversely, it is also unreasonable to conclude that owls or murrelets beyond this distance would never be harassed. A more supportable interpretation is that currently available information does not support a conclusion that owls or murrelets more distant to the anticipated sound/visual disturbances are likely to suffer a significant disruption of normal behavior patterns.

The reporting of take associated with auditory and visual disturbances is necessary, even if somewhat imprecise. It is appropriate to consider all reasonable means to minimize take including, but not limited to, seasonal restrictions and substitution of equipment type to reduce the likelihood of injury, so long as those means are consistent with the "minor change rule" [50 CFR §402.14 (i)(2)]. When considering measures to reduce the effects of harassment, the analyst should bear in mind not only the spatial extent of the disturbance, but also the timing and duration of the disturbance.

Finally, activities which result in estimated distances of zero meters would be expected to have no effect on either owls or murrelets. Activities resulting in estimates of 50 m or less may, under some circumstances, be considered not likely to adversely affect, due in part to the species preference of nesting high up in large trees. However, the analyst should be prepared to describe and justify reasons for these findings.

Other Considerations

This guidance does not consider the direct effects of predation by corvids (ravens, crows and jays) and other predators as a result of human activities in murrelet and owl habitat. That is, while corvids may increase in number in murrelet and owl habitat in response to human activities, the resulting increased take due to predation (injury) is not addressed here. Distance estimates reported in this guidance reflect only the effects of sound attenuation and visual detection on behaviors appropriately interpreted as harassment. We have considered predation only in the sense that detection of the nest as a result of owl or murrelet harassment behavior (e.g., flushing from the nest) may increase the risk of predation, regardless of density of predators, and thus represents a "likelihood of injury."

This analytical method addresses most forest habitat conditions that affect the attenuation rate of sound (and thus the level of sound detected by the owl or murrelet at its location). These

conditions include dampening effects of forest vegetation, variability in natural ambient sound typically encountered under forest conditions, use of multiple pieces of identical equipment, and the effect of elevated nest sites on sound attenuation. Departure from the tabled values in this guidance to account for special forest conditions is generally inappropriate except under highly unusual circumstances. A factor *not* considered in this methodology is the effect of topography on sound attenuation. Therefore, a site-specific assessment of topography should be considered. Steep slopes, ridges, and designed sound barriers may increase sound attenuation when they form complete barriers to the direct line of sound transmission between source and the location of the receiver (here, the actual location of the potentially harassed animal). In general, small ridges or walls not clearly blocking the sources from a highly elevated nest would provide little or no attenuation. When clearly supported by site-specific information regarding topography, action-generated sound may be reduced by one or two levels in the analysis, when compared to existing ambient sound levels.

For some projects, elevated sound levels may cease following completion of the project. For example, sound level following the completion of timber harvest is likely to return to pre-harvest levels, and so would not result in long-term or permanent sound and visual disturbance to owls and murrelets. On the other hand, actions such as the creation of a new road may result in elevated sound levels both during construction and during future use and maintenance of the road. The analyst should carefully consider both spatial and temporal aspects of noise and visual disturbance for each project.

Activities producing sound levels of 70 dB or less (estimated at 15.2 m from the sources), such as use of hand tools, small hand-held electric tools, or non-motorized recreation, would not generally rise to the level of harassment, except in certain circumstances, such as when used in very close proximity (i.e., <25 m) to an active nest. However, under these circumstances, visual detection of human activities by the species near its nest is assumed to be of more consequence than auditory disturbance, and take should be described in such terms.

Activities producing sound levels greater than 110 dB (estimated at 15.2 m from the sources), such as open-air blasting, aircraft, or impact pile-driving, are not addressed in this analysis, and should be evaluated through a more detailed site-specific analysis.

Table 2. Some Common Sound Levels for Equipment/Activities.

	Range of Reported dB Values @ Distance Measure *(Distance measured @ 50 ft (15.2 m) unless otherwise indicated)*		
Measured Sound Source	**Reported Decibel Value**	**"Standardized" Value @ 50 ft** [1]	**Relative Sound Level** [2]
Quiet Whisper	30 @ 3 ft	6	Ambient
Ambient Sound Level - Forest Habitats (low end[3])	25	25	Ambient
Library (ambient sound level)	30 @ ambient	30	Ambient
Conversation (low end)	55 @ 1 m	31	Ambient
Conversation (high end[4])	62 @ 2 ft	34	Ambient
Conversataion	60 @ 3 ft	36	Ambient
Speech (normal)	65 @ 1 m	41	Ambient
Ambient Sound Level - Forest Habitats (high end)	43.8	44	Ambient
Home Vacuum Cleaner	70 @ 1 m	46	Very Low
Loud Singing	75 @ 3 ft	51	Very Low
Generator (light home/recreational, 900-2,800 W)	59 @ 7 m	52	Very Low
Air Conditioner Window Unit	60 @ 25 ft	54	Very Low
Generator (light commercial, 4,000-5,000 W) (low end)	61 @ 7 m	54	Very Low
Pickup Truck (idle) (low end)	55	55	Very Low
Garbage Disposal (low end)	80 @ 1 m	56	Very Low
Garbage Disposal (high end)	80 @ 3 ft	57	Very Low
Generator (light commercial, 4,000-5,000 W) (high end)	65 @ 7 m	58	Very Low
Conversation (indoor)	60	60	Very Low
Chain Saw Running (rain) (low end)	61	61	Low
Food Blender (low end)	85 @ 1 m	61	Low
Generator (heavy home, 3,300-5,500 W) (low end)	68 @ 7 m	61	Low
Generator (light industrial, 2,600-9,500 W) (low end)	68 @ 7 m	61	Low
Milling Machine	83 @ 4 ft	61	Low
Pickup Truck (idle) (high end)	77 @ 8 ft	61	Low
Motorcycle on Trail (620 cc street legal, meter at ground level)	61.9	62	Low
Powerline	50 @ 200 ft	62	Low
Chainsaw (Stihl 025)	46 @ 105 m	63	Low
Generator (economic home, 2,300-4,500 W) (low end)	70 @ 7 m	63	Low
Street Motorcycles < 100 cc (low end)	65	65	Low
Motorcycle on Trail (100 cc, 2-stroke, meter at ground level)	65.7	66	Low
Chainsaw (McCulloch Promac 260, low end)	46.1 @ 150 m	66	Low
Chainsaw (Stihl 025, low end)	53.8 @ 60 m	66	Low
Food Blender (high end)	90 @ 3 ft	66	Low
Motorcycle on Trail (620 cc street legal, meter elevated 15 m)	66.6	67	Low
Generator (welding, 4,000 W)	74 @ 7 m	67	Low
Passenger Car (50 mph)	67	67	Low
Passenger Car (60 kph)	65 @ 20 m	67	Low
Generator (heavy home, 3,300-5,500 W) (high end)	75 @ 7 m	68	Low
Generator (medium commercial, 6,000 W)	75 @ 7 m	68	Low
Power Lawn Mower	92 @ 1 m	68	Low
Motorcycle on Trail (100 cc, 2-stroke, meter elevated 15 m)	68.1	68	Low
Generator (economic home, 2,300-4,500 W) (high end)	76 @ 7 m	69	Low
Chainsaw (McCulloch Promac 260)	59.9 @ 50 m	70	Low
Generator (25 KVA or less)	70	70	Low
Yelling	92 @ 4 ft	70	Low
Pickup Truck (driving)	87 @ 8 ft	71	Moderate
Motorcycle on Trail (300 cc, 2-stroke, meter at ground level)	71.3	71	Moderate
Chainsaw (McCulloch Promac 260)	61.3 @ 50 m	72	Moderate
Gas Lawn Mower	96 @ 1 m	72	Moderate

Measured Sound Source	Reported Decibel Value	"Standardized" Value @ 50 ft [/1]	Relative Sound Level [/2]
Mowers, leaf blowers (low end)	72	72	Moderate
Chainsaw (Stihl 025, high end)	60.5 @ 60 m	73	Moderate
Generator (light industrial, 2,600-9,500 W) (high end)	80 @ 7 m	73	Moderate
Street Motorcycles 350-749 cc (low end)	73	73	Moderate
Welder	73	73	Moderate
Automobile	80 @ 25 ft	74	Moderate
Jackhammer (muffled)	74	74	Moderate
Pile Driving (1999 ODOT Study, low end)	74	74	Moderate
Roller (low end)	74	74	Moderate
Street Motorcycles >= 750 cc (low end)	74	74	Moderate
Chain saws (low end)	75	75	Moderate
Off-Road Motorcycles < 100 cc (low end)	75	75	Moderate
RVs (small) (low end)	75	75	Moderate
Concrete Vibrator	76	76	Moderate
Passenger Cars/Light Trucks (65 mph) (low end)	76	76	Moderate
Flatbed Pickup Truck	93 @ 8 ft	77	Moderate
Log Truck	67 @ 46 m	77	Moderate
Pump (low end)	77	77	Moderate
Street Motorcycles 170-349 cc (low end)	77	77	Moderate
BPA Powerline	66 @ 200 ft	78	Moderate
Generator (low end)	78	78	Moderate
Off-Road Motorcycles 100-169 cc (low end)	78	78	Moderate
Street Motorcycles 100-169 cc (low end)	78	78	Moderate
Backhoe	69 @ 46 m	79	Moderate
Off-Road Motorcycles 170-349 cc (low end)	79	79	Moderate
Motorcycle on Trail (300 cc, 2-stroke, meter elevated 15 m)	79.6	80	Moderate
Backhoe (low end)	80	80	Moderate
Boat motors (low end)	80	80	Moderate
Cat Skidder	70 @ 46 m	80	Moderate
Chainsaw (McCulloch Promac 260, high end)	59.5 @ 150 m	80	Moderate
Compressor (low end)	80	80	Moderate
Concrete Mixer (low end)	80	80	Moderate
Front-end Loader (low end)	80	80	Moderate
Ground Compactor (low end)	80	80	Moderate
Horizontal Boring Hydraulic Jack	80	80	Moderate
Medium Construction (low end)	80	80	Moderate
Medium Trucks & Sport Vehicles (65 mph) (low end)	80	80	Moderate
Paver (low end)	80	80	Moderate
Rock Drill and Diesel Generator (low end)	58 @ 200 m	80	Moderate
Roller (high end)	80	80	Moderate
Vacuum Street Sweeper	80	80	Moderate
Cat Skidder	59 @ 200 m	81	High
Concrete Truck (low end)	81	81	High
Off-Road Motorcycles < 100 cc (high end)	81	81	High
Pumps, generators, compressors (low end)	81	81	High
Concrete Pump	82	82	High
Dump Truck Dumping Rock	72 @ 46 m	82	High
Ground Compactor (high end)	82	82	High
Rock Drills and Jackhammers (low end)	82	82	High
Slurry Machine (low end)	82	82	High
Street Motorcycles < 100 cc (high end)	82	82	High
Train	90 @ 20 ft	82	High
Chainsaw, large	73 @ 46 m	83	High

Measured Sound Source	Reported Decibel Value	"Standardized" Value @ 50 ft [/1]	Relative Sound Level [/2]
Chainsaw, large	61 @ 200 m	83	High
Concrete Batch Plant	83	83	High
Dump Truck Dumping Rock	54 @ 400 m	83	High
General construction (low end)	83	83	High
Highway Traffic (uphill, discontinuous traffic, wet)	61 @ 200 m	83	High
Log Loader	73 @ 46 m	83	High
Power Mower	107 @ 3 ft	83	High
Road Grader (low end)	83	83	High
Backhoe (high end)	84	84	High
Dozer (low end)	84	84	High
Dump Truck	84	84	High
Flat Bed Truck	84	84	High
Generator (high end)	84	84	High
Heavy Construction (low end)	84	84	High
Large Truck (low end)	84	84	High
Motorcycle	88 @ 30 ft	84	High
Motorcycle Enduro Event	62.3 @ 180 m	84	High
Pile Driving (1987 WDOT Study, low end)	84	84	High
Rock Drill and Diesel Generator (low end)	55 @ 400 m	84	High
Motorcycle on Trail (200 cc, 2-stroke, meter at ground level)	84.5	85	High
5 Motorcycles	67 @ 120 m	85	High
Auger Drill Rig	85	85	High
Concrete Mixer (high end)	85	85	High
Concrete Truck (high end)	85	85	High
Crane (low end)	85	85	High
Diesel Truck (40 mph)	85	85	High
Drill Rig (low end)	85	85	High
Dump Truck	63 @ 200 m	85	High
Equipment > 5 horsepower	85	85	High
Gradall (low end)	85	85	High
Highway Traffic (uphill, discontinuous traffic, wet)	75 @ 46 m	85	High
Impact Wrench	85	85	High
Large Tree Falling	63 @ 200 m	85	High
Log Loader	63 @ 200 m	85	High
Mounted Impact Hammer Hoe-Ram (low end)	85	85	High
Mowers, leaf blowers (high end)	85	85	High
Passenger Cars/Light Trucks (65 mph) (high end)	85	85	High
Pump (high end)	85	85	High
Road Grader (high end)	85	85	High
Rock Drill (low end)	85	85	High
RVs (large) (low end)	85	85	High
RVs (small) (high end)	85	85	High
Scraper (low end)	85	85	High
23 ft Detonation Cord, on surface (low end)	80 @ 100 ft	86	High
Chain saws (high end)	86	86	High
Chainsaw (Cantor, one chainsaw running)	86	86	High
Dump Truck Dumping Rock	64 @ 200 m	86	High
Gradall (high end)	86	86	High
Large Diesel Engine	100 @ 10 ft	86	High
Motorcycle Enduro Event	68.4 @ 120 m	86	High
Pneumatic wrenches, rock drills (low end)	86	86	High
Rock Drill and Diesel Generator (high end)	64 @ 200 m	86	High
12 ft Detonation Cord, buried (low end)	66 @ 580 ft	87	High

Measured Sound Source	Reported Decibel Value	"Standardized" Value @ 50 ft [/1]	Relative Sound Level [/2]
Diesel Truck (50 kph)	85 @ 20 m	87	High
Front-end Loader (high end)	87	87	High
Hydromulcher (low end)	71 @ 300 ft	87	High
Pumps, generators, compressors (high end)	87	87	High
Crane (high end)	88	88	High
Dozer (high end)	88	88	High
Drill Rig (high end)	88	88	High
Off-Road Motorcycles 350-750 cc (low end)	88	88	High
Street Motorcycles 100-169 cc (high end)	88	88	High
Motorcycle on Trail (200 cc, 2-stroke, meter elevated 15 m)	88.2	88	High
5 Motorcycles	55 @ 760 m	89	High
Chainsaw (Cantor, two chainsaws running)	89	89	High
General construction (high end)	89	89	High
Jackhammer	89	89	High
Large Truck (high end)	89	89	High
Medium Construction (high end)	89	89	High
Medium Trucks & Sport Vehicles (65 mph) (high end)	89	89	High
Motorcycle Enduro Event	73.3 @ 90 m	89	High
Paver (high end)	89	89	High
Scraper (high end)	89	89	High
Street Motorcycles 350-749 cc (high end)	89	89	High
Chain Saw Running (rain) (high end)	80 @ 150 ft	90	High
Compressor (high end)	90	90	High
Concrete Saw	90	90	High
Heavy Trucks and Buses (low end)	90	90	High
Hydra Break Ram	90	90	High
Mounted Impact Hammer Hoe-Ram (high end)	90	90	High
Circular Saw (hand held)	115 @ 1 meter	91	Very High
Highway Traffic (downhill, discontinuous traffic, wet)	81 @ 46 m	91	Very High
Motorcycle Enduro Event	78.8 @ 60 m	91	Very High
Pneumatic Chipper (low end)	115 @ 1 m	91	Very High
Pneumatic Riveter	115 @ 3 ft	91	Very High
Slurry Machine (high end)	91	91	Very High
Track Hoe (low end)	75 @ 300 ft	91	Very High
Highway Traffic (downhill, discontinuous traffic, wet)	70 @ 200 m	92	Very High
Large Tree Falling	82 @ 46 m	92	Very High
Motorcycle Enduro Event	85.8 @ 30 m	92	Very High
Chainsaw	117 @ 3 ft	93	Very High
Clam Shovel	93	93	Very High
Railroad (low end)	93	93	Very High
Street Motorcycles >= 750 cc (high end)	93	93	Very High
Explosives (low end)	94	94	Very High
Hydromulcher (high end)	88 @ 100 ft	94	Very High
Jake Brake on Truck	110 @ 8 ft	94	Very High
Boat motors (high end)	95	95	Very High
Guardrail Installation and Pile Driving (low end)	95	95	Very High
Heavy Trucks and Buses (high end)	95	95	Very High
Impact Pile Driver (low end)	95	95	Very High
Off-Road Motorcycles 350-750 cc (high end)	95	95	Very High
Pneumatic Chipper (high end)	115 @ 5 ft	95	Very High
RVs (large) (high end)	95	95	Very High
Vibratory (Sonic) Pile Driver (low end)	95	95	Very High
Diesel Truck	100 @ 30 ft	96	Very High

Measured Sound Source	Reported Decibel Value	"Standardized" Value @ 50 ft [/1]	Relative Sound Level [/2]
Heavy Construction (high end)	96	96	Very High
Jet Overflight (low end)	80 @ 300 ft	96	Very High
Vibratory (Sonic) Pile Driver (high end)	96	96	Very High
Logging Truck	97	97	Very High
Pneumatic wrenches, rock drills (high end)	97	97	Very High
Rock Drills and Jackhammers (high end)	97	97	Very High
Street Motorcycles 170-349 cc (high end)	97	97	Very High
Door Slamming	98	98	Very High
Dump Truck	88 @ 46 m	98	Very High
Pile Driving (1999 ODOT Study, low end)	98	98	Very High
Railroad (high end)	98	98	Very High
Rock Drill (high end)	98	98	Very High
Helicopter S-61 (large, single rotor, loaded) (low end)	79 @ 500 ft	99	Very High
Rock Drill and Diesel Generator (high end)	70 @ 400 m	99	Very High
Off-Road Motorcycles 100-169 cc (high end)	100	100	Very High
Off-Road Motorcycles 170-349 cc (high end)	100	100	Very High
Rock Drill and Diesel Generator	90 @ 46 m	100	Very High
Exterior Cone Blast w/ sand bags (low end)	72 @ 0.25 mi	101	Extreme
Helicopter S-61 (low end)	77 @ 800 ft	101	Extreme
Impact Pile Driver (high end)	101	101	Extreme
Pneumatic tools, jackhammers & pile driver (low end)	101	101	Extreme
Amplified Rock and Roll	120 @ 6 ft	102	Extreme
Helicopter S-61 (large, single rotor, loaded) (high end)	82 @ 500 ft	102	Extreme
Pile Driving (1987 WDOT Study, high end)	103	103	Extreme
Truck Horn	120 @ 8 ft	104	Extreme
Guardrail Installation and Pile Driving (high end)	105	105	Extreme
23 ft Detonation Cord, on surface (high end)	85 @ 580 ft	106	Extreme
Impact Pile Driving	106	106	Extreme
Track Hoe (high end)	96 @ 150 ft	106	Extreme
Columbia double rotor logging helicopter (reading from road)	79 @ 400 m	108	Extreme
Pave Hawk Military Helicopter	92 @ 105 m	109	Extreme
Columbia double rotor logging helicopter (read in forest)	100 @ 46 m	110	Extreme
Pneumatic tools, jackhammers & pile driver (high end)	110	110	Extreme
12 ft Detonation Cord, buried (high end)	92 @ 500 ft	112	Extreme
Helicopter S-61 (high end)	106 @ 100 ft	112	Extreme
Rock Blast	91 @ 575 ft	112	Extreme
Columbia double rotor logging helicopter (reading from road)	84 @ 400 m	113	Extreme
Engine Exhaust (no muffler)	140 @ 3 ft	116	Extreme
Military Flight (low end)	98 @ 500 ft	118	Extreme
Exterior Cone Blast w/ sand bags (high end)	100 @ 500 ft	120	Extreme
Treetop Blast (low end)	110 @ 200 ft	122	Extreme
Columbia double rotor logging helicopter (read at clearing)	101 @ 200 m	123	Extreme
Jet Overflight (high end)	86 @ 4,000 ft	124	Extreme
Exterior Cone Blast (obstructed)	107 @ 500 ft	127	Extreme
Jet takeoff	120 @ 200 ft	132	Extreme
50 HP Siren	130 @ 100 ft	136	Extreme
Jet Plane	130 @ 100 ft	136	Extreme
Treetop Blast (high end)	116 @ 0.1 mi	137	Extreme
Military Flight (high end)	120 @ 600 ft	142	Extreme
Explosives (high end)	145 @ 330 ft	162	Extreme

[/1] "Standardized" values are sound levels converted to 50-foot equivalents (i.e., as though measured at 50 feet distance from source). For comparison purposes.

[2] Relative Sound Level: a general, subjective ranking of relative noise levels created by the sources considered here,when used for analysis of relative noise effects on species.

[3] "Low end" indicates the lower value when a range of values is reported for a sound source.

[4] "High end" indicates the higher value when a range of values is reported for a sound source.

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ATTACHMENT E

METHODS FOR SURVEYING MARBLED MURRELETS IN FORESTS: A REVISED PROTOCOL FOR LAND MANAGEMENT AND RESEARCH

Compiled and edited by:

Diane Evans Mack
William P. Ritchie
S. Kim Nelson
Elena Kuo-Harrison
Peter Harrison
Thomas E. Hamer

For the
Pacific Seabird Group
Marbled Murrelet Technical Committee

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Janet Anthony, *WDFW*
Brian Cooper, *ABR, Inc.*
Sharon Dechesne-Mansiere, *U of Victoria*
Lee Folliard, *USFWS*
Ron LeValley, *Mad River Biologists, Inc.*
Sherri Miller, *USFS PSW*
Danielle Prenzlow Escene, *WDNR*
C.J. Ralph, *USFS PSW*
Steve Singer, *Singer Environmental*

Others who submitted comments and suggestions for the final product were:

Gayle Anderson, *Boise Cascade*
Dave Buchholz, *ODF*
Steven Courtney, *SEI*
Eric Cummins, *WDFW*
Kim Flotlin, *USFWS*
Elizabeth Gayner, *BLM*
John Grettenberger, *USFWS*
Shelley Hall, *NPS*
Scott Horton, *WDNR*
Dave Huber, *BLM*
John Hunter, *USFWS*
Paul Jones, *Friends of Caren*
Linda Long, *USFS PSW*
Sarah Madsen, *USFS*
Douglas Meekins, *Hamer Environmental*
Scott Osborn, *CDFG*
Ken Ostrom, *USFWS*
Phyllis Reed, *USFS*
Lynn Roberts, *USFWS*
Clint Smith, *ODF*
Amanda Wilson, *OSU*
Mike Wilson, *ODF*

The 2000-2002 Statistical Analysis Steering Committee, which directed the analyses of survey data and reviewed results, was comprised of:

Danielle Prenzlow Escene, Facilitator, *WDNR*
Diane Evans Mack, *USFS PNW*
Lee Folliard, *USFWS*
Kim Flotlin, *USFWS*
Tom Hamer, *Hamer Environmental*
Scott Horton, *WDNR*
Joe Lint, *BLM*
Kim Nelson, *OSU*
Scott Osborn, *CDFG*
Martin Raphael, *USFS PNW*
William Ritchie, *WDFW*
Lynn Roberts, *USFWS*
Mike Wilson, *ODF*

Past (1996-2000) Statistical Analysis Steering Committee members who contributed to planning included:

Naomi Bentivglio, *USFWS*
Steven Courtney, *SEI*
Danny Grunbaum, *UW*
Nancy Lee, *USFWS*
Sarah Madsen, *USFS*
Tami Matsumoto, *USFS PSW*
Gary Miller, *USFWS*
Sherri Miller, *USFWS PSW*
Martin Nugent, *ODFW*
Bob Progulske, *USFWS*
C. J. Ralph, *USFS PSW*
Howard Stauffer, *USFS PSW*
Lenny Young, *WDNR*

Statistical tests used for this revision were designed and executed by:

TimMax, *USFS PNW*
Jim Baldwin, *USFS, PSW*
Karen Hyer, *USFS, PNW*
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LIST OF FIGURES

Figure 1. A 4-ha (10-acre) timber harvest area is located in the middle of a 122-ha (300-acre) stand of potential habitat. The survey area (timber harvest area and potential habitat within one-quarter mile of the harvest boundary) includes 83 ha (206 acres). 30

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METHODS FOR SURVEYING MARBLED MURRELETS IN FORESTS: A REVISED PROTOCOL FOR LAND MANAGEMENT AND RESEARCH

INTRODUCTION

The Marbled Murrelet (*Brachyramphus marmoratus*) occurs only in North America, from Alaska south to Santa Cruz, California (Nelson 1997), and wintering as far south as Baja California, Mexico (Erickson et al. 1995). The former Asian race of the Marbled Murrelet is now a separate species, the Long-billed Murrelet (*Brachyramphus perdix*). The Marbled Murrelet is closely associated with old-growth and mature forests for nesting (papers in Ralph et al. 1995), and population declines have been attributed in part to loss or modification of forest habitat (USFWS 1997). This species is state-listed as endangered in California and threatened in Oregon and Washington (Nelson and Sealy 1995). It is listed as nationally threatened in Canada, although it occurs only in British Columbia. In September 1992, the U.S. Fish and Wildlife Service listed Marbled Murrelets as federally threatened in Washington, Oregon, and California (USFWS 1997). The species is not listed in Alaska.

Unlike most members of the family Alcidae, Marbled Murrelets most often nest in trees. Exceptions occur in southcentral and western Alaska and British Columbia, where a few nests have been found on the ground in forested and non-forested areas (e.g., Simons 1980, Bradley and Cooke 2001). As of 2002, at least 300 tree nests had been located (S. K. Nelson, pers. comm.). From these locations and additional data gathered over the past 15 years, it is apparent that murrelets nest in old-growth and mature coniferous forests throughout most of their range (Nelson and Sealy 1995, Ralph et al. 1995, Burger 2002). They also have been found in younger forests with structural elements similar to old growth, such as remnant old-growth trees or younger trees with platforms created by deformities or dwarf mistletoe infestations (Grenier and Nelson 1995, Nelson and Wilson 2001).

To be effective in maintaining adequate nesting sites, forest land managers need to determine murrelet inland distributions and patterns of habitat use. Few murrelet surveys were conducted in forests before 1984. Methods for conducting surveys from a fixed location were initially evaluated and modified through research in Oregon and California (Paton and Ralph 1988, Nelson 1989). The Pacific Seabird Group (PSG), a professional scientific organization, has taken a lead role in coordinating and promoting research on murrelets. PSG 'protocol surveys' have been conducted since 1992 on federal, state, and private forest lands, following protocols put forth in Ralph and Nelson (1992) and Ralph et al. (1993, 1994). These protocols were designed to provide researchers and land managers with standardized techniques to detect murrelets in forests. Since 1994, continued inland surveys and research directed at various aspects of this species' breeding ecology have generated new insights on nesting behavior, activity patterns, and habitat use.

This document is a revised protocol. It compiles information from all previous protocols and provides new recommendations for survey visits based on analyses of murrelet surveys conducted during1989-1998. It provides supporting documentation for many of the recommendations, and clarifies some aspects of the protocol's use and application. Most importantly, the recommended number of survey visits has changed from previous versions. Research continues to broaden our understanding of murrelet ecology, both inland and at sea, and we expect that this protocol will need modification again in the future. Thus, it is intended as a working document, based on the best available data currently in hand, to be revised as new information is learned.

PURPOSE AND OBJECTIVES

The objectives of this protocol are to provide scientifically-based methods for biologists, managers, and researchers to: (1) document the occurrence or probable absence of murrelets in a forest at the time of surveys; (2) interpret the biological significance of behaviors observed during surveys to evaluate how murrelets are using forests (i.e., classify sites as 'presence', 'occupied', or 'probable absence'; (3) identify the geographic distribution of the Marbled Murrelet; and (4) provide consistency in surveys among land managers. This protocol is based on analyses of 10 years of survey data to provide a statistically-reliable approach to classifying surveyed areas. Surveys are designed to achieve a high confidence that occupied sites are classified correctly. While applicable in Washington, Oregon, and California, the described methods may require modification for use in British Columbia and Alaska, and may not be applicable during years with abnormal climatic or oceanographic conditions. The guidelines were developed primarily for management purposes, but are generally applicable to research, with modifications to meet specific research objectives.

It is critical to recognize that a protocol aimed at many different users for a variety of purposes cannot cover all possible scenarios. This protocol is to be used hand-in-hand with additional requirements attached by state, provincial, or federal agencies. These generally are distributed in letters accompanying the protocol, at survey training seminars, and in approved project- or site-specific management plans. Because regulatory agencies make the final determination on all aspects of surveys conducted for forest management purposes, the appropriate regulatory agency should be consulted prior to making decisions regarding habitat suitability or planning surveys to meet management objectives.

PLANNING AND CONDUCTING SURVEYS

Definitions

For purposes of this protocol, the following definitions apply.

Marbled Murrelet nests have been found primarily in mature and old-growth habitat and, in a few cases in Oregon, in younger (60-80 years) forests that have trees with dwarf mistletoe or other deformations or structures that provide a nest platform (Nelson 1997, Nelson and Wilson 2001). Douglas-fir, coast redwood, western hemlock, western red cedar, yellow cedar, mountain hemlock, and Sitka spruce predominate nest stands found to date (Hamer and Nelson 1995a, but see Bradley and Cooke 2001 for a tree nest in a large deciduous red alder and nests on cliffs). Therefore, **potential habitat** that should be surveyed for murrelets is defined as (1) mature (with or without an old-growth component) and old-growth coniferous forests; <u>and</u> (2) younger coniferous forests that have platforms. A **platform** is a relatively flat surface at least 10 cm (4 in) in diameter and 10 m (33 ft) high[1] in the live crown of a coniferous tree. Platforms can be created by a wide bare branch, moss or lichen covering a branch, mistletoe, witches brooms, other deformities, or structures such as squirrel nests. It is important to note that murrelets have occupied small patches of habitat within larger areas of unsuitable habitat (Nelson and Wilson 2001). Some occupied sites also have included large, residual trees in low densities, sometimes

[1] Based on the characteristics of most nests found to date, but note that four nests in Oregon have been found less than 15 meters above the ground (A. Wilson, pers. comm.).

less than one tree per acre (Grenier and Nelson 1995, Ralph et al. 1995). The presence of platforms appears to be the most important stand characteristic for predicting murrelet presence in an area (Hamer et al. 1994). Platform presence is more important than tree size, which alone is not a good indicator of platform abundance (Hamer 1995; S. K. Nelson, pers. comm.). Therefore, any forested area with a residual tree component, small patches of residual trees, or one or more platforms should be considered **potential** murrelet nesting habitat. **Continuous** potential habitat is that which contains no gaps in suitable forest cover wider than 100 m (328 ft).

An **audio-visual survey** is the process of determining murrelet presence, probable absence, and occupancy of a site by visiting it on the ground and observing for murrelets. The **survey area** is the entire area that is under observation. For example, it could be an entire isolated stand of potential habitat or a portion of a stand of potential habitat. Large survey areas should be divided into **survey sites,** which contain one or more survey stations (see p. 7 for a more complete discussion of survey sites). A **survey station** is the location where the observer stands when conducting a survey visit. A **survey visit** is a single morning's survey. The **survey period** is the 2-hour period in which a survey visit is conducted; it begins 45 minutes before official sunrise and continues at least 75 minutes after sunrise, except in Alaska (see p. 18).

The unit of measure for surveys is the **detection** of a single bird or group of birds, defined as the sighting or hearing of one or more birds acting in a similar manner and initially occurring at the same time. Sequential detections are distinguished by a break of five seconds or more. For example, a bird circling overhead for three minutes calling continuously would be counted as a single detection. If that bird stopped calling and was out of sight for more than five seconds and then started to call or was seen again in a different area, the observer should count it as two detections. This is because the observer would be uncertain if it was the same or a different bird. When a group is observed and then splits into two groups, the observation is treated as a single detection. If two groups are spotted separately and then coalesce, the surveyor should record the groups as two detections.

The following definitions apply to sites that have been surveyed for murrelet activity. These definitions are detailed on p. 22, 'Classification of Sites'. A site with murrelet **presence** is a site of potential habitat where there has been at least one murrelet detection. Presence sites include occupied sites. An **occupied site** is where murrelets have been observed exhibiting **subcanopy behaviors,** which are behaviors that occur at or below the forest canopy and that strongly indicate that the site has some importance for breeding. Occupied sites include **nest sites**. A **nest site** is a site with an active nest or evidence of a nest, including eggs, eggshell fragments, or a downy chick.

Inland Limit for Surveys

The data in Table 1 document the extent of the inland range as currently known. These data are provided as guidelines when planning surveys, particularly if the intent of inland surveys is to encompass all areas potentially used by Marbled Murrelets. They are not intended as strict limits by state. It is important to note that nest searches have been conducted in fewer areas than surveys, so the farthest inland detection (not necessarily nest) should be used as your guideline for planning surveys.

Some regions within states might not support murrelet activity as far inland as the maximum distances in Table 1 suggest. For example, Marbled Murrelets have been detected 59 km (37 mi)

inland near Happy Camp, in Siskiyou County, CA, but 3,592 surveys at 449 sites ranging 37-72 km (23-45 mi) inland and south from Happy Camp to Mendocino County yielded no detections (Hunter et al. 1998, Schmidt et al. 2000). A study on the Rogue River and Siskiyou National Forests and Medford District BLM demonstrated that murrelet occurrence in the Siskiyou Mountains in Oregon was associated with the extent of the hemlock/ tanoak vegetation zone, which occurs 16-51 km (10-32 miles) inland (Dillingham et al.1995, Alegria et al. 2002). For consultation purposes, the U. S. Fish and Wildlife Service (2002) no longer requires surveys for Marbled Murrelets beyond this hemlock/tanoak zone (see map in Alegria et al. 2002). Thus, consult with your regulatory agency if you are unsure how far inland to survey in your region.

Table 1. Known inland limits of Marbled Murrelet nests and detections.

	Farthest Inland (km)			
State/Province	Nest	Occupied Site	Detection	Sources[a]
Alaska	<10			1,2
British Columbia	35[b]			3
Washington	35	84		
Cowlitz Co.		<32		
s. Cascade Mtns			113	4,5
Oregon	49	65	129[c]	6,7,8,1
Siskiyou Mtns			51	9,10
N. California	28[d]	39		
Siskiyou Co.			59[e]	
Humboldt Co.			40	
Santa Cruz Mtns	16			

[a] Sources: 1-Nelson 1997; 2-Whitworth et al. 2000; 3-Lougheed 1999; 4-Ritchie and Rodrick 2002; 5- D. Lynch, pers. comm.; 6-Witt 1998a; 7-Witt 1998b; 8-E. Gaynor, pers. comm.; 9-Dillingham et al. 1995; 10-Alegria et al. 2002.
[b] A grounded fledgling with an egg tooth was reported 101 km inland (Rodway et al. 1992).
[c] Nesting behaviors not observed.
[d] Grounded fledglings and eggshell fragments have been found ~39 km inland.
[e] Extensive surveys elsewhere in Siskiyou Co. yielded no detections (Hunter et al. 1998, Schmidt et al. 2000).

Habitat Assessment

Identifying where murrelet surveys should be conducted is a critical first step in the process. A habitat assessment is an on-the-ground evaluation of the habitat within an area of proposed management activity. We are not attempting to define habitat here, given the large regional variation, but instead we describe the procedure in general terms. A habitat assessment cannot be completed from maps and aerial photos alone. It should include a 'walk-though' of the entire project area, looking specifically for the presence of platforms or, in younger-aged areas, for small patches of habitat or remnant large trees. By definition (p. 3), large-diameter trees do not have to be present for an area to contain potential habitat. Moss cover or deformities can create platforms on smaller-diameter limbs. Alternatively, moss does not have to be present within the

canopy, as murrelets can nest on duff platforms (Hamer and Nelson 1995a). Perceived lack of flight access for murrelets into an area should not eliminate that area for consideration. Stands on ≥20% slope often create natural access due to the layering of canopy trees, and streams create natural flyways (Hamer et al. 1994). Aspect has not been identified as a limiting factor for murrelet nests (Hamer and Nelson 1995a, Burger 2002). In summary, any area with a residual large tree component, small patches of potential habitat, or suitable nest platforms should be evaluated for the need for surveys.

Failure to identify potential habitat, and thus 'clear' an area for management activities, could have a substantial negative impact on the population. Deciding what constitutes murrelet habitat may involve local or region-specific considerations. For example, in Mendocino and Santa Cruz counties of California, murrelets can occur in atypical redwood forest, where sparsely distributed single large trees occur in mixed redwood/Douglas-fir. To minimize uncertainty regarding habitat assessments, we recommend that you confer with the appropriate regulatory agency when planning surveys and identifying habitat that should (or should not) be evaluated.

Survey Types

Ralph et al. (1994) described two types of surveys, General and Intensive, which were designed to address different objectives. General Surveys are no longer recommended for timber surveys or for research, as they were not designed to document probable absence. This protocol adds Radar Surveys as an option for very specific and limited objectives. Please note that Radar Surveys may not be used in place of Intensive Surveys for determining occupancy.

Radar Survey. Radar surveys employ a stationary marine radar system to detect and track murrelets in flight. Radar surveys cannot determine occupancy, but can often be used to identify presence of birds at stands (i.e., identify where occupancy is a possibility). Because it is likely that radar can reliably determine presence of birds in a shorter period than the current audio-visual protocol in some areas (Cooper and Blaha 2002), radar surveys can be used as a 'coarse filter' to quickly and accurately determine whether murrelets are present near, or adjacent to, a forest stand. For the purposes of this protocol, radar surveys can be applied to document probable presence and help identify where follow-up efforts of intensive surveys for determining occupancy would be most effective. To apply the radar technique in addition to the standard audio-visual ground survey technique, it is necessary to consult with the appropriate state and federal agencies. A rigorous sampling design will need to be approved by these agencies. The applications of, and limitations to, radar surveys are detailed in Appendix H.

Intensive Survey. Intensive surveys are designed to determine probable absence or presence of murrelets at a specific site, document occupancy, monitor murrelet activity levels at specific sites (e.g., for a pre-harvest inspection), locate nests, and establish murrelet use patterns. When conducting an Intensive Survey, the observer visits only one station per morning. Intensive surveys are recommended for all proposed timber harvest and management activities.

Intensive Surveys incorporate a three-step process:

(1) Design the survey, including habitat assessment, defining the survey area, and establishing survey sites and stations.

(2) Conduct survey visits in accordance with the protocol to determine if murrelets occur at the site.

(3) Interpret the activity observed to classify the site as probable absence, presence, or occupied.

Additional surveys could be conducted at occupied sites to locate nests or attempt to determine the birds' spatial and temporal use patterns throughout the entire stand. This would

require extensive efforts with numerous people conducting simultaneous surveys. If biologists are interested in verifying nesting within the stand, PSG has developed a protocol that assists observers with nest verification: "Techniques for finding tree nests of the Marbled Murrelet" (Naslund and Hamer 1994).

Defining Survey Area and Sites

Survey Area. The **minimum** area surveyed should be the potential habitat that falls within the proposed project area and within **one-quarter mile** (402 m) of the project area boundary *that is contiguous with* the project area (Figure 1). The intent of the one-quarter mile guideline is to increase the likelihood that all of a continuous block of potential habitat is surveyed, not just that portion that lies within the project boundary. For example, a proposed project boundary might bisect a continuous block of potential habitat. By defining the survey area as one-quarter mile beyond the project boundary, more of the block of continuous habitat is likely to be included. The hypothesis that continuous habitat is important is based on the following observations on the nesting behavior of murrelets and alcids in general:

(1) Although Marbled Murrelets nest solitarily, more than one pair of birds are usually found in a single, continuous forest (Nelson and Peck 1995). The interaction of murrelets in a single stand seems important for social and breeding purposes.

(2) As two or more pairs of murrelets might nest asynchronously in a stand (or perhaps even renest), murrelets could be nesting at different times - and therefore different places - in the same stand in the same year.

(3) Over several years, murrelets might use more than one nest tree or use different parts of a stand for nesting (Nelson 1997). Murrelets exhibit high nest site fidelity, with some stands supporting 20+ years of murrelet use (Divoky and Horton 1995). A few nest trees have been used in consecutive years (Singer et al. 1995, Nelson 1997, Manley 1999); however, most are not, suggesting that breeding birds may move elsewhere within a stand in successive years or may not nest every year.

When a project is planned in a large expanse of potential habitat, surveying the entire continuous block will allow for a more thorough evaluation of the potential impacts to portions of the habitat that are greater than one-quarter mile from the project boundary. For example, in many situations the potential habitat occurs in a long, linear configuration. When the project area is at the edge of this large block, even a one-quarter mile boundary might not include the entire stand of potential habitat (Figure 2). This was the intent of the guideline in the previous protocol that the survey area should include contiguous habitat within one–quarter mile *or* 51 ha (125 acres), whichever was greater. This allowed for a larger portion of the potential habitat to be surveyed when a relatively small portion occurred within the one-quarter mile zone. It also provided a limit to the survey area when the continuous potential habitat extended over a large landscape. We recommend that the one-quarter mile zone define the **minimum** survey area. In conjunction with this zone, we recommend that topographic features, specifically ridgelines, be used to help define the survey area boundary. Ridgelines make a logical break between survey areas from both a survey station layout perspective and from a site classification perspective. The portion of a continuous stand that extends beyond the survey area boundary also should be considered for surveys, and some regulatory agencies may require surveys throughout continuous habitat under some conditions.

Other potential habitat within one-quarter mile, or greater, that is *discontinuous* with the project area may also need to be surveyed if disturbance is a concern. Disturbance is a regulatory issue; consult with your regulatory agency for guidance.

Following are two examples of determining the survey area. The first involves a 122-ha (300-acre) stand of potential habitat, with a planned harvest of 4 ha (10 acres) located in the center of the stand (Figure 1). A 402-m (one-quarter mile) area around the edge of the 4-ha harvest would include 83 ha (206 acres). The second example involves a 101-ha (250-acre) stand of potential habitat, with a planned harvest of 2 ha (5 acres) located on the edge (Figure 2). A 402-m (one-quarter mile) area around the boundary of the 2-ha harvest would encompass 26 ha (65 acres) of potential habitat. The remaining continuous potential habitat could be surveyed to better evaluate potential impacts.

The survey area should be defined by the occurrence of potential habitat. It should not include large expanses of unsuitable habitat, but this should be ascertained by visiting the area on the ground to determine the best way to delineate it. Potential habitat that is separated from other potential habitat by more than 100 m (i.e., surrounded by unsuitable habitat) should be delineated as its own survey area. This 100-m guideline should be applied when defining the area, not at the scale of scattered individual remnant trees or patches. In places where remnant trees are scattered equally throughout younger forest, the continuous potential habitat should be delineated by forest that contains this combination of young and remnant trees. If a large expanse of young forest without remnant trees is adjacent to the potential habitat, it should not be included in the survey area boundary.

Survey Site. A **survey site** is the unit by which survey visits are designed and carried out, and the unit to which the requisite number of visits applies. We recommend limiting the size of the site to 61 ha (150 acres). The survey site boundary should not be confused with the management project or survey area boundaries. When the survey area is small (< ~61 ha), the site encompasses the entire survey area. In this case, the terms 'survey site' and 'survey area' are interchangeable, and the protocol applies equally. More typically, survey areas are large (>61 ha), and should be divided into sites (Figure 3). Some flexibility is allowed in exceeding the 61-ha (150-acre) site guideline, but experience has shown that sampling intensity and coverage are compromised when the site exceeds 69-71 ha (170-175 acres).

A survey site contains ≥1 survey stations which are laid out together and which <u>collectively</u> are surveyed to determine the status of the site, which influences the ultimate status of the survey area. For the site, every station must be visited at least once and the requisite number of total survey visits to achieve the desired likelihood of classification must be planned per year to determine occupancy. For example, using the approach of at least 5, and up to 9, total survey visits per year to achieve 95% likelihood of correct classification, if a site contains less than 5 stations, more than one visit must be made to one or more of the stations (see 'Distribution of Visits among Survey Stations', p.16). If the site contains more than 5 stations, the site will receive more than the minimum 5 visits per year. Individual survey sites within the same survey area may be visited on the same or consecutive days, but survey visits <u>within</u> a survey site generally should be separated by a minimum of 6 and a maximum of 30 days (but see 'Distribution of Visits Throughout the Season', p. 17, for exceptions).

It is critical that each site be identified by a unique name or number and legal description or UTM or lat/long location that will identify that particular site over the years. Furthermore, the boundary of the site must be clearly delineated on a topographic map or aerial photo. Stations within sites also must have unique identifiers, but in addition, all stations within a site must share the same site name. It must be unquestionably clear which stations belong to a site, as there is no

other way of determining if the site was surveyed with the requisite number of visits. Multiple sites within a survey area should share the same area name. Figure 3 illustrates one example of a naming convention, which uses alpha-numeric codes in a hierarchical fashion to identify stations, sites, and areas.

Survey Stations and their Placement

Survey station placement is one of the most crucial aspects of survey implementation. Marbled Murrelets can be difficult to detect in and around their breeding areas, in part due to their small size, rapid flight, cryptic plumage and crepuscular behaviors. Where the likelihood of detecting murrelet activity is low, such as where a small number of birds are nesting due to small stand size or extreme distance to marine waters, good station placement is imperative if murrelet use of the stand is to be correctly classified. O'Donnell (1995) reviewed the effects of station placement on the number of murrelet detections and found that the number of visual sightings of murrelets is strongly influenced by the location of the observer. The use of radar in recent studies also has demonstrated that observers could miss a large number of murrelets in some areas. Concurrent radar and audio-visual surveys in the Santa Cruz Mountains and on the Olympic Peninsula found that ground observers missed 71-100% and 77-90%, respectively, of the murrelets detected on radar, even when provided with the birds' bearing and travel direction by the radar operator in the California study (Cooper and Blaha 2002; Singer and Hamer 1999). Thus, sensible placement of survey stations can help overcome site characteristics that may limit the observer's ability to hear or see murrelets.

There are three steps involved in station layout. The first step is to determine adequate coverage and establish preliminary station locations. This can be accomplished by overlaying circular mylar disks on aerial photos and topographic maps. This is detailed in 'Number of Survey Stations' and 'A Simple Technique for Delineating Site Boundaries and Determining Station Location' (p. 12). The maps and photos are used to identify topography; openings or gaps in the canopy; patchiness of habitat; and natural and artificially-created flight corridors such as streams, lakes, rivers, meadows, avalanche chutes, landslides, paths, and roads. Local knowledge of the area is helpful, but not essential, at the initial design stage.

The next step is to locate the stations on the ground and refine their placement based on site-specific factors. This may help to identify openings that were not evident on aerial photographs, or identify potential sources of localized noise disturbance. Because of the high proportion of audio detections during most surveys, placing stations near sources of loud noises, such as busy roads, is less optimum than a quieter location covering the same area. The ground visit also could identify patches with the most suitable murrelet nesting habitat, such as areas with the highest density of potential nest structures. On-site review allows these locations to be factored into the survey design. Other considerations when placing stations include the growth and foliation of adjacent vegetation, increase in snow melt runoff when locating stations early in the spring, and the viewing window. Openings in the forest canopy and along the perimeter of forest stands offer the best opportunities for viewing murrelets. Chances of detecting murrelets flying silently are increased dramatically if the birds are viewed against a light or bright sky as a background, which silhouettes the birds in the early dawn light.

A third step is not always necessary, but often overlooked. This involves the addition of new or supplementary stations that may or may not conform to the minimum requirements stated in the protocol. These additional stations may improve the surveyor's opportunity to detect murrelets in a difficult setting. Additional stations also can be added after surveys have begun, where detections indicate potential activity in a portion of the survey area receiving minimal

coverage under the existing survey design. For example, once presence has been detected and the objective is to determine occupancy, supplementary stations can be added to augment the data previously collected. Such a station could be one that affords a good view of the target stand but is greater than 50 m from its edge. Stations could also be surveyed in tandem, with one observer placed adjacent to a stream that has good visibility but limited hearing, and a second observer at a station with quiet conditions. Note that two stations surveyed in tandem counts as only one protocol visit for the site.

Guidelines on station placement are intended primarily for management scenarios. Surveys designed for research purposes may follow the general principles outlines herein, but likely would deviate somewhat to meet the research objectives.

Station Effective Area. The distance at which observers conducting audio-visual surveys detect murrelets determines the effective area of a survey station, and thus the number of stations needed to cover the survey site. Previous data (Ralph et al. 1994) suggested that observers generally see birds only within 100 m (328 ft) or hear birds within 200 m (656 ft). Observers can detect birds at greater distances, but many are missed at these distances and classifying behavior is more difficult. At some locations, visibility is restricted and subcanopy behaviors can only be seen at distances less than 100 m. A study on the Olympic Peninsula used radar to measure detection distances and found a steep, steady drop in the number of murrelets detected beyond 100 m (even without accounting for the fact that sampling area increased with distance from observer): 36 (41.4%) occurred ≤100 m from the observers, 25 (28.7%) occurred 101–200 m from the observers, and detections continued to drop with distance from observer (Cooper and Blaha 2002). Until additional data and more complete analyses suggest otherwise, this protocol recommends that 200 meters be set as the maximum detection distance for audio-visual surveys, and thus defines station effective area as a 200-m radius circle centered on the survey station.

Based on the defined station effective area, a maximum of 12 ha (30 acres; roughly equivalent to the area of a 200-m radius circle) can be surveyed from a single survey station under ideal circumstances. In many cases, each station will cover less area. For example, an area with closed canopy, limited visibility and/or steep terrain with many drainages will need many more survey stations than is expected based on acreage only. On the Olympic Experimental State Forest in Washington, average station density was 1 per 7 ha (17 acres) because of the presence of streams, ridges and steep slopes (Horton and Harrison 1996).

Topography and Stand Shape. In a square stand on flat ground, one survey station will cover 12 ha. As the slope steepens, the number of stations required to effectively survey the area increases (Figure 4). This is because the 12-ha estimate of murrelet detectability is based on the horizontal distance one can see or hear a Marbled Murrelet (see above), and slope distance is not equivalent to horizontal distance. An estimate of average slope of a stand can be determined using stereoscopic analysis or from measurements on the ground; horizontal distance can then be determined from standard slope distance conversion tables. The best way to determine the number of stations needed in each stand is to use the 'Simple Technique for Delineating Site Boundaries and Determining Station Placement' (p. 12).

Stand shape also will influence the number of survey stations. A rectangular or irregularly shaped stand will require more survey stations than a square or circular stand of similar area. For example, if you have a flat (no slope), 12-ha (30-acre) stand that is very long and narrow, one station **will not** adequately cover the entire stand (Figure 5).

A general rule of thumb is that your stations should be located **throughout** the site. Station placement should incorporate topographic features and cover every hectare of a given site, no

matter the size. Stations that are located up-slope from the survey site, such as along a ridge with the survey site in a valley below, may offer a broad, sweeping view of the entire site but provide very limited chances to observe murrelets that are accessing the site from an elevation below the ridge top. The silhouette of a dark bird flying directly overhead against the light-colored sky is easier to see than a bird flying against a dark background when viewed from the top of a ridge or high point. If your site includes a ridgetop, mid-ridge and river bottom, you must make sure that your stations effectively survey (not necessarily be placed in) the ridgetop, mid-ridge, and river bottom. If your site is only 12 ha, but is long and narrow, you will need to place a station on each end of the site at a minimum (Figure 5). The additional number of stations required will depend on slope. Remember that if a station is placed on the edge of a site, you may be surveying less than 12 ha of that site (Figure 6).

Location with Respect to Openings. Generally, murrelets remain unseen to the observer; 80% of detections from Washington Department of Natural Resources and Washington Department of Fish and Wildlife surveys (n = 8,376) were audio, compared with 13% visual and 7% both seen and heard (WDFW interagency database). Rates of audio detections were similar in California and Oregon (Paton and Ralph 1988, Nelson 1989). However, behaviors indicating occupancy are derived almost exclusively from visual observations. Therefore, stations should be located so that the observer has an unobstructed view of the sky. Whenever possible, stations should be placed in forest clearings, on quiet roads, at the edge of the site, or in or adjacent to rivers or streams. Murrelets often use stream or river corridors as flight paths to access nest sites. Streams create noise disturbance, but the increased opportunity to observe occupied behaviors might outweigh the negative aspects of noise. However, stations should be located **no farther** than 50 m (164 ft) from the edge of the site being surveyed (e.g., see Figure 6). A common error in survey design that could lead to missed detections and, thus, misclassification of the site, is inadequate survey coverage of interior portions of survey sites. In many cases survey stations are placed along roads or adjacent to the edge of the target site because of easy access and better visibility, but generally the entire site cannot be surveyed adequately if all stations are located around the perimeter. Stations must also be located within the site so that the entire site has survey coverage. Even if well-placed openings are not available in a site, station coverage should not be compromised. The number of stations in a site should not be decreased just because openings are not available or are not well-placed (the number may, however, need to be increased). Ultimately, some stations may need to be set in areas without a good view of the sky.

When there are few clearings within a site, such as in areas with closed canopies or steep complex terrain, visibility will be restricted and the detection of subcanopy behaviors will be very limited. To make up for a lack in visibility and decreased likelihood of observing behaviors that could determine occupancy, we recommend that station coverage and density be increased in these sites. Surveyors should consult with their wildlife resource agency for direction in these cases.

Location with Respect to Potential Habitat. In many younger-aged stands, potential nesting habitat often is located in small patches (micro-sites) separated by areas of unsuitable habitat. In some cases, patches containing the most likely nesting habitat may be ineffectively covered even though the site is being surveyed to the specifications of the protocol. Interpretations of what is potential (or likely) habitat differ, and the complete range of conditions murrelets use for nesting is still not known. In cases where habitat quality varies throughout the survey site (specifically, where larger residual trees containing suitable platforms are spaced at regular or irregular

intervals within a site that contains no other potential platforms), survey stations should be strategically placed to cover the most likely nesting habitat within a site, as long as stations remain distributed throughout all potential habitat within the site. As stated earlier, distinct portions of the forest that do not contain potential nesting habitat (i.e., no platforms) should not be included in the site boundary. If more than one survey visit is required to some of the stations within the site to meet protocol, the additional surveys should be conducted at those stations with the best habitat, or a combination of best habitat, visibility, and proximity to previous detection.

Modifying Station Placement. To maximize the observer's chance of seeing birds, he/she may move up to 50 m (164 ft) from the station during the survey visit. The new location should be less than a one-minute walk away, and the observer should note time and direction of movement. In subsequent visits to an area, additional stations can be established to obtain visual observations. For example, if birds were heard in a nearby gully during a survey, the observer can set up one or more additional station(s) in the gully to increase the probability of observing subcanopy behavior. It is important to assign a unique identification to any new stations, including those that have been moved more than 50 m. If an observer thinks that there is a good chance of observing murrelets at a particular station, additional survey visits can be made to that station. However, all potential habitat within the survey site must be surveyed.

Summary. The following bullets summarize the most important points about survey station placement:

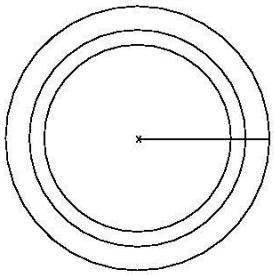
- The goal of station placement is to maximize the surveyor's opportunity to observe murrelets, and specifically murrelet behaviors indicative of nesting, if they occur.
- You must have <u>at least</u> 1 station per 12 ha (30 acres); in almost all cases you will need more than 1 per 12 ha.
- Stations must be distributed <u>throughout</u> the site. If your site includes a ridgetop, mid-ridge and river bottom, you must make sure that your stations are placed in a way to cover all of these areas. In most instances it will not be acceptable to survey from only one side of the site, and it is unacceptable to survey sites only from roads. If there is a river or creek in your site, make sure you have a station in or adjacent to the river or creek despite concerns about noise.
- Stations should be located in an opening if possible, but distribution of stations throughout the site is equally important; therefore, some stations may be located in areas without excellent viewing opportunities.
- When surveying a heterogeneous site, some stations should be placed within patches that contain the most suitable characteristics for nesting, while also maintaining appropriate station distribution.

Intensive surveys can be laborious. For areas that are difficult to access because they have steep slopes, cliffs, thick brush, or are long distances from roads, it may facilitate the survey effort if one or more wide trails are brushed through the stand (this should be done outside of the nesting season if power equipment is used). These trails can serve as access points to several stations (Figure 7). It may be necessary to camp out, hiking to the station before dark the evening before the survey visit.

A Simple Technique for Delineating Site Boundaries and Determining Station Location

Aerial photos and a stereoscope can be used to delineate site boundaries and to locate canopy gaps, road landings, and other suitable locations from which to survey. The 3-D image you get from stereoscopic analysis of 1:12,000 (or other size) aerial photography is helpful for identifying topographic features and determining the appropriate number of stations. Once you have a pair of aerial photos set up under your stereoscope, locations for potential survey stations can be determined by looking for gaps and other open locations, and using a mylar measuring template with 30, 20 and 15 acre circular areas to estimate ground (horizontal) distance based on topography. Stations in gaps or open location should be placed first, and then determine the locations for other survey stations by using the mylar template. Your 12-ha (30-acre) template should be made to the scale of the aerial photo being used. Survey sites (≤ ~61 ha [150 acres]) can then be delineated by circumscribing the area covered by a set of adjoining stations.

Station locations, site boundaries, and the number of stations per site should be finalized after field review. Remember to consider the growth and foliation of adjacent vegetation and increase in snow melt runoff when locating stations early in the spring. Stations should be marked with uniquely-numbered flagging and stakes. Station locations should then be marked on orthophotos or topo maps using photo interpretation and/or measured distances and azimuths from field notes, or using global positioning systems (GPS). UTM coordinates should then be determined for each survey station.



Outer ring: 12 ha (30 acres; 195-m radius)
Middle ring: 8 ha (20 acres; 160-m radius)
Inner ring : 6 ha (15 acres; 138-m radius)

Example of a mylar template with 6-, 8-, and 12-ha circles emanating from a survey station. Templates can be created to the scale of the user's maps or aerial photographs.

Number of Survey Visits

The overall objective of the survey design is to achieve a high confidence that occupied sites are classified correctly. Given that, a secondary goal is to achieve survey efficiency, i.e., optimize the number of surveys that are needed to classify occupancy. The design has two components: (1) the number of visits needed to achieve a desired level of reliability, and (2) the distribution of visits over time, both within a year and across years.

2-Year Protocol. Nelson (unpubl. data) found that murrelets occupied several stands in year one, were absent in year two, and occupied the stands again in year three. A subsequent analysis using pairs of years (1991-1992, 1992-1993, ….1997-1998) from the 1989-1998 three-state murrelet dataset, and using only those sites that were visited a set number of times regardless of

the behaviors observed, showed clearly that some proportion of sites could be occupied in one year but not the other (Table 2; Baldwin 2001a). This estimated proportion of occupied sites that changed status over two years ranged from 18-65% per year, with a weighted average of 39%. Interpretation of this average is not straightforward, as the actual sites sampled differed between sets of years. Nevertheless, the proportions give a general sense of the relative number of occupied sites that changed status in a two-year time frame. This analysis also showed that status was not independent between years. The underlying causes of changes in status of a site are unknown, but between-year variation could be due in part to ocean conditions and food supplies.

Table 2. Proportion of Marbled Murrelet occupied sites that changed status within a two-year period, based on murrelet sites from Washington, Oregon, and nw California (Baldwin 2001a).

Years	Proportion of occupied sites that changed status	Number of qualifying sites
1997-1998	0.376	56
1996-1997	0.450	65
1995-1996	0.503	94
1994-1995	0.415	196
1993-1994	0.181	145
1992-1993	0.444	150
1991-1992	0.647	23

These results demonstrate that a one-year protocol would risk misclassifying occupied sites. The 1989-1998 dataset did not include enough sites to assess a change in status over three or more years. Thus, intensive surveys should be conducted for at least **two consecutive years**. A two-year protocol partially accounts for years where breeding effort is low, resulting in fewer or no detections in otherwise occupied stands. Nevertheless, in some years it may become evident, from surveys at long-term monitoring sites, that inland detections are atypically low. This could affect the interpretation of results from sites where protocol surveys were conducted to determine occupancy, particularly if the situation occurred in consecutive years. Regulatory agencies should assess the reliability of surveys based on patterns from long-term monitoring sites.

Number of Visits. To set forth recommendations on survey effort, the PSG has followed the frequently-used convention of establishing a target of 95% confidence of survey outcome. Thus, if no more than a **5%** misclassification error for occupied sites is desired, then we recommend a two-stage sampling approach (see below) that incorporates a minimum of **5**, and an expectation of **9,** survey visits in **each of 2 years** to estimate occupancy status at an individual site. For this protocol, error is defined as the probability of misclassifying a site as unoccupied when it is actually occupied. False positives were assumed to be zero, based on consensus that this error was low. The recommended number of visits is based on the most likely application of this

protocol – conducting surveys at a site for which no specific knowledge exists regarding its status. This scenario operates under the following assumptions and objectives:

(1) the area to be surveyed has the same 'average' probability of detection as the sample of sites (the 1989-1998 three-state murrelet dataset) used to estimate q (defined below[2]);
(2) no additional information is available as to the site's likelihood for being occupied or for having no murrelets;
(3) the objective is to detect occupancy if the site is occupied (not merely presence).

Furthermore, the recommendation is based on the weighted average of ~**40%** of occupied sites **changing status** within a two-year time period. (The actual weighted average of 39% was rounded to 40%). As shown in Table 2, some occupied sites are not occupied in both years, but the true situation at a given site is unknown. To assume that all occupied sites are occupied in only one of two years is conservative, and to assume, without any other knowledge, that a site is occupied both years is not supported. Because the sample of sites from each pair of years differed, and sites varied by habitat type and geographic location, the sites themselves influenced the analysis and we could not assume a year-only effect. Thus, a weighted average was used for the calculated number of recommended visits. A different assumption on the extent of change of site status would lead to a different approach. The influence of variation on those assumptions is discussed in Appendix A.

Finally, there is some chance that, if no detections are made on the first s^* visits (see Table 3 and Appendix A for definitions of s and s^*), no detections will be made on the remaining visits. This allows for a two-stage sampling approach, similar to the previous protocol which surveyed for presence first, then increased the number of visits for occupancy. The approach described here differs from previous protocols in that it does not calculate a probability for 'presence' separately, but rather incorporates a probability of no detections on a single visit given that the site is occupied. From the data analyzed, stopping surveys after a set number of visits with no detections ('early stopping rule') had little effect on the probability of detecting occupancy at occupied sites when at least four visits were made (because occupancy was detected early), but reduced the number of visits made to truly unoccupied sites (Baldwin 2002). The recommended survey approach for the average case includes a **stopping rule of 5 visits**.

The average probabilities of observing occupancy under these parameters are displayed in Table 3.

Recommended Approach. Assuming that the desired confidence target is 95% and that the assumptions described above are met, then surveys should be planned within a two-year time frame with a minimum of 5 survey visits, and an expectation of 9 survey visits, in each year to determine occupancy. The recommended approach is summarized below (refer to decision tree, Figure 8).

> If, in year 1, detections are made within the first 5 visits but subcanopy behaviors are not observed, the full 9 visits are made in year 1 and year 2, for a two-year total of 18 visits (unless occupancy is established in fewer visits).

[2] 'q' is the probability of not observing a detection on a single survey visit, given that birds are present, or not observing a subcanopy behavior, given that the site is occupied. 'p' is the opposite of 'q' (1-q), or the probability of detecting a bird on one visit given presence, or seeing a subcanopy behavior given occupancy.

If, in year 1, no detections have been made after 5 visits, surveys can cease for that year. In year 2, if presence-only detections are made within the first 5 visits, the full 9 visits are made for a two-year total of 14 visits.

If, in year 1, no detections have been made after 5 visits, surveys can cease for that year. If, in year 2, no detections have been made after 5 visits, the survey can be stopped with 10 total survey visits and the site classified as probable absence.

By following this process, there is a 0.9546 probability of detecting occupancy, given that the site is occupied. If the assumptions do not apply to your area, specifically if there is reason to believe that (1) the probability of detection at your site(s) is less than the 'average' for the sample of sites used to estimate *q*, and/or (2) additional information on your site(s) suggests that occupancy is low, we recommend a greater number of survey visits in each of two years to increase the likelihood of having <5% error in correctly classifying the site, assuming 95% probability of detecting occupancy is the desired level. Consult your regulatory agency for help in determining the appropriate number of survey visits.

In all cases, visits could be discontinued once subcanopy detections are confirmed, at which point the site is classified as occupied and no further survey visits are required. Depending on the objective of the surveys, you may choose to continue surveys at the site even after occupancy is confirmed.

Caution: the first 'presence' detection near the end of either year might require additional years of surveys to determine if the site is occupied if the expected 9 visits cannot be completed in that year. See 'Distribution of Visits Throughout the Season', below, for potential scheduling problems that could require a third year of visits. Increased survey effort (within the prescribed survey window – see below) should begin immediately following the documentation of presence to avoid adding additional years to the survey effort.

Table 3. Probabilities of detecting occupancy, given a site is occupied in at least one of two years, when, on average, 40% of occupied sites have a true annual status of occupancy in only one of two years. *s* = planned number of visits; *s** = number of visits with no detections, after which surveys could be stopped for that year.

s	***s** = 4*	***s** = 5*	***s** = 6*
4	0.7912		
5	0.8484	0.8528	
6	0.8874	0.8930	0.8947
7	0.9146	0.9209	0.9230
8	0.9337	0.9405	0.9431
9	0.9474	**0.9546**	0.9572
10	0.9573	0.9647	0.9676
11	0.9646	0.9721	0.9751
12	0.9700	0.9777	0.9807
13	0.9739	0.9817	0.9848
14	0.9770	0.9848	0.9879
15	0.9792	0.9871	0.9902
16	0.9810	0.9888	0.9920

As stated before, the recommended survey effort is based on averages calculated from data collected over a three-state area. It does not mean that, for any individual site, you can be assured of 95% probability if you make 9 survey visits in each of two years. Part of this uncertainty is the site's unknown true probability of detection (uncertainty that has always been in the survey protocol), and part comes from not knowing if the site changes status from year to year. An individual site may require fewer or a greater number of survey visits to correctly determine its status. The recommendations herein can be enhanced to achieve a higher probability of correctly classifying an individual site. For example, one could choose to survey the planned number of visits each year (applying no stopping rule), regardless of detections. Another conservative approach could be to assume that an occupied site is occupied in only one of two years (rather than the average of 40% of sites are occupied in only one of two years, as used above). This results in 12 visits needed in each year to achieve 95% probability of detecting occupancy (see Tables A-2 and A-4, Appendix A). Conversely, if one assumed, based on prior knowledge, that occupied sites are occupied both years, only 6 visits in each of two years would be needed (Table A-5). This approach would require consultation with the appropriate regulatory agency.

In summary, one could calculate average probabilities for a variety of situations by using (1) different probabilities for detecting probable absence, presence, or occupancy on a single visit, assuming the site is occupied that year; (2) a different number of planned visits; (3) a different stopping rule; and/or (4) a different assumption of the proportion of occupied sites that change status between years. The appropriate formulas for these calculations are detailed in Appendix A, Table A-3. These different values and assumptions might be derived from previously-collected survey data from a particular geographic area of interest (i.e., a collection of sites with higher or lower detection probabilities), or from models of habitat suitability that assess a site's probability of being occupied. However, to use these parameters to design a different sampling protocol, one **must get assistance from a qualified statistician** to determine the sample size needed and to help with the derivations.

Distribution of Visits Among Survey Stations. We recommend that each survey station be visited at least once per year or a minimum of 5 (with a planned number of 9) survey visits per year to each survey site, whichever is the greater number of visits. The number of visits per station will vary with the number of stations established at survey sites. If one to three stations are established, divide the number of visits among stations so the survey effort equals the requisite number of visits per year for two consecutive years (i.e., 1 station = at least 5 and possibly 9 visits per year to that station; 2 stations = at least 3 visits to 1 station and 2 visits to the other per year; 3 stations = at least 2 visits to 2 of the stations and 1 visit to the third station per year; etc.). Additional visits should be conducted at the station(s) of highest quality (i.e. those with the greatest number of detections, the best view of the sky or stand, and/or in habitat with the highest potential). If five or more stations are established, at least one visit per station per year for two consecutive years is needed. If murrelets are detected at a survey site but subcanopy behaviors have not been observed, at least 9 visits per year are needed to determine occupancy.

When to Survey

Time of year. Although nesting sites are used primarily during the breeding season, Marbled Murrelets have been observed at some inland sites during all months of the year (Carter and Erickson 1992, Cross 1992, Naslund 1993a, O'Donnell et al. 1995). Nevertheless, these areas are most effectively surveyed during the spring and summer, when activity levels are greater and

attendance is more consistent and longer in duration. Murrelet activity increases to moderate intensity during spring and reaches a peak level generally from early July to early August in California, Oregon, and Washington (O'Donnell et al. 1995; W. Ritchie, pers. comm.). This increase in activity in July might be associated with nesting birds, but also could be attributed to nonbreeders prospecting for future nest sites (O'Donnell et al. 1995, Nelson and Peck 1995, Jodice and Collopy 2000, Whitworth et al. 2000). The number of detections decreases markedly after this peak, presumably because many birds have completed their nesting activities and begun a flightless molt at sea.

Based on past survey data and current knowledge, **surveys for management applications** should be conducted during the following periods: **15 April to 5 August** in California (Carter and Erickson 1988, O'Donnell et al. 1995); **1 May to 5 August** in Oregon, Washington, and British Columbia; and **15 May to 5 August** in southeastern and southcentral Alaska (Kuletz et al. 1994, but see Brown et al. 1999 for a potentially earlier start in southeastern Alaska). These dates bracket a substantial portion of the incubation period and early nestling period, based on chronologies identified by Hamer and Nelson (1995b), but should not be confused with breeding seasons for these areas (see below). For the purposes of **researching breeding ecology or monitoring nest sites**, surveys could be initiated at least two weeks earlier and extended at least two to three weeks beyond the periods recommended above.

The breeding season is defined by the earliest known nesting and latest known fledging dates, and is used by regulatory agencies to avoid adverse effects to the species. The breeding season extends 24 March – 15 September in California, and 1 April – 15 September in Oregon and Washington. Thus, the survey period misses some nesting activity, and potentially some opportunities to determine occupancy at a site. For example, 13 of 26 (50%) nests in California were active after, and 4 (15%) before, the survey season (Hamer and Nelson 1995b). Of 22 nests documented in Oregon, 7 (32%) were active after, and 1 before, the survey season (Nelson and Peck 1995; K. Nelson, unpubl. data). This trend is consistent with data from Washington, where 33% of 9 nests were active after the survey season, and a combined total of 44% were active during either the pre- or post-survey season (W. Ritchie unpubl. data). Occupied behaviors documented outside the survey season but within the breeding season should be considered valid observations. Presence-only observations and no detections outside the survey window are not appropriate for site classification.

Murrelet visitation to nesting areas during the non-breeding season may be important in forming or maintaining pair bonds, retention of nest sites, and for selecting future nest sites (Naslund 1993a, Nelson 1997). At two sites in northern California, calling frequency (mean number of calls per detection) was greater during winter than spring and summer, although the duration of detections was shorter (O'Donnell et al. 1995). However, birds are also more likely to be absent during winter, leading to incorrect probable absence determinations (Brown et al. 1999). Therefore, while winter surveys may be helpful for determining site presence in some areas, they cannot be counted towards surveys required in a given year.

Distribution of Visits Throughout the Season. Several studies have shown that detection levels can fluctuate greatly at the same survey area, or even the same station, throughout the breeding season (Manley et al. 1992, Rodway et al. 1993, Kuletz et al. 1995, Jodice and Collopy 2000). There usually is a peak in detections, but the timing varies year to year. For example, in Washington, peaks have occurred from 24 June to early August (W. Ritchie, pers. comm.). From analysis of the 1989-1998 three-state composite dataset, detection rates of murrelet presence and occupancy varied within the 16-week survey season (Baldwin 2001b). For presence, detection rates in a two-week period in the middle of July were higher than the rest of

the season (Figure 9). A five-week period from the beginning/middle of May to the beginning/middle of June had lower presence detection rates. For occupancy, detection rates were low through the season until about a one-week period in the middle of July (Figure 9). The magnitudes of the differences were not great, and factors other than season could have contributed to the variability observed, but the analysis generally supports the emphasis of increased survey effort when detection rates increase.

Surveys should begin within the first two to three weeks of the survey season, and be scheduled at regular intervals throughout the season. To help maintain an even distribution, surveyors should aim for a minimum of 6 and a maximum of 30 days between survey visits to a site. Given that an objective of this protocol is to detect murrelets if they are present, survey visits should adequately cover the time of increased activity. Thus, we recommend at least 2 of the 5 minimum visits (using a 5-visit stopping rule) occur after 30 June but before July 18, with an effort to avoid clustering these two visits at the beginning of July. This increases the chances of surveying during the mid-July peak in detection rates. It also allows time to add 4 visits, if needed, and have at least some of those additional visits still within the peak detection period. When 9 visits are needed, survey visits should be spaced as evenly as possible throughout the breeding season, with at least 4 of the 9 visits for occupancy after June 30, and at least half of those within the first 3 weeks of July. When additional visits need to be added late in the survey season (i.e., after June 30), we recommend a minimum of 2 days between visits during this time. This spacing prevents surveys from being bunched at the very end of the survey period.

For example, an initial survey schedule in California, with the expectation of 9 visits and a minimum of 5, could be: 1 visit in April, 1 in May, 1 in June, and 2 during 1-17 July. If presence is detected on the 5th visit in July, an adequate time remains to conduct an additional 4 visits over the next 2 ½ weeks, with at least 2 days between visits. In Oregon and Washington, the initial schedule could be similar, except the first 3 visits would occur between 1 May and 30 June. In Alaska, survey emphasis may need to be shifted to the last three weeks in July rather than the first two weeks, corresponding to a slightly later peak of activity. Adherence to these schedules, as closely as possible, will increase the quality of surveys and result in a more accurate determination of activity.

Based on the composite data analyzed, it was uncommon for an occupied site to have no detections before the stopping rule threshold (Baldwin 2002). Thus, one should expect at least presence detections at a truly occupied site within the first few visits and then be able to adjust the survey schedule accordingly to accommodate 9 visits to detect occupied behaviors. However, the 2002 survey season was a good example of unusual conditions, with very low activity levels in Oregon and Washington until mid-late June (W. Ritchie, pers. comm.). If murrelets are not detected until July, particularly at a number of sites, there is a potential to run out of resources before the requisite 9 surveys can be completed. This could translate to an extra year of surveys. One needs to schedule carefully and have enough qualified surveyors to conduct another 4 visits if the first presence-only detection is made in mid-late July.

Time of day. The survey period in California, Oregon, Washington, and British Columbia is defined as the two-hour period from 45 minutes before to 75 minutes after official sunrise <u>or</u> for 15 minutes after the last detection, whichever is longer. In southeastern Alaska, surveys should begin at least 60 minutes before sunrise (Brown et al. 1999), and surveys should begin 90 minutes before official sunrise in southcentral Alaska (Kuletz et al. 1994). Exceptions to this timing are detailed below under 'Environmental Conditions Affecting Surveys'. By following these guidelines, some survey visits will last longer than 75 minutes after sunrise, especially on cloudy days or days with heavy fog when detections generally continue longer. However, if a

survey has unquestionably determined occupancy during the regular two-hour survey period, staying longer is not necessary, although it could yield additional supporting detections.

Radar surveys in Washington and British Columbia consistently have detected murrelets in stands earlier than 45 minutes before sunrise. An average of 25% of radar detections occurred before the official survey start time at stands on the Olympic Peninsula (Cooper and Blaha 2002). However, because many of these targets were silent and would not have been detected on a PSG audio-visual survey in the near-dark conditions, surveys will continue to begin 45-90 minutes before sunrise depending on regional location (see above). It also should be recognized that opportunities to observe occupied behaviors can occur after the survey period, particularly during chick rearing. For example, while there appears to be an initial wave of fish deliveries to chicks right at sunrise (in low light conditions when an observer is less likely to detect them), second feedings occurred on average 54 minutes after sunrise (SE 9.6, n = 40 observations) and as late as 225 minutes post-sunrise (Nelson and Hamer 1995b). Similarly, at three nests in British Columbia observed in three different years, 63% of 104 feedings occurred more than one hour after sunrise (P. Jones, pers. comm.). Later arrival times generally were associated with cloudy mornings. Thus, additional opportunities to observe an occupied behavior (i.e., adults flying into a stand to deliver fish) occur after the end of the survey period, particularly during the height of chick rearing.

Use the Nautical Almanac to determine sunrise times for your area. Do not rely on tide tables, local newspapers, or television stations because they can vary up to 15 minutes from official sunrise. Sunrise tables can be obtained from the U.S. Naval Observatory at web site http://aa.usno.navy.mil/AA/data, and at http://www.hia.nrc.ca/services/sunmoon/sunmoon.html for British Columbia.

Marbled Murrelets also can be detected inland during the evening. Radar surveys generally find consistent but lower volume of inland evening flights compared with morning surveys (B. Cooper, pers. comm.). Evening audio-visual surveys could be useful in determining presence or occupied behavior, but are not recommended as part of this protocol because they would not count toward determining probable absence.

Environmental Conditions Affecting Surveys. The effects of environmental conditions on murrelet surveys are twofold. They affect (1) the timing, duration, and intensity of murrelet activity; and (2) the ability of observers to detect the birds audibly and/or visually.

Murrelet activity at inland sites begins later, lasts longer, and is often more intense on mornings with overcast conditions, fog, drizzle, or rain than on mornings with clear conditions (Hamer and Cummins 1990, Manley et al. 1992, Naslund 1993b, Rodway et al. 1993, Nelson and Peck 1995). If rainy, cloudy, or foggy conditions exist at the end of the regular two-hour survey period, observers who continue to survey for an additional 30 minutes might detect possible late activity. Cloudy conditions are defined as a continuous ceiling or significant cloud layer that reduces vertical viewing to <2 canopy heights. Foggy conditions are defined as a cloud ceiling lower than the height of the tallest trees at the site or by low fog which decreases horizontal visibility to less than 100 m.

The conditions described above also potentially limit an observer's ability to detect murrelets aurally or visually. Rain and wind can make it difficult to hear murrelets calling. Low cloud ceilings or thick fog make it difficult to see murrelets. We recommend that if conditions that limit murrelet detectability, including heavy rain, hail, strong wind, logging activity, vehicle traffic, or loud aircraft, exist for more than 10% (12 minutes) of the survey period, the survey be rescheduled and repeated again on another morning soon after, *unless* occupied behaviors are detected on that morning. These conditions also include a cloud ceiling lower than the height of

the tallest trees at the site or low fog that decreases horizontal visibility to less than 100 m. Because murrelets might still be detected during these conditions, if the surveyor is already at the station, the survey should not be terminated (even if it will be repeated), and the observer should remain for the duration of the two-hr period unless heavy rain or strong wind threaten his/her safety. Note that the 12-minute limitation refers to 12 minutes of interrupted observations (continuous or discontinuous) once the survey is underway, and does not allow for the survey to begin late or end early.

INTERPRETING SURVEY RESULTS TO CLASSIFY SURVEY SITES AND AREAS

Significance of Murrelet Behaviors

Murrelet nests are extremely difficult to find; therefore, a set of behavioral criteria has been established to determine if potential habitat is likely to be occupied by murrelets. These behaviors have been documented at active nest sites and can be observed during an audio-visual survey, providing the rationale to use them as indicators of occupancy. These behaviors also have been associated with purposes other than attending an active nest, suggesting that the stand has some importance for breeding.

Flight. Marbled Murrelet flight is direct and involves rapid, often continuous wing beats. Flight speeds average 73-136 km/h (45-85 mi/h) and can reach maximum speeds of 158 km/h (98 mi/h) (Hamer et al. 1995; Burger 1997; Cooper and Blaha 2002). Murrelets generally fly at higher altitudes over land between nesting and foraging areas, and fly lower at or near nests. Murrelets often fly only a few meters above water, but such low-level flight is rarely seen inland except along roadways.

SUBCANOPY FLIGHTS. Subcanopy flights include those below, through, into, or out of the forest canopy within or adjacent to potential habitat. Flight below the canopy is most commonly observed during the breeding season (O'Donnell et al. 1995). Adults flying to nests approach from below the forest canopy, often along a route of gaps among overstory trees or other natural 'corridors' (Nelson and Peck 1995, Singer et al. 1995). Nesting birds can consistently use the same flight path within a season, although each bird of a pair may have different paths, and arrival paths may differ from departure paths. Thus, birds flying along the same route on successive days could indicate nesting. In addition to direct flights to nests, murrelets can engage in 'fly-bys' before and after visits to the nest, where a nesting bird flies past the nest tree below the canopy at nest height. 'Fly-bys' occurred during the incubation and nestling periods in California (Singer et. al. 1995), but also have been observed at nests after nesting was completed (S. K. Nelson, pers. comm.). While an observer may not be aware of a nest, these flights lend support for the association of subcanopy flights with nesting. Subcanopy flights are often nonvocal, but can include wing-beat sounds. Observations of subcanopy behaviors usually consist of 1 to 2 birds.

Some flights that are observed below the canopy, and thus technically 'subcanopy' behaviors, are not indications of occupancy. For example, murrelets en route to nesting areas in the Santa Cruz Mountains flew quite low (just above the top of riparian hardwood trees) when following stream channels inland, particularly on foggy or heavily overcast mornings (S. Singer pers. comm.). In addition, low-flying birds have been observed in steep canyons or crossing ridgelines in non-habitat areas (S. Singer, pers. comm.; C. Smith, pers. comm.). In general, if

subcanopy flights are seen in areas lacking potential habitat, they are not an indication of occupancy. If there is any question about the significance of subcanopy behaviors, please consult with your regulatory agency for advice.

LANDINGS. In addition to landing at active nests, murrelets have been observed landing in trees near known nests throughout the breeding season, or in trees with nests that were active in a previous year (Nelson and Peck 1995). Murrelets also land in trees prior to egg laying, presumably to inspect potential nest sites (Nelson and Hamer 1995) and to copulate (D. Buchholz, pers. comm.). Landings also may indicate territorial behavior, resting or roosting (Naslund 1993b).

CIRCLING AND ABOVE-CANOPY FLIGHTS. Circling and other above-canopy flights, such as dives, indicate possible occupancy of a site (reviewed by Nelson and Hamer 1995). These behaviors are a red flag that should prompt additional survey effort to observe subcanopy activity. Shallow or steep dives that originate above the canopy but terminate below canopy have been observed more frequently (67%) near known nest trees. These 'jet dives' may function to maintain pair bonds or be used in territorial defense (Nelson 1997). Circling is common over some nest sites (Nelson and Peck 1995; Hamer, Ralph, unpubl. data), but not all. Nesting birds at three active nests in the Caren Range of BC were not observed to circle before returning to the ocean (P. Jones, pers. comm.), nor was circling from other birds observed over this stand. Circling often includes $\geq$2 murrelets. Circles can be small (~10-20 m radius) or greater than 1 km-radius (0.62 mi). Murrelets might use large sweeping circles to gain altitude. Occasionally, observers note 'partial circles,' or birds following a curving flight path. In most cases, it is likely that the birds were circling, but limited visibility prevented the observer from seeing complete circles. Upon leaving a nest, such as after an incubation exchange or fish delivery, breeding birds may join with other murrelets over the nest site before departing for the ocean (Nelson 1997). Murrelets also have been seen circling over young or non-forest habitats. However, in most cases these areas have been near or adjacent to old-growth trees (T. Hamer, unpubl. data; S. K. Nelson, unpubl. data). When evaluating the significance of circling behavior, the height of the bird(s) above the canopy, frequency of circling, and distance from potential habitat should be considered. We recommend that in all cases where circling is observed, additional surveys be conducted to determine occupancy.

Vocalizations. Murrelet vocalizations are described in Appendix F. Interpreting the association of calling (an audio detection) with the status of a site is difficult. The most audible call, the 'Keer' call, is heard at nest sites, while flying, and at sea (Nelson 1997). Vocalizations at the nest generally are soft and not readily audible from the ground, but are given frequently by both adults during incubation exchanges and chicks during feedings. Loud calls from the nest are rarer. Nevertheless, loud calls were heard from seven nests in Oregon while birds attended a chick or egg, or prior to egg laying (Nelson and Peck 1995; A. Wilson, pers. comm.). In the Caren Range of BC (P. Jones, pers. comm.) and in California (Singer et al. 1995), however, no loud calls were recorded during approaches or exits from active nests. Calls that emanate from one location within the survey site may be a less ambiguous indication of nesting activity than calling in general. Many 'Keer' calls are from birds heading to the local area, but some are from birds in flight traveling beyond the site being surveyed. As social interactions increase, calling also increases, and an increase in calling in late summer may be related to subadults and nonbreeders visiting forest stands (Nelson 1997).

Of the nonvocal sounds heard during surveys, wing sounds can be detected from murrelets flying nearby, and 'jet sounds' are associated with dives (described under Circling), which can be associated with nests.

Classification of Sites

The behaviors described above lead to three classifications of sites and, ultimately, survey areas (see 'Applying Site Classification', p. 23). During surveys, the behaviors observed should be clearly documented. When appropriate, narrative also should be provided to include additional detail and insight into reported detections.

Probable Absence. A site of potential habitat where no murrelets were detected after the requisite number of surveys.

Presence. A site of potential habitat where murrelets were detected, but subcanopy behaviors were not observed. Additional survey effort is required at areas with birds present to determine whether or not a site is occupied. **Presence sites** include those with:

- non-stationary audio detections;
- birds flying in small- or large-radius circles above the canopy;
- above-canopy dives (that do not end below the canopy) or other above-canopy flight.

Occupied Site. An **occupied site** is a site where at least one of the following subcanopy behaviors or conditions occurs:

- discovery of an active nest, a recent nest as evidenced by a fecal ring or eggshell fragments (see Appendix B) on structures in the forest canopy, or an old nest cup and landing pad;
- discovery of a downy chick, an egg, or eggshell fragments on the forest floor;
- birds flying below, through, into, or out of the forest canopy within or adjacent to a site of potential habitat. This includes birds flying over or along roads, young stands, or recently-harvested areas adjacent to potential habitat. However, only the adjacent site of potential habitat, not the non-habitat, should be classified as occupied. If birds are observed along a road where there is more than one site that the birds could be using, additional surveys may be required in some cases to determine which is occupied, if these sites are not part of the same survey area. Some subcanopy flights, such as low-flying birds observed in steep canyons or crossing ridge lines in non-habitat areas, are not associated with the site of interest and should not be considered occupied behaviors. Questions about flight behavior and occupancy should be directed to your regulatory agency for resolution.
- birds perching, landing, or attempting to land on branches;
- birds calling from a stationary location within the site. A detection should be considered 'stationary' when three or more calls are heard at less than 100 m (328 feet) from the observer, and the position of the bird does not appear to change. Detection of stationary calling is rare in most regions.

Occupied sites include nest sites, but an occupied site also can be used for purposes other than nesting that are essential for the complete life history of the bird (Nelson 1997). For example, courtship displays in other alcids can take place near, but not at, the breeding site. Murrelets have been observed landing in unsuitable trees in unsuitable habitat contiguous with or

near suitable habitat in Oregon and British Columbia (S. K. Nelson, pers. comm.). These landings generally involve more than one murrelet and the birds remain standing in these young trees for a period of time. Thus, the places where birds engage in courtship or other breeding-related activities might not be in the exact same area or stand as a nest, but these areas are just as important as nesting sites for the birds' life history.

Applying Site Classification

Because the survey area, by definition, is continuous potential habitat, the highest classification of probable absence, presence, or occupancy among the sites within the survey area applies to the survey area. When one survey site encompasses the entire survey area, the outcome of surveys at that site applies to the survey area interchangeably. In contrast, when a survey area is divided into more than one site, the outcomes at the sites, collectively, determine the status of the survey area. For example, if a block of continuous potential habitat is divided into three contiguous survey sites, and one of those three sites yields subcanopy detections, the entire survey area is considered occupied, not just that one site, because all the sites form one large piece of continuous habitat (see 'importance of continuous habitat', p. 6). However, the application of status to the survey area does not, by default, mean that the status is applied to all continuous habitat beyond the survey area, although there could be situations where a regulatory agency decides that it does. For example, if only 40 ha (100 acres) of a large block of habitat (e.g., 405 ha [1000 acres]) was defined as a survey area and occupied detections were recorded, at a minimum the defined survey area would be classified as occupied. The status of the vast habitat beyond, but continuous with, the survey area boundary should be determined with the appropriate regulatory agency.

This demonstrates the importance of delineating survey boundaries in a logical way, using topographic features in addition to other guidelines. For example, if an occupied detection was made at the edge of a survey area, and the survey area boundary did not include a ridgeline that was close by, it would make sense to include the unsurveyed area up to the ridgeline as part of the habitat considered occupied. If the ridgeline had been incorporated into the survey area boundary from the start, delineating occupied habitat would be more straightforward.

How Long Do Survey Results Apply?

The detection of occupied behaviors in forests implies that the area serves as a breeding location for murrelets. We have no data from which we can recommend how long after surveys are completed that the results of those surveys remain valid. Murrelet surveys reflect the breeding status of sites for the time period during which surveys were conducted. As a breeding area, murrelets may nest there every year, in alternate years, or once in several years (Manley 1999). The extent of use, re-use, or abandonment of nest areas, or establishment of new areas, is unknown. However, recent observations of murrelets in 70-100 year-old forests regenerated from heavy timber harvest in Mendocino County, CA, and in northwestern Oregon may indicate immigration as the habitat has matured to suitability (R. LeValley, pers. comm.; D. Buchholz, pers. comm.), although it is not known if birds merely moved from an adjacent contiguous site, moved from a greater distance away, or actually persisted in remnant old-growth trees. In addition, Marbled Murrelets are believed to have strong fidelity to an area previously used for nesting (DeSanto and Nelson 1995, Divoky and Horton 1995). Forest patches, nest trees, and nest cups have been reused in subsequent years (by the same or different birds), and murrelets have been observed landing in a previously-used nest tree in a year when it was not used for

nesting (Nelson and Peck 1995, Singer et al. 1995, Hamer and Meekins 1999, Manley 1999). Repeated use of forest stands suggests that these sites play a role in supporting reproduction.

Although it is possible for murrelet presence/probable absence in forest stands to change through time, we recommend that occupied stands should be treated as occupied indefinitely. Some occupied sites monitored for a decade or more have remained occupied (W. Ritchie, pers. comm.). For probable absence sites, if a significant time lag (≥5 years) occurs between the completion of protocol surveys and the implementation of activities that would modify suitable habitat, additional surveys may be appropriate to support the results of previous surveys, especially given that the number of survey visits needed to determine occupancy has increased from protocols used before 2003. Consult with regulatory or evaluating agencies regarding these issues.

DATA COLLECTION

Training

Training is recommended for observers conducting surveys on most forest birds (Kepler and Scott 1981), and Marbled Murrelets are no exception. Intensive training and annual review and evaluation in detecting and identifying Marbled Murrelets and their vocalizations is strongly recommended and often required, as most murrelets remain unseen to the observer. It is recommended that an intensive instructional period with a minimum of three training mornings, followed by a fourth morning of performance evaluation or field examination, be implemented. Training should be conducted at a site with high activity levels to expose trainees to a wide range of vocalizations and activity during the morning. Trainees should be provided a tape with the full range of vocalizations of known murrelet calls, and be able to compare them with similar calls of other species, such as American Robin, Northern Flicker, Osprey, and Red-shouldered Hawk. They must also become familiar with the common call groups, '*Keer*' group, '*Groan*' group, '*Whistle*' group, described further in Nelson (1997) and Dechesne (1998). We recommend that all trainees have their hearing tested by a professional, and have adequate vision. See Emlen and DeJong (1981) and Ramsey and Scott (1981) for discussions on counting birds and variable hearing abilities. See Appendices C-F for more details on training, evaluations, hearing tests, confusing species, and vocalizations.

Data Quality

In addition to each agency or entity housing their own survey data, data also are voluntarily submitted to state or regional clearing houses. Thus, it is essential that the data be accurate. We recommend that data quality be assessed at several levels, beginning with the supervising field biologist of the field crews. Supervisors should have field experience with murrelet surveys, and should review all data sheets to help assure that the data meets the highest quality possible. This review should ensure that: correct and consistent site and station identifiers were used, the survey visit started on time, observations were not disrupted for more than 12 minutes total, detections were accurately recorded, and occupied detections were accurately defined. We also recommend that relatively inexperienced surveyors (i.e., with only 1-2 seasons conducting surveys) not be responsible for delineating survey sites and designing station layout.

Equipment Needed

Equipment for surveying should include: a clipboard, pencil, data forms, digital wrist watch, a light source (i.e., a headlamp or a flashlight), binoculars, compass, and a permanent marker and colored flagging for marking the locations of survey stations. A tape recorder is strongly recommended for all surveys and is extremely useful in areas of high activity. Use of a tape recorder allows the observer to scan the survey area continuously while simultaneously recording detections, minimizing the possibility of murrelets going undetected.

Reporting Observations

We recommend that data collected during survey visits be recorded on the data sheet described in Appendix G. This data form was revised by the Washington Department of Fish and Wildlife.

Detailed information on murrelet behavior needs to be recorded with each observation. Include in the notes section of the form information on the location of the bird's flight (over drainage, ridge, etc.), unusual behaviors or interactions, and details on **subcanopy behaviors** (e.g., 'bird flew between two trees and then headed up the Drift Creek drainage').

Observations of birds landing in trees, and chicks or eggshells on the forest floor, should be reported immediately to interested scientists and responsible wildlife agencies in your area so that active nests can be searched for.

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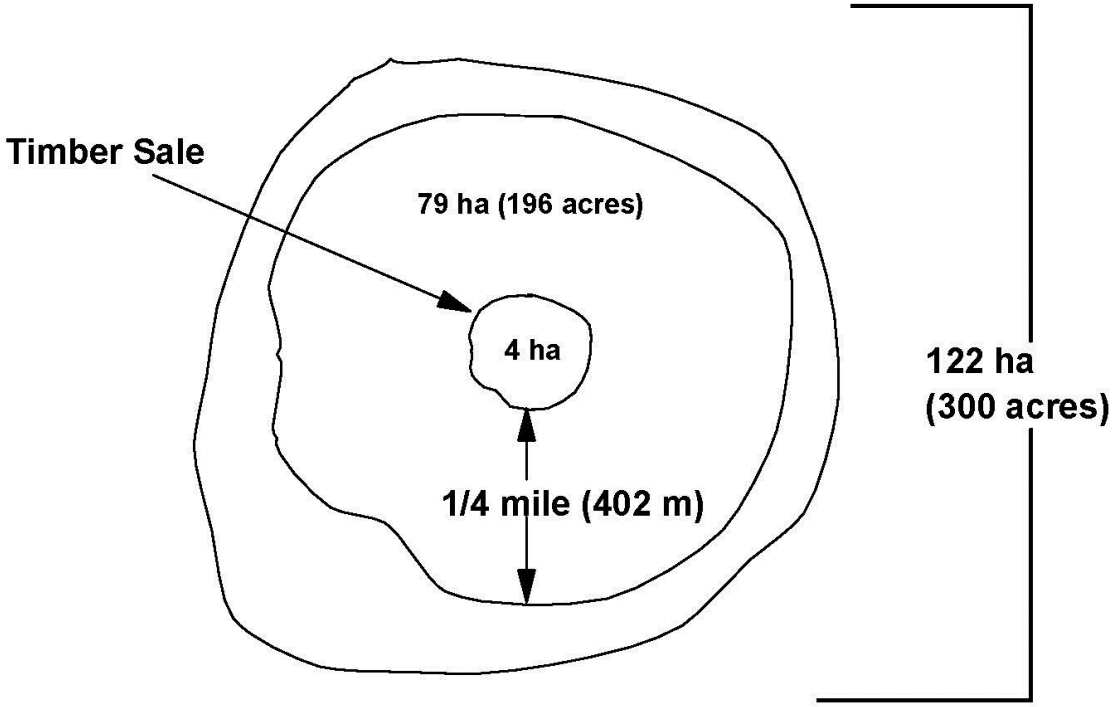


Figure 1. A 4-ha (10-acre) timber harvest area is located in the middle of a 122-ha (300-acre) stand of potential habitat. The survey area (timber harvest area and potential habitat within one-quarter mile of the harvest boundary) includes 83 ha (206 acres).

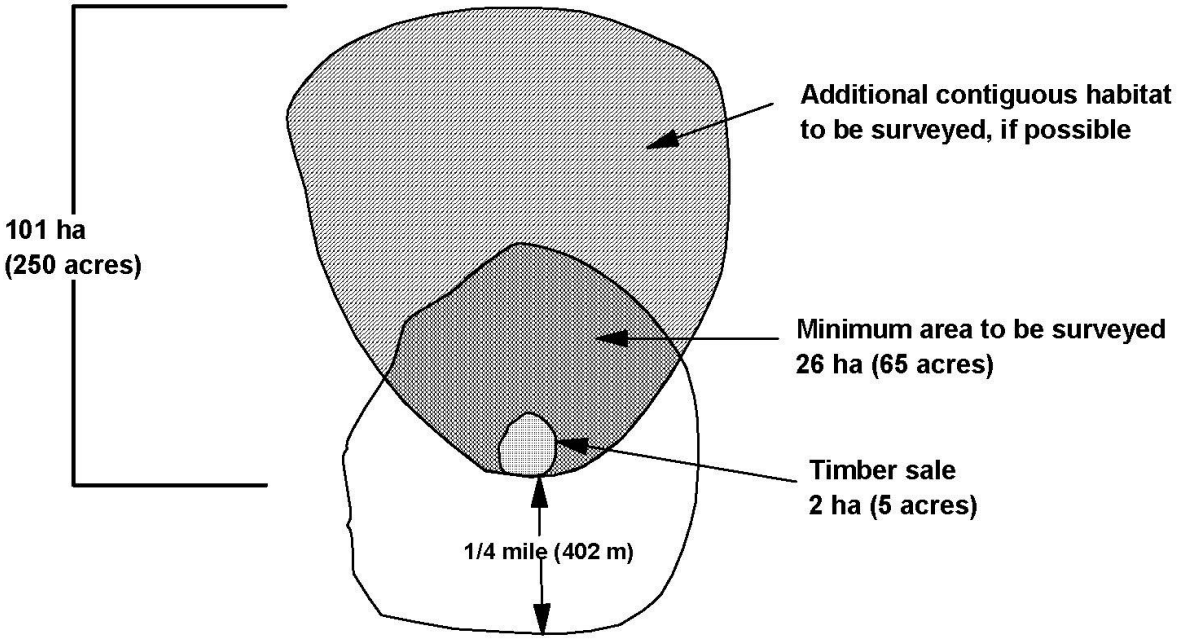


Figure 2. A 2-ha (5-acre) timber harvest area is located on the edge of a 101-ha (250-acre) stand of potential habitat. A one-quarter mile boundary around the proposed harvest area includes 26 ha (65 acres) of potential habitat. This captures a small portion of the entire continuous habitat. The additional continuous habitat that extends beyond the one-quarter mile boundary should also be considered for surveys.

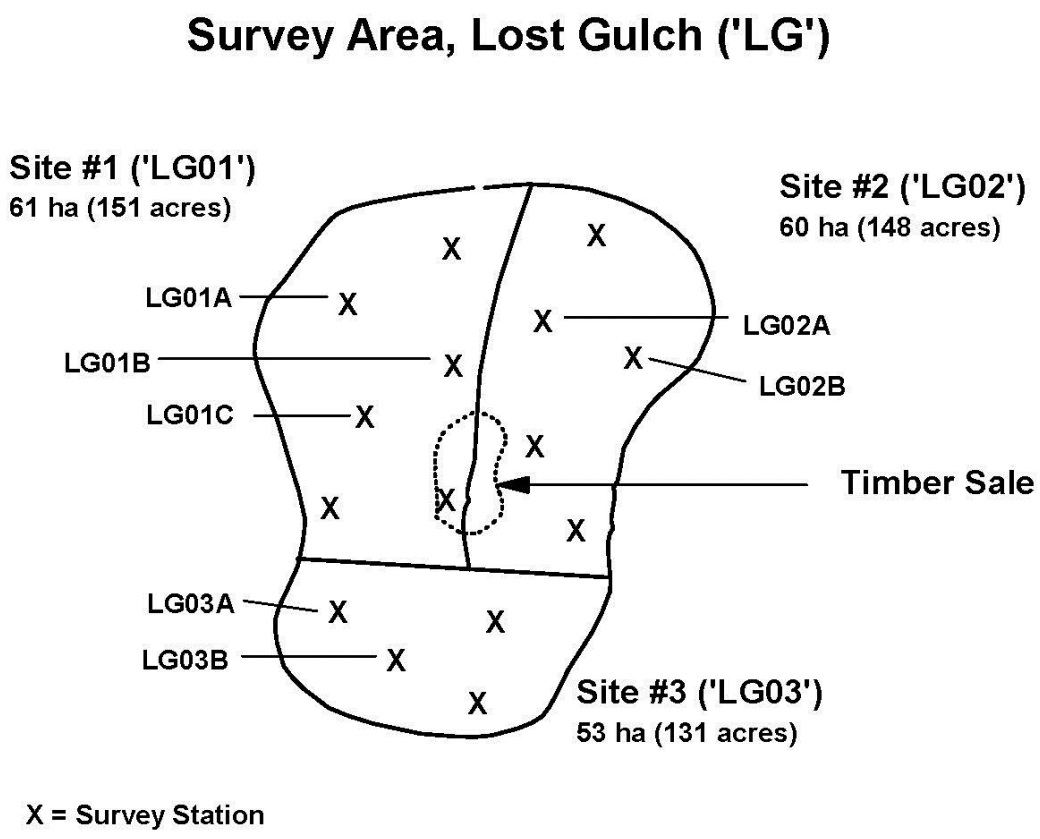


Figure 3. A large survey area of 174 ha (430 acres) divided into three survey sites, and an example of a naming convention to uniquely identify survey area, sites, and stations.

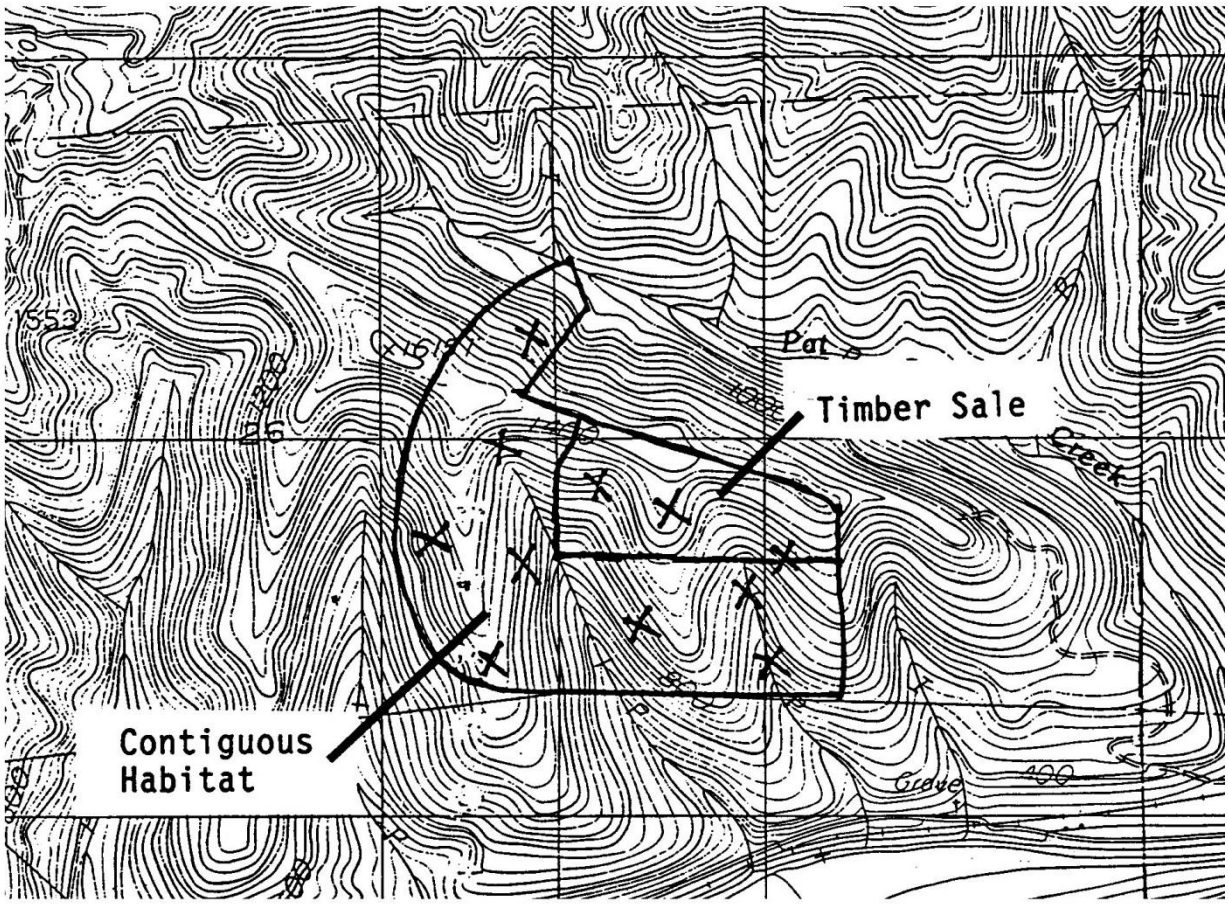


Figure 4. The survey area (timber harvest area and potential habitat within 1/4 mile of the sale boundary) includes 85 ha (210 acres). Eleven stations (approximately one station per 8 ha [20 acres]) are needed to survey this area because of limited visibility and steep and complex terrain.

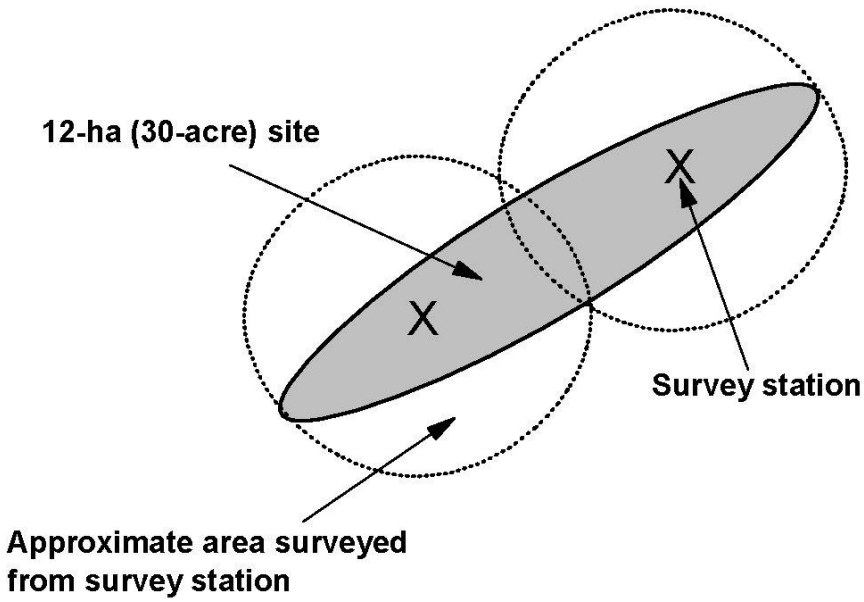


Figure 5. Two stations are needed to survey this 12-ha (30-acre) site that has a long and narrow shape.

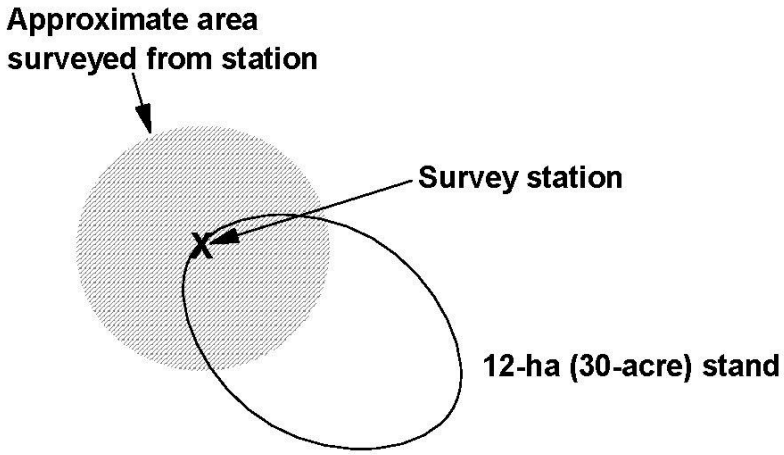


Figure 6. Less than 6 ha (15 acres) of this 12-ha (30-acre) site would be surveyed with this survey station. At least one additional station would be needed to survey this site adequately.

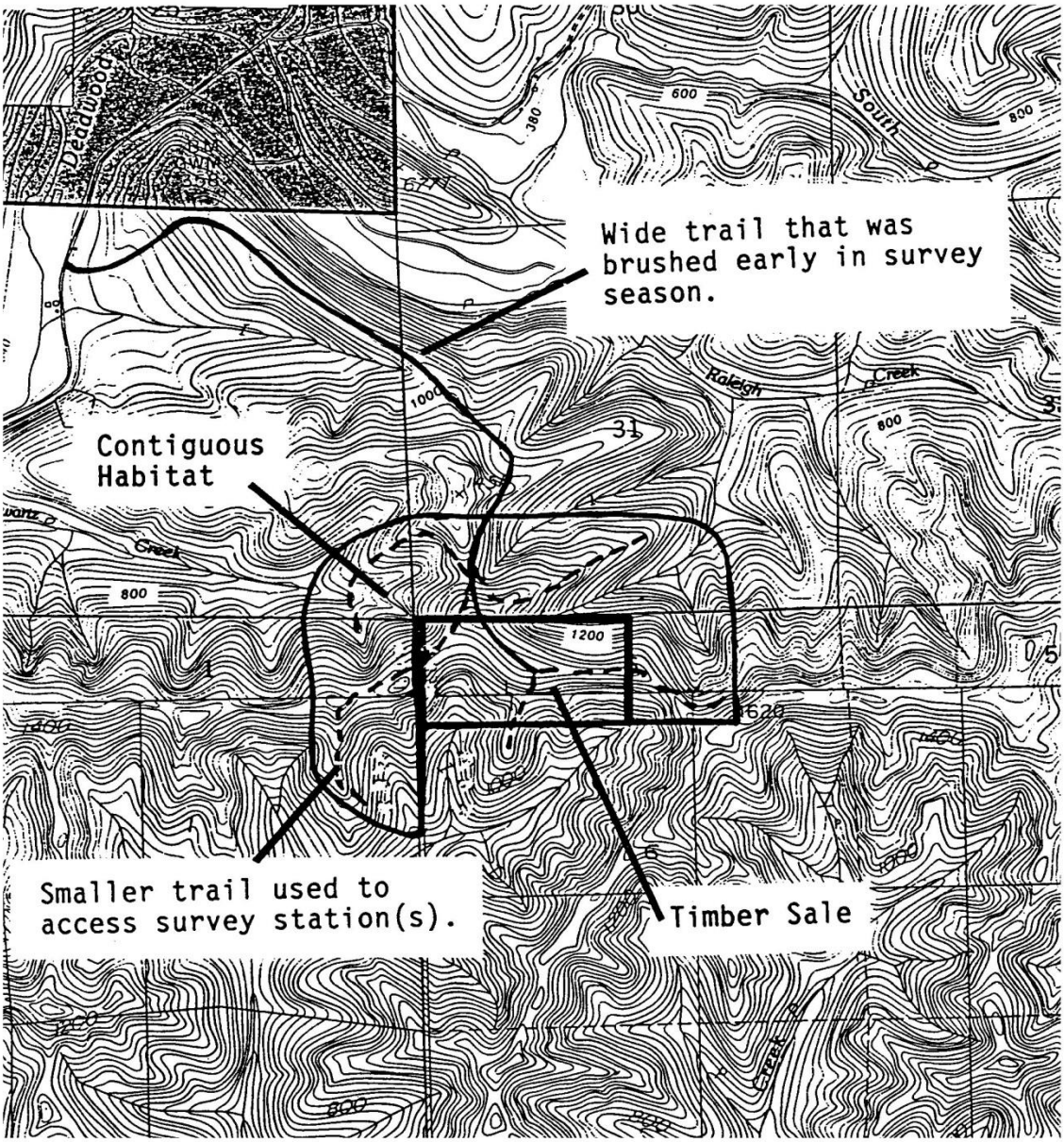


Figure 7. Example of using one large brushed trail to access many survey stations.

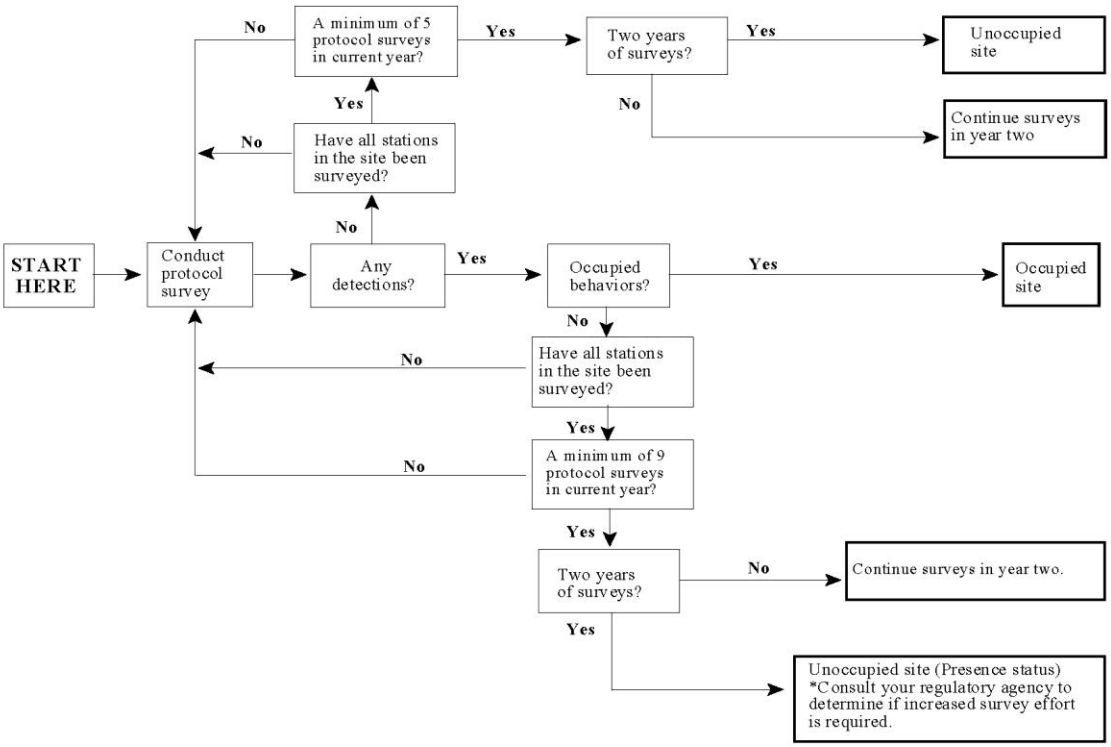
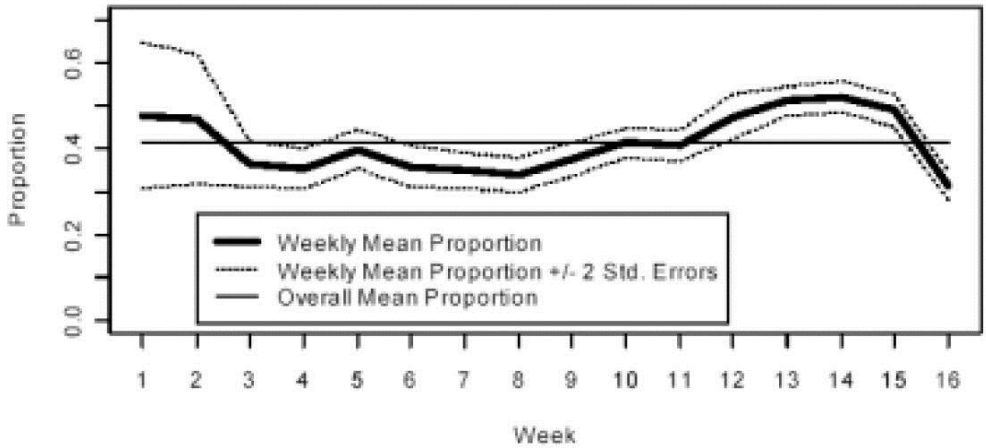


Figure 8. Decision tree to evaluate stands for occupancy of Marbled Murrelets.



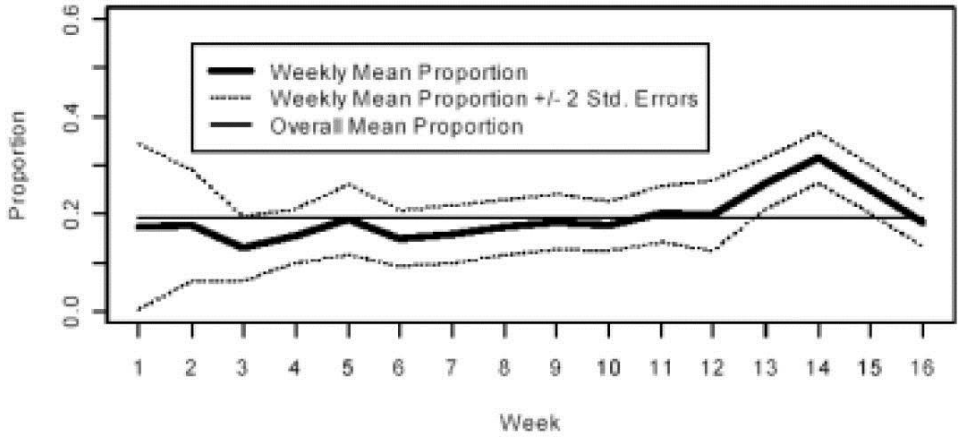


Figure 9. Proportion of visits with presence (top) and occupancy (bottom) at sites with at least one visit of presence or occupancy, respectively. Data for occupancy were restricted to sites surveyed with binomial sampling (a set number of visits regardless of detections). Week 1 begins 15 April, week 12 begins 1 July, week 16 begins 29 July. From Baldwin 2001b.

APPENDIX A

SUMMARY OF RE-ANALYSIS FOR *q* and NUMBER OF SURVEY VISITS

Compiled by Diane Evans Mack[1] and Danielle Prenzlow Escene[2]

During 1999-2002, data from Marbled Murrelet inland surveys were assembled from Washington, Oregon, and northwestern California and analyzed for improved estimates of *q*. *q* is the probability of not observing a detection on a single visit, given that birds are present, or not observing a subcanopy behavior, given that the site is occupied. *p* is the opposite of *q* (1-*q*), or the probability of detecting a bird on one visit, given presence, or seeing a subcanopy behavior, given occupancy. Previous estimates of *p* and *q*, derived in 1995 on a more limited dataset, were used to determine the number of visits needed to detect presence or occupancy with 95% probability of being correct (i.e., <5% error in classification). The previous analysis could not provide information on how to distribute visits over time. The new composite dataset included surveys from 1989-1998 at 3082 sites (see Max 2001 for description of data). It included all surveys, even those to sites where no detections were made (absence sites).

There are several important caveats regarding the 2002 analysis. The available composite dataset had certain biases that influenced the parameters from which the results were derived. In summary:

- This was a retrospective analysis of existing data. Overall, the surveys were not designed to answer some of the questions we wanted to address to improve the protocol. For example, a relatively small proportion of sites were surveyed three or more years, so we were unable to assess whether a three-year survey protocol would function better than a two-year protocol.
- Surveys may or may not have been representative of the landscape. Regarding distribution, it is reasonable to expect that, in the future, the protocol will be applied in much the same way that previous surveys were conducted – to a limited landscape, not randomly. However, geographic areas may have inconsistent representation in the data among years. Also, earlier selection of sites in the dataset may have been in better quality habitat, whereas later (and future) surveys may have been in lower quality habitat. The definition of habitat also has changed over time. On the positive side, estimates of detectability are less influenced by these unknown changes in proportions of sites of varying habitat quality (Baldwin 2002).
- Visits to many sites were stopped when occupied behaviors were observed. This limited the examination of a site's change in status over time.

The re-analysis initially mapped out four hierarchical avenues of exploration: a new estimate of *q*, and tests for seasonal, spatial, and annual variability in *q*. Results of these are summarized in Table A-1. The biggest change in the 2002 results from previous estimates of *q* was the incorporation of a temporal component to *q*. Initial estimates of *q* were calculated on a site basis.

[1] Pacific Northwest Research Station, Olympia Forestry Sciences Lab., 3625 93rd Ave SW, Olympia, WA, 98512.
[2] Washington Department of Natural Resources, P.O. Box 47104, Olympia, WA, 98504.

Table A-1. Summary of planned and developed tests for re-analysis of Marbled Murrelet inland survey data. Original schema and descriptions of tests with their proposed designs are available at http://www2.psw.fs.fed.us/mamu/

Planned Tests	**Design**	**Outcome**	**Source**
Revised estimate of q (and P)	Assumes status of sites does not change Maximum likelihood estimation (MLE) using all data	'all-year' q Presence: $q = 0.589 \pm 0.029$ Occupancy: $q = 0.825 \pm 0.041$	Max 2001
Seasonal variability (Test '1')	Randomization test	Detection rates vary within the 16-week survey season	Baldwin 2001b
Spatial variability (Test '2a') Irrespective of seasonal variability	Randomization test	Detection probabilities for presence and occupancy vary among sites for all years pooled and in every year individually, except 1989	Nations and Manly 2002
Spatial variability (Tests '2b-1' and '2b-2') Assuming no seasonal variability	2b-1: AIC to compare distributions of p estimated using MLE 2b-2: Randomization test	Test 2b-1 complicated; committee decided not to pursue Test 2b-2 determined by statisticians to have limited usefulness; not pursued	
Spatial variability (Tests '2c-1' and '2c-2') Modeling	2c-1: Logistic regression w/ habitat attributes 2c-2: Maximum likelihood estimation w/ stratification schemes	Test 2c-1 not feasible; no habitat data available Test 2c-2 conducted for province (see one-year q, below); habitat not possible; committee decided to not pursue other strata	
Annual variability (Test '3-b')	Randomization test, assuming no other sources of variation	Not pursued – annual variation in q less important than other sources of variation, and site status change (changes in P; see below) more meaningful	
Developed Tests			
Revised estimate of q (and P)	Assumes status of sites changes Maximum likelihood estimation; site-year combinations	'one-year' q Presence: $q = 0.550 \pm 0.020$ Occupancy: $q = 0.784 \pm 0.026$	Baldwin 2002
One-year q by physiographic province	Maximum likelihood estimation Similar to spatial variability test, estimating q by strata (i.e, province)	Results presented to committee, but too many underlying sources of variation (other than province) for estimates to be meaningful or reliable	
Site status change	MLE to estimate proportion of sites that change status	9-28% of all sites and 18-65% of occupied sites change status year to year	Baldwin 2001a
What is the overall success rate of a 2-year protocol?	MLE to estimate q_0, q_1, q_2 to calculate probability with two-stage sampling	Probability tables with stopping rules and different average proportions of sites that change status	Baldwin 2002, Prenzlow Escene 2002
What is the overall success rate of a 3-year protocol?	Markov chain using estimates of proportions of annual site status	Not completed based on statisticians advise that results would not be defensible with data at hand	

In other words, q was based on the total visits to a site, regardless of whether visits occurred in only 1 year, 2 years, or 6+ years (Max 2001). This analysis (termed the 'all-year' q) assumed that the status of a site did not change from year to year. The exploration of status change (Baldwin 2001a) demonstrated the need to account for P (proportion of sites that are occupied) in the estimate of q. This led to a 'one-year' q for presence (0.5505) and for occupancy (0.7842), based on all site-year combinations in the dataset (Baldwin 2002).

Because q is a conditional probability of not observing the behavior given that it does occur, q would not be expected to change from year to year. Years when the behavior truly doesn't occur actually demonstrate a change in P, not q. The fact that a relatively high proportion of sites changed status confirmed the need for a survey protocol that encompasses more than one year. Because the existing data were inadequate to examine status change over three or more years, we accepted a two-year protocol.

The associated numbers of visits for the 'one-year' q are summarized in Table A-2. For example, given that a site has presence in a year, the probability of *not* observing a presence behavior on a single visit during that year is 0.5505 (q for presence). Thus, within a one-year time frame, a site with a true annual status of presence would need to be visited 5 times ($1-q^5$) to reach a 0.9494 probability of detecting presence during that year. Stated another way, a site with a true annual status of presence would need to be visited 5 times (q^5) to have a 0.0506 probability of *not* detecting presence during that year. Given that a site is occupied in a year, the probability of *not* observing an occupied behavior on a single visit during that year is 0.7842 (q for occupancy). Thus, a site with a true annual status of occupancy would need to be visited 12 times (q^{12}) to have a 0.0541 probability of *not* detecting occupancy during that year.

Table A-2. Probability of detecting presence and occupancy based on a one-year definition of status and a one-year time frame, with q-values from Baldwin 2002. All data were used.

Number of visits	Presence	Occupancy
4	0.9082	0.6218
5	**0.9494**	0.7034
6	0.9722	0.7674
7	0.9847	0.8176
8	0.9916	0.8570
9	0.9954	0.8878
10	0.9974	0.9120
11	0.9986	0.9310
12	0.9992	**0.9459**
13	0.9996	0.9576
14	0.9998	0.9667
15	0.9999	0.9739
16	0.9999	0.9795

The data presented in Table A-2 could be used to design a simplified sampling scheme, but the 1989-1998 dataset allowed two other components to be considered: the effect of two-stage sampling (stopping early when no detections are made) and status changes at sites. These

components were used to address survey efficiency, while minimizing the risk of misclassifying a truly occupied site.

In order to recommend two-stage sampling (i.e., incorporate a stopping rule), one needs to determine not only the probability of not observing an occupied behavior, but also the probability of not observing even presence behaviors on a single visit. Baldwin (2002) reports the appropriate detection probabilities from the dataset analyzed: given that a site is occupied in a year, the probability of observing no detections on a single visit during that year (q_0) is 0.4244. Given that a site is occupied in a year, the probability of observing presence-only behaviors on a single visit during that year (q_1) is 0.3416. Given that a site is occupied in a year, the probability of observing occupied behaviors on a single visit during that year (q_2) is 0.2341.

In addition, knowing that the status of a site could change over two years, one could assume several scenarios: (1) any site is occupied (or has presence status) in <u>only</u> 1 of 2 years, (2) any site is occupied (or has presence) in <u>both</u> years, or (3) on average, some proportion of sites is occupied in only 1 of 2 years.

The formulas for calculating the probability of observing occupancy for these scenarios and with two-stage sampling are listed in Table A-3 (from Prenzlow Escene 2002). The table assigns Q and Q' to the formulas for probability of observing occupancy for the case of occupied in 1 of 2 years and 2 of 2 years, respectively. The table also assigns the variables A, B, and C to the proportions of sites in the various combinations of true annual site status over two years, conditional on observing at least one observation of occupancy. Since at least one year must have a true annual site status of occupancy, A + B + C = 1. The formula to incorporate proportions of sites that change status into the final calculation (average probability of detecting occupancy) is: $AQ + BQ + CQ'$ which equals $(A + B)Q + CQ'$ which equals $(1 - C)Q + CQ'$.

Table A-3. Formulas for calculating the probability of observing occupancy under different scenarios of true annual site status, incorporating a stopping rule in the sampling approach. The final formula for average probability of detecting occupancy is $AQ + BQ + CQ'$, or $(1 - C)Q + CQ'$.

True Annual Site Status			
Year 1	**Year 2**	**Probability of Observing Occupancy**	**Proportion**
Absence	Absence	0	0
Absence	Occupancy	$Q = 1 - (q_0 + q_1)^s - q_0^{s*}(1 - (q_0 + q_1)^{s-s*})$	A
Occupancy	Absence	$Q = 1 - (q_0 + q_1)^s - q_0^{s*}(1 - (q_0 + q_1)^{s-s*})$	B
Occupancy	Occupancy	$Q' = 1 - (q_0 + q_1)^{2s} - q_0^{s*}(1 - (q_0 + q_1)^{s-s*})(q_0^{s*} + (q_0 + q_1)^s)$	C

This protocol recommends a sampling design based on 40% of occupied sites changing status over two years (from the weighted average of sites changing status over pairs of years from 1991-1998; Baldwin 2001a) and a stopping rule of 5 visits, assuming a desired 95% probability of correctly classifying occupied sites. This sampling design can be assessed against those using alternative proportions and numbers of visits by comparing Tables A-4 through A-8. Additional scenarios are displayed in Prenzlow Escene 2002.

Table A-4. Probabilities of detecting occupancy in one year, given that a site is occupied in only 1 of 2 years (equivalent to an average of 100% of occupied sites changing status). *s* = planned number of visits per year; *s** = number of visits with no detections, after which surveys could be stopped for that year ('stopping rule' visits). From Baldwin 2002.

Occupied in 1 year, absence in the other (A=0.5, B=0.5, C=0)				
s	***s** = 4*	***s** = 5*	***s** = 6*	***s** = **s*** **no two-stage sampling**
4	0.6557	---	---	0.6557
5	0.7287	0.7363	---	0.7363
6	0.7846	0.7948	0.7980	0.7980
7	0.8274	0.8396	0.8439	0.8453
8	0.8602	0.8739	0.8791	0.8815
9	0.8853	0.9002	0.9060	0.9092
10	0.9046	0.9203	0.9266	0.9305
11	0.9193	0.9357	0.9424	0.9467
12	0.9306	0.9476	0.9545	0.9592
13	0.9392	0.9566	0.9638	0.9687
14	0.9459	0.9635	0.9709	0.9761
15	0.9509	0.9688	0.9763	0.9817
16	0.9548	0.9729	0.9805	0.9860

Table A-5. Probabilities of detecting occupancy in one year, given that a site is occupied in both of 2 years (0% of occupied sites changing status). *s* = planned number of visits; *s** = number of visits with no detections, after which surveys could be stopped for that year ('stopping rule' visits). From Prenzlow Escene 2002.

Occupied in both of 2 years (A=0, B=0, C=1.0)				
s	***s** = 4*	***s** = 5*	***s** = 6*	***s** = **s*** **no two-stage sampling**
4	0.8815			0.8815
5	0.9282	0.9305		0.9305
6	0.9560	0.9585	0.9592	0.9592
7	0.9727	0.9751	0.9758	0.9761
8	0.9827	0.9849	0.9857	0.9860
9	0.9888	0.9908	0.9914	0.9918
10	0.9925	0.9943	0.9949	0.9952
11	0.9948	0.9964	0.9969	0.9972
12	0.9962	0.9977	0.9981	0.9983
13	0.9971	0.9985	0.9988	0.9990
14	0.9977	0.9990	0.9993	0.9994
15	0.9981	0.9993	0.9995	0.9997
16	0.9984	0.9994	0.9997	0.9998

Table A-6. Average probabilities of detecting occupancy in one year, assuming that, on average, 30% of sites are occupied in only 1 of 2 years, and the remaining 70% in both years. From Prenzlow Escene 2002.

A=0.15, B=0.15, C=0.7				
s	***s** = 4**	***s** = 5**	***s** = 6**	***s** = *s* no two-stage sampling**
4	0.8138			0.8138
5	0.8684	0.8722		0.8722
6	0.9046	0.9094	0.9108	0.9108
7	0.9291	0.9345	0.9362	0.9369
8	0.9460	0.9516	0.9537	0.9547
9	0.9578	0.9636	0.9658	0.9670
10	0.9661	0.9721	0.9744	0.9758
11	0.9722	0.9782	0.9806	0.9821
12	0.9765	0.9827	0.9850	0.9866
13	0.9797	0.9859	0.9883	0.9899
14	0.9822	0.9884	0.9908	0.9924
15	0.9839	0.9902	0.9925	0.9943
16	0.9853	0.9915	0.9939	0.9957

Table A-7. Probabilities of detecting occupancy in one year, assuming that, on average, 40% of sites are occupied in only 1 of 2 years, with the remaining 60% in both years. **This is the recommended protocol.**

A=0.2, B=0.2, C=0.6				
s	***s** = 4**	***s** = 5**	***s** = 6**	***s** = *s* no two-stage sampling**
4	0.7912			0.7912
5	0.8484	0.8528		0.8528
6	0.8874	0.8930	0.8947	0.8947
7	0.9146	0.9209	0.9230	0.9238
8	0.9337	0.9405	0.9431	0.9442
9	0.9474	**0.9546**	0.9572	0.9588
10	0.9573	0.9647	0.9676	0.9693
11	0.9646	0.9721	0.9751	0.977
12	0.9700	0.9777	0.9807	0.9827
13	0.9739	0.9817	0.9848	0.9869
14	0.9770	0.9848	0.9879	0.9901
15	0.9792	0.9871	0.9902	0.9925
16	0.9810	0.9888	0.9920	0.9943

Table A-8. Probabilities of detecting occupancy in one year, assuming that 70% of sites are occupied in only 1 of 2 years, and the remaining 30% in both years. From Prenzlow Escene 2002.

A=0.35, B=0.35, C=0.3				
s	***s** * = 4*	***s** * = 5*	***s** * = 6*	***s** * = **s*** **no two-stage sampling**
4	0.7234			0.7234
5	0.7886	0.7946		0.7946
6	0.8360	0.8439	0.8464	0.8464
7	0.8710	0.8803	0.8835	0.8845
8	0.8970	0.9072	0.9111	0.9129
9	0.9164	0.9274	0.9316	0.9340
10	0.9310	0.9425	0.9471	0.9499
11	0.9420	0.9539	0.9588	0.9619
12	0.9503	0.9626	0.9676	0.9709
13	0.9566	0.9692	0.9743	0.9778
14	0.9614	0.9742	0.9794	0.9831
15	0.9651	0.9780	0.9833	0.9871
16	0.9679	0.9809	0.9863	0.9901

Acknowledgements

The Statistical Analysis Steering Committee was facilitated by Danielle Prenzlow Escene. Jim Baldwin and Tim Max designed and conducted the tests summarized herein, with assistance from Karen Hyer, Chris Nations, and Brian Manly. Diane Evans Mack, Kim Flotlin, Lee Folliard, Tom Hamer, Scott Horton, Joe Lint, Kim Nelson, Scott Osborn, Bill Ritchie, Lynn Roberts, Marty Raphael, and Mike Wilson comprised the review committee.

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APPENDIX B

DESCRIPTION OF MURRELET EGGS AND EGGSHELL FRAGMENTS

Compiled by Steve Singer[1]

Size and Shape

Marbled murrelet eggs are subelliptical in shape with sizes ranging from 57.0-63.0 mm in length, 35.0-39.5 mm in width, and 36-41 g in mass (Nelson 1997). One reported measurement of eggshell thickness was 0.21 mm at the waist (Kiff 1981). Surface texture is usually smooth and non-glossy.

Color and Markings

Egg background color is olive-green, lime green, or greenish-yellow, and more precisely corresponds to Munsell colors of 2.5 GY 8/3, 2.5 GY 8/4, 7.5 Y 8/4, 7.5 Y 8.5/4, and rarely, 6.5 GY 8/3 (see Table B-1). Eggs are variably marked with irregular spots and splotches that are brownish, blackish, grayish, purplish, or sepia-like in color (Figure B-1). Spots and splotches may be 8 mm in their longest dimension (Becking 1991), although most are smaller than 2 mm in diameter.

It is not yet known if there is any geographic variation in egg color or markings. Some published descriptions have failed to match eggshell color with known color standards, thereby limiting their usefulness. Those that have done so have used Ridgway (1912), Smithe (1974, 1975, 1976), or the Munsell Book of Color (Anonymous 1976). Of these color standards, only the latter has enough described colors to provide an exact match for all egg colors based on unfaded color swatches. A comparison of different color standards used to describe Marbled Murrelet eggshell colors is provided in Table B-1.

Figure B-1. Nearly intact side of large Marbled Murrelet eggshell fragment, Big Basin Redwoods State Park, 1993. Photo by S. Singer.

[1] Santa Cruz Mountain Murrelet Group, P.O. Box 7422, Santa Cruz, CA. 95061.

Table B-1. Background Marbled Murrelet egg color as defined by different color notation standards.

Ridgeway (1912)	Smithe (1974, 1975, 1976)	Munsell Book of Color (Anon. 1976)
"pale glass green"[a]	No equivalent	2.5 GY 8/3
"pale chalcedony yellow"	No equivalent	7.5 Y 8/4 7.5 Y 8.5/4
"pale dull green-yellow"	No equivalent, but somewhat lighter that #59 "lime green" and more yellow than #162 D "opaline green"	2.5 GY 8/4 2.5 GY 8.5/4
"pale turtle green"[b]	#162 D "opaline green"	6.5 GY 8/3

[a] Sources: descriptive articles in References, also unpublished data.
[b] Uncommon eggshell color described in Singer et al. 1991.

Recommendations on Describing Eggshell Fragments

Eggshell fragments are often found in murrelet nests or on the ground below. Their condition can be useful in determining the fate of the nest if not otherwise known. Researchers should collect the following information:

- Number, size, and shape of fragments and location where found
- Background color based on Munsell Book of Color (but note that shell fragments weather toward brown relatively quickly under acid conditions of coniferous forests)
- Number, size, and shape of spots and splotches and color description based on Munsell Book of Color.
- Texture and thickness of the eggshell
- Presence of any other egg or nestling materials associated with the eggshell fragments, such as shell membrane, albumen, yolk, blood, feathers, or feather sheaths.

Eggshells should be donated to museums and scientists with the proper permits in your area. It is not permissible to keep eggshell fragments without the proper federal, state, or provincial permits.

Copies of the Munsell Book of Color are available in the library of any college or university with an Arts Department or can be ordered from Gretag MacBeth, 617 Little Britain Road, New Windsor, New York, 12553. Their web site is at http://munsell.com.

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APPENDIX C

MARBLED MURRELET OBSERVER TRAINING PROTOCOL

Compiled by Sherri L. Miller[1], C. John Ralph[1], and Ron LeValley[2]

Introduction

Presented here is a protocol to train and evaluate potential observers. The training program helps the trainees to develop their ability to see and hear murrelets in the forest and to accurately record observations on a data form. The evaluation process provides a standardized method for determining if an individual's abilities will yield reliable and dependable survey data.

Training for **first and second year** murrelet surveyors should include all of the following steps: (1) a hearing test (see Appendix C); (2) a seminar on murrelet biology and forest survey protocol; (3) field training, with a minimum of three survey mornings, from a qualified instructor within or outside of your agency or organization; and (4) a field exam with a qualified evaluator in their geographic area. Trainees should take the field exam after they understand the protocol and are proficient in survey techniques. Once a trainee passes the field exam, they are qualified to conduct murrelet forest surveys.

After two years of survey experience that includes murrelet detections on multiple surveys, training in subsequent years should include steps (1), (3) and (4) as listed above, except with two to three practice survey mornings in the field recommended prior to the field exam. Surveyors who do not perform murrelet surveys regularly should also include step (2) in their annual evaluation. It is important that surveyors refamiliarize themselves **each year** with the calls and techniques needed to conduct accurate murrelet surveys. We also recommend that to help maintain their skills, surveyors who do not encounter murrelets during the season should visit a site with moderate activity levels at least one time during the season. This mid-season refresher would best take place during late June or early July to prepare a surveyor for the increased activity levels documented in July.

Observer Qualifications

Our experience indicates that most individuals with adequate sight and hearing abilities are capable of being trained to recognize Marbled Murrelets following the PSG protocol. However, the quality and reliability of observations is greatly enhanced if surveyors possess basic bird identification skills, or, preferably, begin with the ability to identify by sight and sound the common birds of the survey areas. Surveys at sites with low or zero murrelet abundance require a higher degree of competence and documentation (Hunter and LeValley 1996). Given the expense of sorting out false positive detections, land managers should be willing to expend the effort to insure that the data gathered are of the highest quality possible.

Seminar

A seminar on the biology of the Marbled Murrelet should include the following: species description, breeding chronology, flight behavior, habits, habitat and nest site description, and a summary of potential threats to the bird. A slide show or video including pictures of adults, juveniles, chicks, eggs, eggshell fragments, and some habitats used by murrelets should be

[1] Redwood Sciences Laboratory, U.S.D.A. Forest Service, 1700 Bayview Drive, Arcata, California, 95521.
[2] Mad River Biologists, 1497 Central Ave., McKinleyville, California, 95519.

included. A video of murrelets in flight over forests should be incorporated if accessible. The seminar can provide information regarding the legal history and current status of the species. Questions from the audience should be answered regarding all aspects of the biology of the species.

The importance of adequate training and preparation for the evaluation should be emphasized at the seminar. Proper training will not only help observers to pass the evaluation, but also will improve the quality of data collected throughout the season.

The survey protocol should be reviewed and information presented on where to survey (potential habitat), when to survey (dates and times of survey), how to establish the survey site, and the number of survey stations required. Examples of how to establish survey stations should be presented with a discussion of where to place stations at the site.

A complete description of how to record and interpret data and bird behavior should be included in all aspects of the training and reviewed annually.

Field Training

Field training should always be conducted at an area of high murrelet activity, preferably well in excess of 25 detections per morning. If this level of activity is not found in the local area, it is recommended that trainees be transported to an area of high murrelet activity.

Before the first day of training, it will be helpful to the trainees to read and become familiar with the PSG survey protocol (Evans Mack et al. 2002) and to listen to a Marbled Murrelet vocalization cassette tape with accompanying descriptions. An outline of the daily objectives for the training and equipment for surveys should be obtained from the instructor prior to the training session. Equipment needed for the training includes: a tape recorder, at least one blank cassette tape, binoculars, a compass, a digital watch, and 5-10 blank survey data forms.

Outline of field training schedule

Day 1.--The first day of the field training begins 15 minutes before the survey time, at an area that will not disturb nesting murrelets. Trainees can listen to the murrelet vocalization tape while the instructor identifies the types of murrelet calls. The instructor should discuss calls from other species which may cause confusion. The training tape can include some of these calls of other species.

At the survey training site, trainees observe and listen for murrelets while the instructor points out the birds and calls. The instructor can discuss (1) murrelet behaviors in the forest and the importance of behaviors in identifying occupied sites; (2) the data sheet, including the types of data taken and priorities when recording information; (3) observation and recording techniques; and (4) calls and flight patterns of other birds that can cause misidentification problems.

The use of the Notes section on the data form should be encouraged. Interpretation of survey results will be enhanced by narrative notes that clarify the data. The instructor should discuss the importance of using binoculars to identify some species which can be confused with murrelets (e.g., swallows, swifts). It also should be noted that since the use of binoculars during a survey can cause the surveyor to miss murrelets, their use should be limited to species verification. The instructor should encourage trainees to ask questions throughout the session and during a discussion period following the survey.

During the last portion of the survey period, the instructor can record a few detections to demonstrate recording methods. At the close of the session, trainees are asked to practice recording before the next day's session by observing birds of any species flying overhead. By

recording these birds, they will become more familiar with the data required and the order in which the information is recorded.

A classroom session on this day can be used to explain details of recording observations on the data forms and mapping detections, and to show videos and/or slides.

Day 2.--On this day, trainees practice identifying murrelet calls and observing behaviors during visual detections. The instructor should measure and mark distances and tree heights at the training site to help trainees sharpen their skills for estimating distance to, and height of, the birds. A 50-m or 100-m tape can be used after the session to further help with distance estimates. Considerations of station placement at a site can be covered in the field on this day.

The instructor should record a few detections on a tape recorder, play back the recording, discuss the data with the trainees, and answer questions. Trainees can then record detections on their own while receiving assistance from the instructor. At the end of the morning's session, trainees should transcribe a portion of their data with the assistance of the instructor. This is an excellent way to see what data they are missing or recording incorrectly. Again, we suggest that trainees spend some time before the next session observing and recording birds of other species. Estimating height and distance also can be practiced on other birds.

Day 3.--All trainees can conduct a complete survey on this day, as the instructor circulates between trainees, helping with comments on accuracy and technique. At the end of the survey, tapes are transcribed, and any questions on data are clarified by the instructor. Trainees should be familiar with the techniques for conducting and recording a murrelet survey by the end of this day. It is helpful for the trainer to record and transcribe a segment of the morning's activity for comparison to the trainees transcriptions.

Day 4.--A simultaneous survey, described below, will be conducted on this day of the training.

Evaluation Survey (Field Exam)

When training is completed, an evaluating agency or organization should be contacted and arrangements made for an evaluation survey. The evaluation survey can only be conducted by a qualified evaluator. See Qualified Instructors and Evaluators, below, for information on evaluator qualifications.

Evaluation is based on the results of a simultaneous survey conducted by the trainees and an evaluator. The number of participants per evaluation will be determined in part by the size of the site. More importantly, the evaluator must be able to watch the participants and their reactions to birds to assess their ability. We recommend that group size be limited to 10 trainees per evaluator whenever possible, with a maximum of 12 trainees per evaluator.

Participants should arrive at the site early enough to allow time for instructions and still begin the survey at the appropriate time. During the survey, trainees are positioned approximately 5-8 meters apart. This helps ensure that observers have essentially the same viewing field, such that similar numbers of birds can be detected by all observers, but reduces the likelihood that they will cue in on detections by watching the evaluator or other observers or be distracted by others speaking into their recorders. Watches should be synchronized or a time check recorded on the tape recorders at the beginning of the survey. The evaluator may call out a time check during the survey, at which time all surveyors record the time on their tape.

In periods of low activity during the evaluation survey, the evaluator can record calls of other species, recording the same type of information as for a murrelet. These observations can then be checked against the trainees' recorded data to determine whether species are being correctly identified. The evaluator should record at least 10 to 20 observations of other species.

At the end of the survey, the data should be transcribed under the direct supervision of the evaluator. After transcription, all of the data sheets are turned into the evaluator, who tallies and evaluates the results for each participant.

Evaluation of Survey Results

To evaluate the results, we suggest that, for each 10-minute period of the survey, the number of detections of murrelets be tallied according to the following six categories: number heard, number seen, total number of detections, number of detections with occupied behaviors, number detected within 200 meters of the participant, and those detected at greater distances. If birds are both heard and seen, they are tallied once in each of the first two categories.

Each surveyor's results for three categories -- number heard, number seen, and number of occupied detections and/or total detections -- are compared with the evaluator's observations for each 10-minute period and for the entire survey. Two criteria of success are described below, one for sites with many birds, making it likely that some birds would be missed during peak activity, and another for sites with fewer detections.

To ensure consistency with previous evaluations, it is best that the tallied data be reviewed again by another experienced person for interpretation and evaluation of the results. For example, in California, one instructor reviews all of the results obtained under each evaluator, and then these decisions are reviewed again by a representative of the California Division of Forestry and California Department of Fish and Game.

Sites with many birds

At a site where the evaluator records 35 or more detections, reasonable measures of success for a surveyor are the following: if the participant records at least 60% of the number of observations in two of the three categories, and at least 50% in the remaining category, it can be considered that the participant has sufficient skill to determine the presence of murrelets in a forest stand. These figures are based on our experience in training people and comparing with expert surveyors. In these comparisons, the expert surveyors always detected in excess of 70% of the best observer. Further, we feel that any person detecting more than 60% of the birds in a stand with 35 or more detections would be unlikely to overlook so many birds that a nesting stand would be misclassified as "unoccupied".

If a participant records more detections than the evaluator, their results should be reviewed carefully to determine if they counted non-murrelet targets (suggesting that they misidentified murrelets) or double-counted what should have been single detections. There should be some allowance for visual detections, because the evaluator can't see everything. The number of audio detections should not exceed the evaluator's total.

Sites with fewer birds

If the survey site generally has fewer murrelet detections and the evaluator records less than 35 detections during the simultaneous survey, a different measure of success can be used. A participant should record at least 70% of the number of observations in two of the first three categories, and at least 60% in the remaining category. Activity during an evaluation should consist of a mix of both auditory and visual detections. **Evaluation surveys with less than 25 detections during a one-day evaluation, or 18 detections in each of two consecutive days of evaluation, are not acceptable**. Detections should include vocalizations and at least 6 visual observations each day.

At the discretion of the instructor and evaluator, the criteria listed above may be relaxed for trainees that meet one or more of the following conditions: (1) birds not heard by the trainees are usually in excess of 200 m from the evaluator; (2) occupied behaviors are in excess of 80% of the standard and agree with the evaluator; and (3) missed detections occur during very busy (greater than 10 detections) 10-minute periods when the presence of many birds may make individual detections difficult to define.

The results of participants with more detections than the evaluator should be reviewed for misidentifications or double-counting, as stated above.

Qualified Instructors and Evaluators

Instructors and evaluators should be highly-qualified field ornithologists very familiar with not only murrelets, but also all other bird species (especially their calls and songs) at evaluation sites. Both evaluators and instructors should have a minimum of three years' survey experience from a variety of survey situations (both high and low detection sites) and in a range of forest stand types.

Instructors are responsible for the first three days of the training sessions as outlined above. Instructors should have a demonstrated ability to teach and interpret the survey protocol. As such, an instructor must be knowledgeable in the areas of murrelet ecology, general habitat associations, protocol interpretation, survey design, and regional management and regulatory requirements. Evaluators (who may also be instructors) are responsible for the evaluation survey on day 4 of the training. Evaluators must be knowledgeable in murrelet ecology, protocol interpretation, and have the ability to survey consistently within 10% of other evaluators. Evaluators must be listed on the official evaluator list (see below) in order to be qualified to conduct evaluation surveys.

Instructors and evaluators should complete an extensive refamiliarization session annually, and a hearing test should be done at least every other year. The annual session should include a complete review of changes in survey protocol, new information suggesting alternative interpretation of survey data, and an update from local regulatory agency staff. It also should include simultaneous surveys with other instructor/evaluators. Consistent results (within 10%) between the evaluators during simultaneous surveys must be achieved before outside evaluations begin. A potential evaluator should spend at least 5 mornings conducting simultaneous surveys with a qualified and experienced evaluator and obtain the same 10% consistency.

Lists of Qualified Surveyors, Instructors and Evaluators

A list of current qualified surveyors, instructors and evaluators should be kept by each evaluating organization each year in case it is requested by regulatory agencies (e.g., the U.S. Fish and Wildlife (USFWS) State Office or the State Fish and Wildlife Office) or, in the case of contractors, by the contracting land managers. This list should include the names of participants who passed the evaluation survey and those who passed the more rigorous requirements (see above) to become an evaluator. The list should also include those individuals who are qualified to be an instructor according to the guidelines above.

Follow-up Surveys

Follow-up surveys should be conducted by crew leaders with the trainees at their assigned survey sites after the initial training and evaluation. These surveys help to identify deficiencies in survey technique which may develop once observers are conducting field work. Two types of follow-up surveys should be conducted: (1) at low-use sites, within 1-2 weeks after successful

evaluation; and (2) a mid-season survey at any site with detections, especially for those who have not seen or heard murrelets during the early part of the survey season.

Follow-up surveys at low-use sites are important to verify that observers are (1) identifying single murrelets in areas with few observations; and (2) not confusing murrelet calls with the calls of other forest birds in their survey areas. Because most training and evaluation are done at high-use sites, it is imperative that crew leaders verify that observers know how to accurately conduct surveys at low-use sites. It is recommended that these follow-up surveys take place for 1-2 days at sites with an average of 10-20 detections per morning. The crew leader should conduct a simultaneous survey, similar to the initial evaluation, to identify how the observers would benefit from additional instruction. If no low-use sites are available in your area, high-use sites can be used. In this case, the survey period could be split between the periods of peak murrelet activity and the non-peak times. The crew leader could then focus on the non-peak times and compare the numbers and types of observations recorded by the observers.

Mid-season training should occur during late June or very early July, and should include 1-2 days of surveys at low- or high-use sites. Crew leaders should review the survey protocols and reevaluate the observers' survey skills. This also is an important time to answer questions that have developed over the survey season and to revitalize crew morale.

Reference

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APPENDIX D

HEARING EXAMINATION for MARBLED MURRELET FOREST SURVEYS

Compiled by William Ritchie[1] and S. Kim Nelson[2]

Introduction

Given that a larger proportion of Marbled Murrelet detections are audible rather than visual, normal levels of hearing are required of all Marbled Murrelet survey personnel. Surveyors should have their hearing tested by a certified audiologist or physician prior to conducting protocol surveys. These standard tests are available at a reasonable price and offered at any clinic with an audiologist on staff. Most employers will reimburse employees for the cost of testing. Some large firms and agencies employ their own audiologist.

In addition to having normal hearing, or corrected hearing that meets the test criteria, a prospective murrelet surveyor must attend a recognized training program and demonstrate a proficiency in their ability to conduct protocol Marbled Murrelet surveys under the guidelines set forth by the Pacific Seabird Group. Individuals also should have normal or corrected vision.

Examination Procedure

Prior to testing, the patient will be asked to answer questions pertaining to their medical background and exposure to sources of loud noise. Audiologists use specialized equipment calibrated to provide diagnostic pure-tone audiometric testing. An audiometer provides a measure of a person's ability to hear sounds of different frequencies and intensities. These tests are typically performed in sound-treated examination rooms in order to obtain accurate results. The results of the testing should report the patient's hearing thresholds at sound frequencies within the normal range of human hearing, between 250 Hz and 8,000 Hz. Upon completion, the audiologist or physician should provide the patient with an audiogram and confirmation of normal hearing ability. An audiogram represents the hearing thresholds in decibels (dB), and can be displayed graphically or as a list of values.

It is recommended that a hearing test be conducted prior to hiring individuals for murrelet survey work. Producing the results of an acceptable hearing test should be a condition of hire for everyone expected to conduct protocol murrelet forest surveys. Results of the hearing test must also be reviewed by the training evaluator before a surveyor can qualify as proficient. A person's hearing should be tested at a minimum of once every two years, or more frequently if they have been exposed to any loud noise. The Occupational Safety and Health Association (OSHA) defines loud noise to be of an intensity $\geq$85 dB for $\geq$8 hours in duration (e.g., small aircraft flights, chainsaw, gunshots, loud music, etc.). This is roughly equivalent to a situation where a normal level of conversation within three feet begins to become difficult to discern due to the intensity of the noise. When assessing previous exposure to loud noise, one should consider that as noise intensity levels increase, the duration time of exposure before reaching the critical threshold will decrease. OSHA recommends annual testing whenever an individual is exposed to these conditions.

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[1] Washington Department of Fish and Wildlife, Olympia, WA 98501
[2] Oregon Cooperative Wildlife Research Unit, Oregon State University, Department of Fisheries and Wildlife, 104 Nash Hall, Corvallis, OR 97331-3803.

Evaluating Test Results

A review of the audiogram is necessary to determine if an individual has an acceptable level of hearing to conduct murrelet surveys. Marbled Murrelet vocalizations and sounds associated with flight range between 2,000 Hz and 5,000 Hz. In order for a person to have an acceptable hearing test, they should have good hearing at all frequencies, but especially in this range. The American Medical Association and OSHA define good hearing as 0 to 25 dB in both ears. This means that at all frequencies within the normal range of human hearing, an individual's hearing thresholds should be 25 dB or less. Individuals with good hearing, or corrected hearing that meets the definition of 'good' hearing, are qualified to conduct protocol murrelet forest surveys upon successful completion of an approved survey training program.

Marginal hearing is defined as 0 to 25 dB in one ear, and a level not to exceed 60 dB in the other ear. If an individual with marginal hearing can demonstrate proficiency in their ability to detect Marbled Murrelets during the survey evaluation, given their impaired hearing, they can conduct protocol murrelet forest surveys. This determination is made at the discretion of the training evaluator. Evaluators must be assured of the surveyor's ability to identify murrelet vocalizations at distances greater than 200 meters (600 ft), and their ability to discern correct detection and flight directions.

Poor hearing is defined as greater than 25 dB in both ears. Individuals with poor hearing, including those who meet the definition of poor hearing with corrective devices, are not qualified to conduct protocol murrelet forest surveys.

APPENDIX E

FOREST BIRD AND MAMMAL SPECIES POTENTIALLY MISIDENTIFIED AS MARBLED MURRELETS *AND* POTENTIAL MURRELET PREDATORS

The following species have been identified as sources of potential confusion if present during a Marbled Murrelet forest survey. They may be misidentified by sight, sound, or both by an inexperienced observer. Observers should be able to identify the species on this list to ensure the accuracy of the survey data reported. Marbled Murrelet flight is characterized by rapid, constant wing beats. See Appendix E for a detailed description of murrelet sounds. Species are identified by Common Name/A.O.U. code (birds).

Potentially Misidentified

Heard and Seen

Common Nighthawk (CONI)
Varied Thrush (VATH)
American Robin (AMRO)
European Starling (EUST)

Heard

Killdeer (KILL)
Bald Eagle (BAEA)
Red-shouldered Hawk (RSHA)
Red-tailed Hawk (RTHA)
Osprey (OSPR)
Northern Flicker (NOFL)
Red-breasted Sapsucker (RBSA)
Hairy Woodpecker (HAWO)
Olive-sided Flycatcher (OSFL)
Western Wood-Pewee (WWPE)
Steller's Jay (STJA)
Gray Jay (GRJA)
Swainson's Thrush (SWTH)
Hermit Thrush (HETH)
Hutton's Vireo (HUVI)
Black-headed Grosbeak (BHGR)
Song Sparrow (SOSP)
Western Tanager (WETA)
Evening Grosbeak (EVGR)

Mammal: Douglas squirrel

Seen

Wood Duck (WODU)
Harlequin Duck (HADU)
Common Merganser (COME)
Spotted Sandpiper (SPSA)
Band-tailed Pigeon (BTPI)
Mourning Dove (MODO)
Black Swift (BLSW)
Vaux's Swift (VASW)
Tree Swallow (TRSW)
Violet-green Swallow (VGSW)
American Dipper (AMDI)

Mammal: Bat spp.

Potential Marbled Murrelet Predators

The following is a list of potential predators of adult Marbled Murrelets or their nests (eggs or young). The presence of these predators during the survey should be noted at the bottom of the last page on the Survey Activity Table form.

Bald Eagle (BAEA)
Sharp-shinned Hawk (SSHA)
Cooper's Hawk (COHA)
Northern Goshawk (NOGO)
Red-shouldered Hawk (RSHA)
Peregrine Falcon (PEFA)
Great Horned Owl (GHOW)
Barred Owl (BAOW)
Northern Spotted Owl (SPOW)
Steller's Jay (STJA)
Gray Jay (GRJA)
American Crow (AMCR)
Northwestern Crow (NWCR)
Common Raven (CORA)

Douglas squirrel
Red squirrel
Deer mouse
Keen's mouse
Northern flying squirrel
Townsend's chipmunk
Bushy-tailed woodrat

APPENDIX F

MARBLED MURRELET VOCALIZATIONS

Reviewed by William Ritchie[1]

Familiarity with murrelet vocalizations is essential for anyone planning to conduct a protocol survey. The majority of murrelet detections are auditory (Paton and Ralph 1988, Hamer and Cummins 1990, Nelson 1990), especially at interior forest survey stations with limited visibility. Marbled Murrelet vocalization recordings are currently being collected and analyzed to characterize the different calls. Presently there are four recognized vocalization categories: (1) "*Keer*" calls, (2) Whistle calls, (3) Groan/grunt calls (formally known as alternate calls), and (4) Fledgling begging calls (Nelson and Peck 1995, Nelson 1997, Dechesne 1998). These categories of vocalizations can include a variety of variable call combinations. To date there have been no identified sexual differences, call functions, or geographic variability in murrelet vocalizations. However, in time we may be able to associate vocalizations with behavior.

The most distinctive and commonly heard vocalization is the "*Keer*" call. The frequency range for this call is 2,000 to 5,000 Hz, with a mean frequency of about 3,500 Hz. There are typically 2 or 3 elements to the "*Keer*" call, with the initial note of the call reaching a maximum at 5,000 Hz (see sonagrams in Nelson 1997 and Dechesne 1998). "*Keer*" calls are intermediate in length at about 300-350 milliseconds. This call can be described as a piercing, high pitched "gull-like" call that phonetically sounds like "*Keer-Keer*". Whistle calls generally consist of a short broadband initial segment followed by a narrow-band mid-frequency note of longer duration than the "*Keer*", and without the repeating series of calls. This type includes the whistle-like "*Kee*", single note calls similar to the initial segment of a "*Keer*" call, and the "soft-que" call, a long plaintive sounding ("*eeeh-eeeh*") whistle. Groan/grunt (alternate) calls can be heard frequently at inland sites, at sea, or while the adults are present at the nest during feeding visits. These vocalizations are similar to the raspy, nasal-sounding calls given by other alcids at breeding colonies. Many times a groan call is part of a "*Keer*" call sequence, or given in reply to another vocalizing murrelet. Long series of calls given by the same bird sometimes grade from "*Keer*" to groans without an abrupt change (Dechesne 1998). Adults bringing fish to the nestling often give a muted grunt call sounding like "*rrUH-rrUH*". The fledgling food begging call is a continuous series of soft, high-pitched "*peep*"s, sometimes heard when an adult arrives at or near the nest to feed the chick. In most cases vocalizations at the nest are not audible from the ground.

There are two additional auditory detections that may be heard at inland sites. These are not vocalizations, but sounds produced by air passing over the feathers of a murrelet in flight. The first is a jet sound, which can be heard when a murrelet is in a steep descent or when it is ascending following such a dive. This loud, slightly wavering, whooshing sound is a bit like a jet plane rapidly passing overhead. It is rarely heard and often occurs near or above nesting areas. The second, the sound of the murrelet's wing beat, has a wide frequency range, resulting in a rapidly alternating sound. These sounds have been described as similar to that of a rope being twirled rapidly in the air or a hand saw blade being shaken (Nelson 1997). Though the

[1] Washington Department of Fish and Wildlife, Olympia, WA 98501

detection of murrelet wing sounds is often associated with below canopy flight, it also originates from murrelets flying above the canopy. If wing-beat sounds are detected during a survey without any visual sighting, additional surveys are necessary to determine if the site is occupied.

Once a surveyor learns the basic calls, they should develop their ability to identify similar-sounding vocalizations from other forest birds. This will help identify murrelet calls at sites with background noise and differentiate distant murrelet calls from other similar-sounding calls.

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APPENDIX G

DATA FORM[1] AND INSTRUCTIONS FOR ITS COMPLETION

Cover Page (page 1)

Item #

1 Page Number of the total number of pages of data for the survey. This includes Cover Page, Survey Activity Table page(s), and Map page(s).

2 Survey Visit to Protocol: Circle Y (Yes) or N (No) to indicate if the survey was conducted following the guidelines of the Pacific Seabird Group protocol. Include the initials of the person who is making this statement, often the crew or project leader. To answer this question will involve a review of the survey visit by someone affiliated with the survey effort, who should check the survey form for compliance with the protocol, and possibly speak with the observer. The review is not to be done by the observer. An affirmative response does not necessarily imply that the entire survey effort was acceptable or that regulating or evaluating agencies will find the survey to be valid.

3 Total Detections: Total number of murrelet detections recorded during a survey visit. All detections should be assigned a detection number (Detect. #), including un-mappable detections. No other species observations should be included in this count.

4 Other Species of Concern: Circle Y (Yes) or N (No) to indicate if other species of concern were observed; refer to your state or provincial Fish and Wildlife agency Species of Concern list. Record details of observation(s) ***at the end of the last page of the Survey Activity Table***.

5 Month, Day, Year: Date of survey visit. Use 2 digits for Month and Day, and four digits for Year (e.g., May 10, 2000 = 05/ 10/ 2000).

6 Area Name: Name of survey area being surveyed.

7 Site Name and Number: Site name and number from which survey visit is conducted. Each survey site should have a ***unique*** number or alphanumeric identifier.

8 Station Number: Station number from which survey visit is conducted. Each survey station should have a ***unique*** numeric identifier relative to a survey site.

9 Station Location: Location of station where survey visit was conducted. Several mapping coordinate systems are in use throughout the range of the murrelet. Township, Range, Section is used in much of WA and OR. UTM is available anywhere, with a GPS unit.

T,R,S - Record township, range, meridian [circle either **E** (east) or **W** (west)], section, sixteenth section ("Q, Q"), of quarter section ("Q"). Use 2 digits for each T,R,S value (e.g., **T** 09 **N**, **R** 06 **W**, **S** 10, NW **QQ** of SE **Q**).

[1] Data forms specific to each state and province should be obtained from the PSG web page at www.pacificseabirdgroup.org.

UTM - Enter the UTM zone and coordinates from a USGS or equivalent (for BC) topographic map if the T, R, S system is not used in your area, or if a GPS is used. Indicate the source used to determine the station location (e.g., type of map or GPS). If a GPS is used, indicate whether the coordinates are differentially corrected or what the error value (FOM) was when the position was taken, ***and*** what map datum (e.g., NAD 27 CONUS, WGS 84, etc.) the unit was set for.

10 Observer Name(s): First name, middle initial, and last name of the observer(s).

11 Initials: Initials of observers' full name.

12 Affiliation: Agency, tribe, or company name.

13 Phone: Agency, tribe, or company telephone number including area code. This should be a contact who can be reached during and after the survey season in the event that questions arise regarding the survey data.

14 Station Elevation: Using a USGS 7.5 minute or 15 minute topographic map, or a properly calibrated altimeter or GPS, record the station elevation. An equivalent topographic map may be used for BC. Indicate whether the value is in feet or meters.

15 Position on Slope: Select the code that best describes the station's position on slope. Codes: **B** = Canyon bottom or coastal plain, **L** = Lower 1/3, **M** = Middle 1/3, **U** = Upper 1/3, **R** = Ridgetop.

- To determine position on slope, use a topographic map to identify the ridgetop and valley bottom elevation at 90 degrees (perpendicular) from the contour where the station is located. Then subtract the lower value from the higher, and divide by 3 to determine the position based on the station's elevation.

16 Station Placement: Circle whether survey station is located **Inside** or **Outside** the survey site. Stations on the survey site boundary are considered Inside.

- One station may adequately cover an area of approximately 30 acres (12 ha). Station placement in dense forest, with abundant understory and high overhead cover, limit visibility and mask sounds, thereby affecting the observer's ability to see and hear murrelet activity. Topography is also a factor to consider when establishing stations because rugged, steep terrain will affect the observer's range of detectability. In these situations, station density should be increased as needed to provide adequate survey coverage of the site being surveyed.

17 Distance from Survey Site Boundary: This measurement applies only to **Outside** stations. Indicate distance from the survey station to the survey site boundary. Stations are generally located ≤50 meters (164 feet) from the edge of the survey site boundary.

18 Units of Measure for All Horizontal Distances: Indicate the units used for all horizontal distances reported on the survey form (e.g., meters, feet, yards, etc.). This will include distances to survey site boundary for stations outside of the site and for closest distances to birds. The recorded units must be consistent throughout the survey visit.

19 Station Canopy Cover: Select the canopy cover class code that best describes overhead canopy cover at the survey station. Codes: **1** = 0 -25%, **2** = 26 -50%, **3** = 51 -75%, **4** = 76 -100%. This can be derived as an ocular estimate of the area immediately adjacent (approx. 25 m radius) to the

survey station, or an actual measurement using a densiometer or other device. This data can be useful in determining the viewability from a station.

- It's often easier to estimate ***openings*** in the canopy, whether making an ocular estimate or using a densiometer. The ***inverse*** value represents the amount of canopy cover. The value recorded must represent canopy ***cover***, so remember to translate openings to cover (%cover = 100% - %opening).

ENVIRONMENTAL CONDITIONS: Record conditions as observed at the survey station at the beginning and end of the survey visit; note other significant changes in conditions as they occur throughout the survey visit.

- Also record any conditions that may impair vertical visibility to 2 canopy heights, horizontal visibility to 100 m (328 ft), and audibility to 200 m (656 ft). If these conditions exist for a cumulative total of greater than ***12 minutes*** during the survey visit, the visit should be rescheduled.

20 Sunrise Time: Official sunrise time derived from The Nautical Almanac tables based on the date of the survey visit and geographic area. ***Add 1 hour for daylight-saving time!*** Use 4-digit "24 Hour Time"(e.g., 5:18 A.M. = 0518, or 6:30 P.M. = 1830). Copies of these tables may be available for your specific geographic area from your regulatory agency or Marbled Murrelet Survey Training Instructor.

e.g., Geographic Area of Survey (WA)	Table
King, Island, Snohomish Co.	**Seattle, WA**
Skagit, Whatcom Co.	**Vancouver, BC**
Kitsap, Mason, Pierce Co.	**Tacoma, WA**
eastern Jefferson, eastern Clallam Co. (E of R09)	**Port Angeles, WA**
San Juan Co.	**Friday Harbor, WA**
western Clallam, western Jefferson Co.	**Tatoosh Island, WA**
Grays Harbor, Lewis, Thurston Co.	**Olympia, WA**
Pacific, Wahkiakum Co.	**Astoria, OR**
Clark, Cowlitz, Skamania Co.	**Portland, OR**
Kitattitas, northern Yakima Co.	**Stampede Pass, WA**

21 Source or Table: Indicate the Sunrise/Sunset table or source reference used to determine the survey times OR enter the appropriate code indicated by bold type above, if applicable.

22 Begin Survey Time: Actual time survey visit is started using "24 Hour Time" described above. A morning visit should begin at least **45** minutes ***before*** official sunrise. If a survey visit actually begins later, also note number of minutes late (e.g., "5 min. late").

23 End Survey Time: Actual time survey visit is completed using "24 Hour Time" described above. A morning visit generally ends **75** minute ***after*** official sunrise; more time is added depending on whether murrelet detections occur at the end of a visit and/or if overcast conditions with rain and fog are present at the end of the standard survey period.

24 Temperature at Sunrise: Record temperature at official sunrise time. Indicate whether Celsius (**C**) or Fahrenheit (**F**). Be sure the thermometer is placed above the ground when taking the temperature.

25 Temperature at End of Survey: Record temperature at the end of the survey visit. Indicate whether Celsius (**C**) or Fahrenheit (**F**). Be sure the thermometer is placed above the ground out of the sun when taking the temperature.

26 Time: Record times in 4-digit "24 Hour Time". Enter time when survey visit began and ended and indicate "Begin Survey " and "End Survey " in the Notes column. Also enter the time when significant weather or environmental conditions occur that affect murrelet detectability from the station.

27 Vertical Viewing:

a Ceiling: This is the height of the ***primary*** cloud/fog layer relative to the canopy of the survey site as viewed from the station. Record the appropriate code: **UL** = Unlimited (clear); **HI** = > 2.0 canopy height; **MID** = > 1.25 to ≤ 2.0 canopy height; **LO** = ≤ 1.25 canopy height; **U** = Unknown; cannot see adequately to describe due to station placement.

▪ There may be several layers of clouds visible simultaneously during a survey visit. For this protocol, the ceiling is the continuous primary cloud layer most closely associated, and in proximity to, the forest canopy. Patchy ground fog may develop as the air temperature warms above water bodies or forests. These types of conditions should be reported as fog in the Precipitation column of the survey form. A very low ceiling, or fog bank, would be reported as a low ceiling and heavy fog.

b Cloud Cover: Select the class code that best describes the amount of overhead cloud cover visible from the station. This is an ocular estimate.
Codes: **0** = 0% (clear sky; no cloud cover); **1** = about 33% of sky covered; **2** = about 66% of sky covered; **3** = 100% of sky covered; **U** = Unknown; cannot see adequately to describe conditions due to station placement.

c Visibility to 2 Canopy: From the survey station, note whether vertical visibility is unimpaired to 2 canopy heights. Codes: **Y** = Yes; **N** = No; **U** = Unknown; cannot see adequately to describe conditions due to station placement.

▪ Environmental conditions that impair vertical visibility are moderate to thick fog, or moderate to heavy rain, hail, and snow.

28 Horizontal Visibility to 100 m: From the survey station, note whether horizontal visibility is unimpaired within 100 m (328 ft). Codes: **Y** =Yes; **N** = No; **U** = Unknown; cannot see adequately to describe conditions due to station placement.

▪ Environmental conditions that impair horizontal visibility are moderate to thick fog, or moderate to heavy rain, hail, and snow.

29 Audibility to 200 m: From the survey station, note whether audibility is unimpaired within a 200 m (656 ft) radius. Codes: **Y** = Yes; **N** = No

▪ Moderate to loud noise will impair ability to hear murrelet calls at distances less than 200 meters.

30 Precipitation: Select the appropriate codes to indicate precipitation intensity ***at the survey site*** as observed from the station. List only one code per column. Use the following codes in each of the type columns:

Rain: **N** = None; **L** = Light (mist, drizzle, soft rain); **M** = Moderate (obscuring rain); **H** = Heavy (intense rain).

Fog: **N** = None; **L** = Light (translucent haze, thin fog); **M** = Moderate (obscuring fog); **H** = Heavy (dense fog).

Other: For other precipitation conditions use the following type and intensity codes: **N** = None; **HL** = Light Hail, **HM** = Obscuring hail, **HH** = Intense hail; **SL** = Snow flurry, **SM** = Obscuring snows, **SH** = Intense snow storms, Blizzard.

31 Wind: Record the wind speed based on the Beaufort Wind Scale. Observe the effects of wind conditions on trees and vegetation visible ***at ground level at the station*** and record the appropriate code (0= <1 mph, calm; 1= 1-3 mph, leaves barely move; 2= 4-7 mph, leaves rustle and small twigs move; 3= 8-12 mph, leaves and small twigs in constant motion; 4= 13-18 mph, small branches move; 5= 19-24 mph, large branches and small trees start to sway; 6= 25-31 mph, large branches in constant motion; 7= 32-38 mph, whole trees move; 8= 39-46 mph, twigs and small branches break).

- Moderate to high winds of Beaufort 4 (13-18 mph) and above generally affect audibility.

32 Noise: Record the appropriate code(s) to indicate noise conditions that ***affect ability to hear clearly*** within a 200 m (656 ft) radius: **N** = None; **A** = Airplane; **B** = Bird song/calls; **C** = Creek or other water drainage; **M** = Machinery (logging, mining, road construction, etc.); **P** = Precipitation (rain/hail); **T** = Tree drip; **V** = Vehicle (trucks, cars, etc.); **W** = Wind; **O** = Other (***explain in Notes column***). List more than one if applicable.

33 Notes: Record "Begin Survey" and "End Survey" to correspond to appropriate times recorded. Note any other pertinent information that can help to better describe or explain the conditions during the survey visit.

SHADED AREA AT BOTTOM OF PAGE FOR STATE OR PROVINCIAL FISH AND WILDLIFE AGENCY USE ONLY

Survey Activity Data Page

Item #

1 Detections - Page Total: Enter the total number of ***murrelet detections***; every detection should have a detection number (detect. #), including un-mappable detections. This is the total number of detections per single-sided page.

2 Page Number of the total number of pages.

3 Initials: Initials of observers' full name.

4 Month, Day, Year: Date of survey visit. Use 2 digits for Month, Day, and four digits for Year (e.g., May 10, 2000 = 05/ 10/ 2000).

5 Area Name: Name of survey area being surveyed.

6 Site Name or Number: Site name or number from which survey visit is conducted. Each survey site should have a ***unique*** number or alphanumeric identifier.

7 Station Number: Station number from which survey visit is conducted. Each survey station should have a ***unique*** numeric identifier relative to a survey site.

8 Data Reference Number: State or provincial Fish and Wildlife agency use only. Used for identifying and tracking individual survey visits.

9 Units of Measure: Indicate measurement used for Closest Distance to Bird. Circle either **U.S.** or **Metric**.

SURVEY ACTIVITY: Record details of murrelet detections in this table. A detection is defined as the visual or auditory observation of one or more murrelets ***acting together*** in a similar manner and initially occurring ***at the same time***.

- A "5 Second Rule" is applied to distinguish between separate detections. It may be helpful to count "1 one thousand, 2 one thousand, etc."
  - If a murrelet detection is **auditory**, 5 seconds of silence must pass in order to classify the next auditory sound as a new detection.
  - If a **visual detection** of a murrelet is lost from view for more than 5 seconds, the next sighting is a new detection.

- If two or more groups of murrelets coalesce into one larger group, record data on a separate line for each group and write, e.g., "detect. # 10 and detect. # 11 joined", in the Notes column. ***Assign each detection its own unique detection number***. Refer to the definition of a detection above.

- If one group of murrelets split into two or more separate groups of birds, each new subgroup is still considered part of the original detection, but each is recorded on a separate line as follows. Prioritize the subgroup with the lowest canopy height first. If all subgroups are at the same canopy height, then prioritize circling behavior over non circling. Write, e.g., "detect. # 5 split", in the Notes column to link birds associated with the same detection. Assign a detection number ***only to the highest priority subgroup***, since all the birds were initially part of the same group, and thus only constitute one detection. Each subgroup will have the same Time, and Initial

Detection and Flight Directions, but likely will have differing Heights, Closest Distances, and Depart and Final Directions. Thus each subgroup will need a separate line to record all the relevant data.

10 Status and I/O: State or provincial Fish and Wildlife agency use only. Used for detection status coding and identifying bird location relative to survey site boundary.

11 Detection #: Each separate ***murrelet detection*** is sequentially numbered one per line as it occurred throughout the survey visit. When mapping the detections, use the detection numbers to cross reference the corresponding line entry. Number only the prioritized subgroup if a group of birds split, because the whole occurrence is considered one detection. Line out the Detect. # column for all associated subgroups. See the Survey Activity section above.

12 Detection Time: Record the time in 4-digit "24 Hour Time" when a murrelet detection occurred. Be sure to record time when survey visit began and ended, and indicate "Begin Survey" and "Ended Survey" in the Notes column on the corresponding lines.

- **U** (unknown) is entered if detection time was not recorded.

13 Initial Detection Direction: Record the direction where the murrelet is first detected ***relative to the observer***. The direction is recorded at a minimum of 45 degree increments (e.g., N = North; SW = Southwest; E = East).

- **U** (unknown) is entered if initial detection direction was not identified. Without this information, the detection cannot be mapped.

- If a bird is seen landing, perching, or flying into or out of a tree or stand of trees, a stationary detection is heard, or an area of concentrated activity is detected, try to obtain an azimuth compass bearing for that location (e.g., "145" = 145 degrees).

14 Type: Record the detection type using the following codes: **H** = Heard only (auditory sound(s) with no visual observation); **S** = Seen only (visual observation with no auditory sounds); **B** = Both Seen and Heard (visual observation with accompanying auditory sounds).

15 Auditory Information: Call types have been assembled into call groups based on their sounds. Review cassette tapes of Marbled Murrelet vocalizations and other auditory sounds to assist with identification. Tapes of other forest bird calls/songs that may have similar sounding notes should also be reviewed periodically.

Vocal Series (vocalizations): Record auditory sounds using the codes listed below. Record the call type heard at the start and end of the detection. The detection may consist of one call type, or a vocal series that grades between two groups. Should the calls grade between two groups, identify the start and end points of the gradient, e.g., "**K-G**".

"**K**" = Keer group (*keers, keheers, and quacks*);
"**G**" = Groan group (longer, variable groans formerly known as alternate calls); and the
"**O**" = Whistle group (longer, variable whistle).
Birds most often grade their calls between two of these groups within a series or bout of calling.

Record the number of calls heard from 1-5. When more than 5 calls are heard in the same detection, record "**M**" for multiple.

Indicate Yes or No to record if overlapping calls (**OL**) are heard as part of the detection.

Other (non vocal sounds): In addition to the vocal sounds described above, there are two other auditory sounds attributed to marbled murrelets. These non vocal sounds are Wing sounds or wingbeats = "**W**" and Jet sounds associated with aerial or power dives = "**J**". Record all types heard for each detection.

- A **solid line ("---")** for "not applicable" is entered in columns that do not apply. Seen only detections are obviously not auditory, i.e., a visual detection with no vocalization or other auditory sounds.

16 # of Birds Seen: Enter the number of birds ***visually observed***.

- If 2 or more groups of murrelets join into 1 group, record data on a separate line for each group and write, e.g., "Detect. #X and Detect. #X_1 joined", in the Notes column. Assign each detection its own unique detection number.

- If one group splits into a separate group of birds, then each subgroup is part of the original detection, and each is recorded on a separate line observing the prioritization procedures outlined above under the SURVEY ACTIVITY heading. Each subgroup will have the same Time and Initial Detection Direction. Assign a detection number ***only*** to the prioritized subgroup.

- A **solid line ("---")** for "not applicable" is entered for ***heard only*** detections.

17 Behavior: Record the behavior type of the bird(s) according to the following codes:

C = Bird(s) seen circling over the forest at > 1.0 canopy height. This behavior includes flight paths that deviate from a straight line, such as full, quarter, and half circles, angular turns, etc.

B = Bird(s) seen circling at or below the forest canopy, i.e., ≤ 1.0 canopy height. This behavior includes flight paths that deviate from a straight line, such as full, quarter and half circles, angular turns, etc.

F = Bird(s) seen flying in a straight flight path over the forest at > 1.0 canopy height.

T = Bird(s) seen flying through in a straight flight path at or below the forest canopy, i.e., ≤ 1.0 canopy height.

L = Bird(s) seen landing in, perching, or departing from a tree. This is a rare event.

S = Bird(s) heard emitting ≥ 3 calls from a fixed point in a tree within 100 m (328 ft) of observer. This is a very rare and unusual event.

U = Bird(s) behavior unknown, i.e., bird(s) seen but behavior not identified, or canopy height not quantified, or detection was heard only and was not stationary.

18 Initial Flight Direction: This is the direction that the murrelets are seen heading when initially detected, i.e., ***the direction the birds are traveling when first detected***. This information allows

for accurate mapping of visual detections, and compliments the Bird Depart Direction data. Enter direction in a minimum of 45 degree increments (e.g., N = North; SW = Southwest, etc.).

- U (unknown) is entered for any auditory detections because flight directions are often difficult to correctly identify.

19 Bird Height: This is determined from ***visual*** observations only. Enter an estimate of bird height in decimal units based on bird location ***relative to the height of the forest canopy***, i.e., the tallest trees observable from the survey station. The height of the ***tallest observable tree*** is equivalent to a unit of 1.0 canopy height. If a bird was seen flying halfway beneath the height of the tallest observable tree, the bird height is "0.5 canopy heights." A bird seen flying over the canopy at one quarter the height of the tallest tree observed is at "1.25 canopy heights."

- If a detection is seen "at or below" canopy height, but an actual height was not determined, enter $\leq$ 1.0 canopy heights in the Notes column.

- If a bird is only seen flying straight or circling over a clear-cut or water adjacent to the survey site, project the height of the tallest tree observable to determine the bird's height. Indicate in Notes if bird only seen over these substrates.

- U (unknown) is entered if the bird(s) were ***seen*** but the height was not quantified.

- A **solid line ("---")** for "not applicable" is entered for ***heard only*** detections.

20 Closest Distance to Bird(s) Seen: Record the closest horizontal distance from observer to the murrelet(s). A bird flying directly overhead is equivalent to a horizontal distance of zero. Distances are recorded only for ***visual*** detections. Most visual detections are within 100 meters (328 feet). ***Indicate units of measurement*** at top of the column.

- For ***heard only*** detections, a solid line "----" is entered in the Closest Distance to Bird(s) Seen column, and an estimated distance, based on the intensity of the sound, is recorded in the Notes column using the following codes: **L** = Loud; **M** = Moderately loud; **F** = Faint/distant.

- Unless the observer has information to the contrary, for the purpose of mapping, "loud" detections will be mapped at 75 m (246 ft) from the observer; "moderately loud" detections will be mapped at 150 m (492 ft) from the observer; and "faint" detections will be mapped at 200 m (656 ft). Most detections are audible only within 200 m (656 ft). The observer should provide, in the Notes column, any additional information that helps interpret distance. E.g., a faint call directly overhead should not be mapped at 200 m.

- U (unknown) is entered if the distance is seen but not quantified.

21 Bird Depart Direction: The direction the murrelet was last detected heading, i.e., ***the direction the bird(s) was traveling when last detected***. Enter direction in a minimum of 45 degree increments (e.g., N = North; SW = Southwest, etc.).

- U (unknown) is entered for any auditory detections because flight directions are often difficult to correctly identify.

22 Final Detection Direction: The ***final*** direction the murrelet was detected ***relative to the observer***. The direction is recorded at a minimum of 45 degree increments (e.g., S = South; NE =

Northeast; W = West).

- U (unknown) is entered if the final direction is not identified.

23 Notes: Additional information which can help to concisely describe and map a detection is entered here. For example: groups of birds that split or join other birds; unusual observed behavior; flight path directional information ("circled clockwise" or "counter clockwise").

❖ At the bottom of the last page of the survey activity table, note the presence of all ravens, crows, and jay species. Also document any other species of concern that were observed by including the species name, number, detection time, behavior, and additional pertinent information. Refer to your state or provincial Fish and Wildlife agency Species of Concern list.

MAPPING MURRELET DETECTIONS

To each survey form, attach a copy of a registered aerial photo, orthophoto (1:12,000), or a USGS or equivalent (for BC) topographic map showing the area/site surveyed. Be certain to indicate the corrected scale if the original scale was enlarged or reduced on a photocopier. Delineate the **area/site** boundary and identify the observer station location using a circle with a dot in the center (⊙), and. If plotting detections on aerial or orthophoto maps, use a topographic map to aid in determining the correct location to plot the detections with respect to the terrain.

Plot the murrelet detections using the directional information, Behavior, and Closest Distance to Bird(s) data from the Survey Activity Table. Indicate the murrelet flight path and behavior (circling, straight flight path, stationary, etc.) relative to the station location using the symbols below. On 1:12,000 scale orthophoto maps, 1 mm = 12 m (39 ft); on 7.5 minute topographic maps the scale is 1:24,000, so 1 mm = 24 m (79 ft).

Audible detection: A dashed line with arrow head (– – – – →) indicates an audibly tracked flight path.
Visual detection: A solid line with arrow head (——→) indicates a visually observed flight path.

Stationary or Unknown Bird Depart/Final Direction: A triangle with a dot in the center (Δ) indicates a stationary detection, or a visual or audible detection without a Bird Depart or Final Direction.

- In the upper right-hand corner of each map page write the: (1) Page # of Total Page #; (2) the TRS or UTM coordinates; (3) survey site name; (4) station number; (5) observer's initials; and (6) date of the visit.

- Label each separate mapped detection with the corresponding Detection # from the first column on the Survey Activity page. At high activity areas, more than one map may be necessary. Indicate the Page # of Total Page # on each map.

- If you have multiple detections with the ***same behavior type*** in the ***same location***, record all applicable detection numbers in sequential order at that location. Use additional maps as needed to record all detections. Detections without an Initial Detection Direction may be un-mappable. All occupied behaviors may be mapped together and other detections separately if desired.

- Under good environmental conditions, the following distance conventions can be generally applied to "heard only " detections: Loud, "close" vocalizations/auditory sounds are usually detectable within 0 to 150 meters (500 feet); "medium range" distinguishable calls/sounds are usually >150 to 200 meters (>500 feet to 660 feet); "distant/faint"calls/sounds usually range from >200 to 400 meters+ (>660 feet to 1300 feet+). Most audible detections are within 200 meters.

- A mylar page may be overlaid on a map to plot detections. A ***permanent*** (non-water based), extra fine tip, black marker should be used. An ordinary pencil eraser can be used to make corrections. Indicate all 4 section corners so the map can be "registered" in the correct location because data points may be digitized into a GIS database. Draw the survey site boundary on the mylar, or attach a copy of the orthophoto with the survey site boundary delineated on it. Indicate the station location and flight path using the symbols above.

APPENDIX H

USE OF RADAR FOR MARBLED MURRELET SURVEYS

Compiled by Brian A. Cooper[1] and Tom E. Hamer[2]

Introduction

The current ground-based Inland Forest Survey Protocol for Marbled Murrelets depends on the use of audio-visual cues to detect birds in flight. Collecting biological information on murrelets this way is difficult, because of the low light conditions during their dawn and dusk peaks in inland activity and their small size, cryptic coloration, and rapid flight speed (Hamer et al. 1995). Further, because ~85% of murrelet detections are auditory (Paton et al. 1990), it is difficult to determine with accuracy the number of birds that actually are flying over a particular area. Ornithological radar, which does not have this auditory bias, has been used successfully to study Marbled Murrelets in both the Pacific Northwest and Alaska (Hamer et al. 1995; Burger 1997, 2001, 2002; Cooper et al. 2001; Cooper and Blaha 2002; Raphael et al. 2002). Radar techniques also have been used to study other avian species for nearly five decades (Eastwood 1967), and marine radar recently has been used to study other nocturnally-active seabirds (Day and Cooper 1995, Cooper and Day 1998, Bertram et al. 1999).

The intent of this appendix is to provide information on the uses and limitations of ornithological radar for Marbled Murrelet surveys. This document is not meant to be an exhaustive discussion or set of survey protocol guidelines, but rather a starting point to inform others of its potential uses. If one does wish to apply this technique, it first will be necessary to get approval of your study plans from the appropriate state and federal agencies.

Uses of Radar for Marbled Murrelet Surveys and Research

The major uses of radar for murrelet surveys and research include: (1) determining if murrelets are present in an area; (2) locating "hotspots" of activity over an area; (3) providing an index of abundance for a drainage or a stand; (4) determining daily activity patterns of murrelets; and (5) for population monitoring. Radar studies indicate that audio-visual observers detect an average of 10–23% of all Marbled Murrelets within 200 m during intensive murrelet surveys, although the percent detected varied widely among sites and among days within a station (Cooper and Blaha 2002). Further, approximately 14% of the murrelets that are detected on intensive surveys are birds passing over the stand of interest on their way to another area. Although radar will not work at all stands because certain terrain types preclude its use, results of Hamer et al. (1995) and Cooper and Blaha (2002) suggest that radar could be used as a 'coarse filter' to quickly and accurately determine whether murrelets are present near, or in the area adjacent to, a forest stand. Cooper and Blaha (2002) found that the number of days to detect murrelets using radar methods was low (Mean = 1.0 day to detect presence).

Because most birds during ground surveys are detected by auditory means, only limited information can be collected on bird flight behavior, flight direction, and flight path, and no information can be collected on relative abundance. Further, the distance of birds from the audio-visual observer is estimated. Radar can supply information on the murrelets' flight path

[1] ABR, Inc. Environmental Research and Services, P.O. Box 249, Forest Grove, OR, 97116
[2] Hamer Environmental, 19997 Hwy. 9, Mount Vernon, WA, 98274

and flight behavior, flight direction of targets to the nearest degree, number of targets, and the distance from the radar to the target to the nearest meter (Hamer et al. 1995). All of this information is critical in determining where birds are headed, which forest stands are likely being used, and the relative abundance of birds in the area. Thus, the quality and usefulness of the survey information collected by radar is much higher than data produced by the ground survey protocol. Radar also might improve survey efficiency because it reliably samples a much larger area (up to a 1400 m radius) than audio-visual observers (up to 200 m radius).

The available data suggest that radar has great potential for quickly determining presence and probable absence of murrelets in a suitable area, but we cannot yet recommend the number of visits or years that would be required to determine presence or probable absence with statistical certainty. If birds were found, however, audio-visual surveys still would be necessary to determine if the stand was 'occupied' by nesting murrelets. Because radar energy cannot penetrate forest vegetation, it generally cannot be used to determine whether a stand is occupied by murrelets. Forest vegetation, hills, and ridges show up as ground clutter or solid echoes on the radar screen, preventing detection of birds in these areas. Given suitable survey locations, however, radar can reliably determine presence in a shorter period than the current audio-visual protocol (Cooper and Blaha 2002). Information from radar surveys also can be used to locate 'hotspots' over a larger stand in which to focus audio-visual observations. Further, the radar method could improve the accuracy of the protocol by detecting presence of birds at low-use sites where murrelets might be missed completely by audio-visual observers. Survey accuracy also can be improved because radar often can help determine whether murrelets that are flying over the survey area actually are in transit to another area.

In addition to surveying Marbled Murrelets at the stand level, ornithological radar can be used to obtain an index of abundance for Marbled Murrelets on a drainage scale (Burger 1997, 2001; Cooper et al. 2001; Raphael et al. 2002). Conservation biologists can use this type of landscape information to compare numbers of murrelets with landscape-level habitat characteristics or prioritize lands for potential habitat acquisition efforts. Careful selection of sampling locations in appropriate drainages and adequate sampling intensity during the breeding season is essential for this type of application, to ensure that a large proportion of the birds using a particular drainage are detected.

Because radar-based counts have low among-day variability, radar sampling also may be well suited for long-term population monitoring. Statistical power analyses suggest that radar-based sampling can produce results in a timely fashion (Cooper et al. 2001).

Limitations of Radar

The major limitations of the radar technique are: (1) it cannot determine occupancy (and sometimes presence) because birds flying near or within the canopy are shielded from the radar and missed; (2) it cannot be used at all sites because of topographic and physiographic constraints; (3) species identification errors are possible; and (4) X-band radar cannot be used during rain (but can be used during drizzle or foggy conditions). Fortunately, there are methods that will minimize the impact of many of these limitations. Perhaps the greatest limitation of radar is that it cannot be used at all locations. For instance, radar cannot be used in areas closely surrounded by tall trees that block the radar beam. Use of a lift-equipped radar can help minimize this problem. With a 10.5-m lift-equipped radar, it was possible to use radar at 56% of 50 randomly chosen murrelet stands in an area of the Olympic Peninsula, Washington, with an

extensive road network and large numbers of manmade openings (Cooper and Blaha 2002). Radar observations would only have been possible at 15% of these sites without the lift.

In most cases, radar needs road access to transport the system to the site, although radar systems have been transported by helicopter or boat to some rugged coastal sites in British Columbia, where the radar unit was placed on a platform near the beach for monitoring at watershed mouths (Burger 1997, 2001). In addition, a boat-mounted radar has been successfully used to observed murrelets at coastal areas in Alaska and British Columbia (Cooper 1993, Cullen 2002).

In general, areas with good access and relatively flat topography, with large numbers of openings in the forest, tend to be the best areas for radar sampling of murrelets at forest stands. At watershed mouths where the radar scans over a lake or sea, narrow inlets that constrict the flight paths of murrelets provide the most reliable counts. Thus, some topographic situations are not conducive to use of radar. Whenever energy is reflected from the ground, surrounding vegetation, or other objects around the radar unit, a ground-clutter echo appears on the display screen. Because ground clutter can obscure bird targets, it should be minimized by tilting the forward edge of the antenna upwards and/or by using a ground-clutter reduction screen (described in Cooper et al. 1991). The antennae of the radar also can be hinged so that it can be raised or lowered at will to reduce ground clutter (Singer and Hamer 1999). Ground clutter also can be reduced by positioning radar in locations that are surrounded closely by trees, low hills, or even large logs. These objects act as radar fences that shield the radar from low-lying objects farther away from the lab. Using radar fences, only a small amount of ground clutter appears in the center of the display screen, creating ideal conditions for detecting avian targets. For further discussion of radar fences, see Eastwood (1967), Williams et al. (1972), and Skolnik (1980).

Radar works as line-of-sight, such that birds flying in 'radar shadows' (ground clutter) behind trees or hills will not be detected. The impact of 'shadow zones' can be reduced by selecting sites that minimize the size, location, and orientation of shadow zones.

Another limitation of radar is that one does not know exactly how many murrelets are associated with a particular radar target. One or more birds that are flying close together on the same flight path can appear as one echo on the radar monitor. Observing the radar images closely for several scans can often resolve the minimum number of birds involved, or one can apply a correction factor to the total number of targets by using the average flock size of targets observed visually.

It is possible that Marbled Murrelets observed entering one watershed could nest in an adjacent watershed (Rodway et al. 1993, Burger 2002). For some types of studies, this bias would not be a concern, but for studies that require an index of abundance for a particular drainage, it may be necessary to monitor both drainages. To determine whether Marbled Murrelets were flying between drainages, it might be possible to conduct telemetry studies, or radar surveys on ridges or passes between drainages (Singer and Hamer 1999).

Murrelets primarily are identified by their flight speed, which tends to be greater than most other species. There are individual sites, however, that have large numbers of problematic species, like Band-tailed Pigeons or waterfowl, that can fly at speeds similar to those of murrelets. We stress that concurrent audio-visual observations (at the radar lab) and radar observations be made, at least initially at each site (and preferably each day), to assess the relative abundance of potentially confounding species and to help filter out non-murrelets from the radar database (Hamer et al. 1995, Cooper et al. 2001, Burger 2001). For radar studies with the objective of determining presence or probable absence, even one error in identification can

be critical, so it may be necessary to always make concurrent audio-visual and radar observations in those instances.

Data Collection

Radar observations should be made only by trained observers, skilled in use of radar, interpretation of radar signals, and in locating appropriate sampling sites. The location of appropriate sampling sites requires the most expertise and is most important. If a poor sampling location is chosen, it will decrease the chances of detecting murrelets at that site. Each radar site should be analyzed for its ability to detect murrelets within the drainage. This can be accomplished by making a map of the radar screen with location of ground clutter, shadow zones, streams, and stand boundaries (if applicable). The amount and location of effective sampling area can then be quantified. Preparation of this map involves photographing or tracing the radar screen at a site and adding layers delineating ground clutter and shadow zones where low-flying birds would not be detected. The shadow zones are drawn based on a visual assessment of all clutter-free zones on the screen. Mapping exercises should be completed for each site so that data collected from these sites can be properly interpreted and assessed at a later date.

Recommendations

If radar-based sampling is to be used for survey, inventory, or monitoring purposes, we make the following recommendations, based on the results of several radar studies to date (Hamer et al. 1995; Burger 1997, 2001, 2002; Cooper et al. 2001; Cooper and Blaha 2002; Raphael et al. 2002):

- conduct concurrent radar and visual observations to check for the presence of species other than Marbled Murrelets, at least initially when commencing radar studies at a new site;
- record species likely to be confused with murrelets that are observed at the site during non-survey times;
- begin sampling during the period from 75 min (for California) or 105 min (for Oregon, Washington, and British Columbia) before official sunrise to 75 min after sunrise (or 15 min after the last audio-visual detection of a Marbled Murrelet, whichever is later) and then determine the most appropriate period to sample (e.g., it may be possible to start sampling later at sites that are farther inland);
- use a combination of flight speed (>50-64 km/hr [>31-40 mi/hr], depending on location), flight behavior (usually fairly direct flight unless circling over a forest stand), and flight path (e.g., from sea to land) to separate targets of Marbled Murrelets from other birds or bats flying within radar range;
- only sample when average wind speeds are <25 km/hr (15 mi/hr), so that slowly flying birds with tailwinds would not be counted as murrelet targets.

For inventory and monitoring purposes, one also should:

- examine landward counts, seaward counts, and total counts to determine which subset of data has the lowest among-day variation in counts and also has an acceptable species identification error rate, and use that subset for the index of abundance;

- examine your data for evidence of a second peak of landward movements after sunrise during the chick-feeding season that might result from adults making a second feeding trip. These data should be eliminated if counts are to be used for inventory purposes.
- conduct surveys during the same time period each year to minimize seasonal variability in radar counts of murrelets.

For inventory purposes, sample at locations that funnel birds into a small, discrete area or plan on deploying more than one radar so that the entire width of a watershed is sampled. The use of radar is slightly less restrictive for monitoring purposes than it is for inventory purposes, because population monitoring measures temporal trends of consistently-collected data and, thus, it is possible to use sites where one does not sample an entire drainage.

Radar Equipment

All of the radar surveys of Marbled Murrelets to date have used an X-band marine radar system. We recommend using a 10–12 kW radar system with a magnetron in good working order. Over time, the magnetron wears out, which makes the unit less sensitive and thus less useful for detecting murrelets. Full descriptions of mobile radar systems can be found in Gauthreaux (1985a, 1985b) and Cooper et al. (1991).

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ATTACHMENT F

Appendix F. Tidewater Goby Survey Protocol

1. Introduction

The tidewater goby (*Eucyclogobius newberryi*), a species of fish endemic to California, has undergone substantial reduction in population size and distribution within its range in recent years. Surveys for the species have been conducted using a variety of methods over the past 2 to 4 decades. We, the U.S. Fish and Wildlife Service, seek to increase the scientific information available upon which to base future management and conservation of the species, including efforts for recovery. Through the survey protocol recommended in this document, we intend to promote survey methods and intensities that ensure sound and supportable presence/absence determinations of species locations, leading to better management decisions based on the best available scientific data.

We provide the following guidance to facilitate the determination of presence or absence of the species in habitats with potential to support it. We anticipate that the primary use for this protocol will be for project-level surveys in support of requests for consultation under section 7 of the Endangered Species Act of 1973, as amended. Additionally, this protocol may also be used for section 10(a)(1)(B) permit applications, and to determine general presence-absence for other management purposes.

In general, surveys for wildlife and fish species may be done to meet a variety of management objectives, including but not limited to: 1) confirming the presence or absence of a species at a particular location, 2) identifying habitats potentially occupied, 3) estimating population size, and 4) determining population trends. For the purposes of this protocol, we have focused primarily on the first objective, determining presence/absence of a species at particular sites. The protocol is also likely to provide supporting information in identifying locations and habitat types currently occupied by the species. It is not the intent of this protocol to estimate population size or determine population trends.

Section 9 of the Endangered Species Act of 1973, as amended, and Federal regulations pursuant to Section 4(d) prohibit the take[1] of endangered and threatened species fish and wildlife species without special exemption. Virtually all methods to survey for gobies require the surveyor to enter the species' habitat,

1 **Take** is defined by the Act as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, collect, or attempt to engage in any such conduct." [ESA §3(19)] **Harm** is further defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. **Harass** is defined as actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering. [50 CFR §17.3]

resulting in an unavoidable risk of take of the species should it occur there. Therefore, a final objective of this survey protocol is to minimize the incidental take of gobies by implementing survey methods and intensities that are likely to minimize the take of gobies through the survey methodology itself.

2. Background

Habitat Affinity

The tidewater goby inhabits primarily waters of coastal lagoons, estuaries, and marshes. The species is benthic in nature as an adult (Swift 1980). Its habitat is characterized by brackish shallow lagoons and lower stream reaches where the water is fairly still, but not stagnant (Miller and Lea 1972; Moyle 2002; Swift *et al.*1989; Wang 1982; Irwin and Soltz 1984). Tidewater gobies exhibit a preference for a sand substrate component for breeding, but they are also found on rocky, mud, and silt substrates as well. Tidewater gobies have been documented in waters with salinity levels from 0 to 42 parts per thousand, temperature levels from 8 to 25 degrees Celsius (46 to 77 degrees Fahrenheit), and water depths from 25 to 200 centimeters (10 to 79 inches) (Irwin and Soltz 1984; Swift *et al.* 1989; Worcester 1992; Lafferty 1997; Smith 1998).

In their study, Trihey and Associates (1996) report tidewater gobies concentrated within 30 meters of the shore and in waters between 0.5 and 1.0 meter deep. In addition, higher densities of tidewater gobies were found in areas containing submerged aquatic vegetation than those containing only emergent vegetation or no vegetation.

Tidewater gobies have been reported from estuaries in California ranging from Tillas Slough at the mouth of the Smith River (northern Del Norte County) to Agua Hedionda Lagoon (northern San Diego County). The distribution of the tidewater goby corresponds to the distribution of sand deposition within the littoral cells along the California coast (Capelli 1997). Apparently, none have ever been found in Mexico or Oregon, based on extensive surveys outside of California.

The tidewater goby appears to spend all life stages in lagoons, in tidally influenced portions of coastal waters, or in freshwater habitats adjacent to these water bodies. Tidewater gobies may enter marine environments when flushed out of the estuary/lagoon by breaching of the sandbars following storm events or human manipulation. The tidewater goby generally lives to about 1 year of age, although some variation has been observed (Swift *et al.* 1989; Wang 1982; Irwin and Soltz 1984). During this single year, it is able to complete its life cycle.

Reproduction occurs year-round, although a distinct peak in spawning occurs in April and May (Moyle *et al.* 1989). Detailed information regarding the biology of the tidewater goby can be found in Wang (1982), Irwin and Soltz (1984), Swift *et*

al. (1989), Worcester (1992), Swenson (1995), Lafferty *et al.* (1999), and Swenson (1999).

Swenson (1995) reported that field studies of tidewater gobies in central California revealed different patterns in population ecology among different habitats. Feeding ecology differed for gobies in lagoon, creek and marsh habitats. Tidewater gobies in the marsh were significantly larger, more fecund and potentially longer-lived than tidewater gobies in the lagoon or creek. However, sandy lagoons may be more important than muddy marshes as spawning habitat because males in lab studies preferred to dig spawning burrows in sand rather than mud. Although lagoons are considered the typical habitat of tidewater gobies, brackish marshes can also be important, perhaps due to better food resources or reduced disturbance regimes. Marshes may serve as refugia, providing a source population for recolonization of the creek and lagoon habitats after high-flow events.

Developing monitoring programs to assess abundance patterns can be difficult because tidewater gobies can be patchily distributed within habitats.

2.1 Legal Status

On March 7, 1994, we listed the tidewater goby as endangered throughout its range under the Act (U.S. Fish and Wildlife Service 1994). We designated critical habitat on November 20, 2000, for the southern California populations (U.S. Fish and Wildlife Service 2000). On June 24, 1999, we published a proposed rule to remove the northern populations of the tidewater goby from the endangered species list (U.S. Fish and Wildlife Service 1999). The proposed rule to delist was withdrawn on November 7, 2002 (U.S. Fish and Wildlife Service 2002), following significant public and species expert comments. Therefore, the current status of the species remains listed as endangered throughout its range, and critical habitat remains as designated in 2000. A recovery plan is in development.

The tidewater goby was listed as a species of special concern by the California Department of Fish and Game in 1980, and was elevated to fully protected status in 1987 (Swift *et al.* 1997).

2.3 Methods Applied to Prior Surveys

This section provides a brief summary of survey methods used in the past, their success, and the recommendations for improvement by those who used them. This information is provided to assist the reader in understanding the effectiveness of those methods, and the relative efficiency of each. In addition, this information assists the reader in understanding why we recommend the methods in the protocol, described later in this document, rather than other methods that to the uninitiated might seem better or more cost effective. We

believe that this information adequately supports our proposed protocol, thus promoting consistency among all surveyors. However, any and all methods proposed to conduct surveys for tidewater goby should receive our consideration, as appropriate.

Tidewater goby abundance and distribution can be affected by habitat characteristics such as vegetation, substrate and depth (Swift *et al.* 1989, Worcester 1992, Swenson 1995). These factors can also influence the efficiency of sampling methods. Tidewater gobies have been successfully collected with both seines (Swift *et al.* 1989, Swenson 1995) and meter-square throw traps (Worcester 1992, Swenson 1995). Other reported methods include dip nets, minnow traps, ichthyoplankton net, snorkeling/direct observation, and plastic tubes. Each is described in more detail below.

2.3.1 Seine Netting

Seine netting is one of the most common methods utilized in tidewater goby surveys (Wang 1984; Holland 1992; Swift 1994; Swenson 1994; Swenson 1996a, 1996b; Lafferty *et al.* 1997; Fong 1997; Swift 1997) throughout the species range. The technique can be applied over a variety of habitats, but does have limitations in areas with dense emergent vegetation (Trihey and Associates 1996). Seining is a commonly used collecting method, well suited for near-shore areas with smooth bottoms and little vegetation.

Seine nets used for goby surveys ranged in length from as short as 1.2 meter (Wang 1984; Swenson 1996b; Swift 1997; Wang and Keegan 1998) to 7.3 meter (Swenson 1994; Swenson 1995). Other commonly used lengths include 1.8 meter (Holland 1992; Swift 1997), 2.1 meters (Swenson *et al.* 1996a), 3 meters (Lafferty *et al.* 1997; Wang 1984), and 5 meters (Swift 1997). The nets ranged in height from 1.0 meter to 1.8 meter. Equivalent ¼ inch mesh seine nets sold in the U.S. range sizes from 6 feet by 4 feet, 10 feet by 4 feet, 6 feet by 10 feet, and 6 feet by seventeen feet.

Various mesh sizes have been used. Reported mesh sizes ranged from 0.5 millimeter to greater than 6 millimeters. Commonly used mesh sizes included those near 3 millimeters [1/4 inch](Wang 1982; Wang 1984; Fong 1997, Lafferty *et al.* 1997; Swift 1997; Wang and Keegan 1998), 4 millimeters (Swenson 1995; Swenson 1996b), 3.1 millimeters (Swift *et al.* 1994), 4.8 millimeters (Fong 1997), and greater than 6 millimeters (Holland 1992; Trihey and Associates 1996; Fong 1997). Due to their small size, especially when in the larval or subadult form, tidewater gobies can easily escape from the seine if the mesh size is too large. Fong (1997) selected a 3.1-millimeter delta mesh because gobies were observed squeezing through the 6.4-millimeter mesh and 4.8-millimeter mesh.

Swift (1997) used 28.5-gram (1-ounce) weights centered 15.2 centimeters (6 inches) apart on the lead line, to ensure the bottom of the seine remain in close contact with the subsurface, preventing gobies from escaping.

Wang (1982, 1984) used 1.2 x 1.0 meter beach seine with 1.0 millimeter mesh to larvae, and juveniles in the inshore zones with vegetation. Wang and Keegan (1998) collected specimens with a beach seine with 500 micron (0.5 millimeter) mesh to sample juvenile and adult tidewater goby and other fish species.

Swenson (1994) used a seine (7.3 meters x 1.2 meter, 4 millimeter-square mesh) in shallow water (5 to 80 centimeters deep) to sample adults and juveniles. Swenson (1995) sampled in water 20 to 120 centimeters deep to capture adults and juveniles.

The distance of each seine haul varied with researcher and application. Holland (1992) used a minimum of three stations to be sampled within the available aquatic habitat. Each station consisted of five sweeps, each sweep was 10 meters in length, and all sweeps were 2 to 3 meters apart. Wang and Keegan (1998) hauled their seines from 3 to 10 meters along the shoreline, depending on the size of the station. Trihey and Associates (1996) hauled the seine perpendicular to the shoreline and landed the net on shore, where possible. Swenson (1995) reported a total linear distance sampled as approximately 150 meters, but did not report the length of each haul. Trihey and Associates (1996) recommended shortening the seine's width to approximately 3 meters to reduce total catch and time for net clearing and to minimize stress to captured fish.

2.3.2 Drop or Throw Traps

Drop or throw trapping is an effective method for sampling small fishes in vegetated areas or in open water sites that are difficult to seine (Kushlan 1981; Rozas and Odum 1988; Chick *et al*. 1992; Swenson 1996a). Tidewater gobies have been successfully collected with meter-square throw traps (Worcester 1992, Swenson 1995).

Trihey and Associates (1996) sampled with throw trap consisting of two 1 meter square plastic frames (polyvinyl chloride pipe, 1.27 centimeter diameter) connected with net sides (1.6 millimeter Delta mesh) (Worcester 1992). The lower frame is weighted with water and metal reinforcing bars, and a skirt of netting enclosing a chain is attached to the lower frame to seal the bottom over uneven substrate. Swenson (1995) constructed the drop net with one frame's corners closed to trap air (the floating top frame) and the other frame's comers left open to fill with water when in use (the heavy bottom frame). These frames were attached to the top and bottom edges of 1.2 meter wide fine netting (1.6 millimeter Delta mesh) to form a square tube.

Setting the drop trap is a two-person task. The two polyvinyl chloride pipe frames are held together and tossed approximately 1 meter away. The two people then moved quickly to the trap to help secure the lower frame to the bottom with their feet. After estimating vegetative cover, fish are cleared from the trap with fine-meshed dipnets. The trap is swept until five consecutive passes of the dipnet yield no additional fish (Trihey and Associates 1996). Worcester (1992) constructed drop nets entirely of 1/16 inch mesh knotless nylon netting or fiberglass screening to prevent larval fish from being lost.

Throw traps are easier to use in vegetated areas than the beach seine and are capable of capturing smaller fish due to the finer mesh size. A seine with finer mesh could capture smaller fish, although the smaller mesh would increase water resistance, which could affect seine effectiveness (Trihey and Associates 1996).

Drop nets and traps have been used to sample nursery habitats (Kahl 1963; Kjelson and Johnson 1973; Kushland 1974; Turner and Johnson 1974; Kjelson 1977). Kushlan (1974) discussed the difficulties and advantages of various drop trap designs with respect to size, portability, and effectiveness. Chamberlain (1988) designed and constructed 2 m x 2 m traps with wood frames and transparent plastic panels to avoid attracting or frightening fish by shadow casting. Trihey and Associates (1996) reported results indicating higher variability among drop trap samples than among seines. Worcester (1992) reported 1/8 inch Delta mesh style knotless nylon netting as too large to contain larval fish. The entire trap was lined with fiberglass window screening to ensure that no fish would be lost through the netting.

Fong (1997) recommended a sample area of roughly 10 square meters seemed as optimal; it balanced the variability associated with small sample area that plagued the drop traps against greater than 1 hour processing times needed for sample areas much greater than 10 square meters.

2.3.3 Dip Net

Worcester (1992) used dip nets to remove fish from within the drop traps, both by visual observation and by blind sweeps of the net. Irwin *et al.* (1984) employed dip nets where the use of seines was impractical. Swift *et al.* (1997) used fine-meshed dip nets on occasion. Goldsmith (pers. comm.) found dip nets to be effective where submergent and emergent vegetation or the small size of the water body makes the use of seine nets difficult.

2.3.4 Hand-towed ichthyoplankton net

Wang (1982) and Wang and Keegan (1998) report successful use of a hand-towed ichthyoplankton net with 0.5-meter mouth and 0.5-millimeter mesh to collect larvae, and juveniles. Planktonic larvae were captured in the shallow areas with an ichthyoplankton net and a fine-meshed beach seine. Juvenile and adult

tidewater goby inhabit the benthic level. Wang and Keegan (1998) attached the net to a bridle 2 meters in length and hand-towed it along an approximate 10 meter course at each station.

2.3.5 Minnow Traps

Lafferty *et al.* (1997) sampled using Gee's minnow traps. Six minnow traps (6millimeter mesh), baited with dry dog-food, were set in the evening in 0.5-2 meter water and inspected the following morning. Swift (1997) occasionally collecting with Gee's minnow traps with either 1/4 inch (6 millimeters) or 1/8 inch (3 millimeters) mesh and fine-meshed dip nets. Although tidewater gobies sometimes occur in unbaited traps with 3 millimeters mesh, it is extremely unusual to find them in the baited traps with 6 millimeters mesh, even in areas where they are extremely abundant Swift (1997), suggesting that gobies escape easily from the larger mesh.

2.3.6 Snorkeling and Direct Observation

Worcester (1992) concluded snorkeling is not feasible for the tidewater goby due to its small size, schooling tendencies, and cryptic nature. The variable nature of the habitat, often with very murky or heavily vegetated water, also precludes direct observational techniques (Worcester 1992). Swenson (1995) reported some success in observing gobies from the shore in shallow water (40 to 100 centimeters) or while snorkeling, but turbidity prevented extensive field studies using these methods. Holland (1992) conducted snorkeling surveys to qualitatively assess the numbers and distribution of gobies in standing water ranging from a maximum depth of 0.9 to 1.0 meter in 1990 to a maximum of 0.75 meter in 1991. Water turbidity was high in 1990 and effectively precluded snorkeling, but visibility was greater than 0.6 meters in 1991 and a snorkeling survey was successful (Holland 1992). However, Worcester (1992) observed at least 100 tidewater gobies in water approximately 3 inches deep on top of a concrete bridge abutment during a snorkeling survey in February, 1990.

Swift *et al.* (1994) examined some areas by swimming transects about 1.0 meter wide with mask and snorkel. A snorkeled transect 270 meters long and 1.0 meter wide recorded 2 tidewater gobies. However, the resulting density of 0.0074 tidewater gobies per square meter and an estimate of 126 fish in the sampled lagoon was much lower than documented with seine hauls. They also report other localities as too turbid for snorkeling. Estimates based on snorkeling were found to be much lower than those based on seining. All population estimates in their repot are based on seine collections.

2.3.7 Plastic tubes

Swenson (1995, 1996b) collected adult tidewater gobies in artificial burrows made of polyvinyl chloride pipe tubes (13 millimeter inner diameter, 13

centimeters long). Plastic Duraleen (available at art supply stores) or other thin plastic sheet, 13.0 centimeter by 5.5 centimeters, was rolled up inside the tube as a liner to collect the adhesive eggs. McGehee (1989) and Bechler *et al*. (1990) report gobies readily adopt plastic tubes as artificial burrows, both in lab aquaria and in the field. "Tube trapping" is a useful method to collect breeding fish, to quantify reproductive output, and to determine the timing and intensity of spawning. The open-ended tubes are shoved into the sediment at an angle of approximately 30 degrees until the lower lip rested at the surface of the substrate (Swenson 1995). Sets of 10 tubes are placed in the sediment in shallow water (less than 1 meter deep, preferably 20 to 50 centimeters deep) at each habitat site (Swenson 1995). Tubes are spaced up to 1 meter apart to minimize territorial interactions by males. Tubes are left in the substrate 14 to 28 days to allow colonization by nesting males.

2.3.8 Sample Size

Fong (1997) estimated 48 and 33 beach seine hauls would be required for two sample regions to obtain density estimates within 20 percent of the mean with 90 percent confidence, based on data reported in Trihey and Associates (1996). Assuming that each seine haul would take an average of 45 minutes, a total of 61 sampling hours would be required for just two regions. In addition to the amount of time involved, this heavy sampling intensity would result in impacts to the tidewater goby habitat. For their purposes, the sampling effort was generally less than 5 seine hauls per region. Trihey and Associates (1996) recommended that sampling effort should consist of 3 to 5 seine hauls per site and 5 to 10 drop trap samples. Swift *et al*. (1997) recommended that to detect seasonal changes in populations, collections in lagoons be repeated bimonthly.

2.3.9 Sampling Season and Timing

Fong (1997) reported that October sampling indicates higher fish abundance occurs in the fall rather than the winter sampling period. Overall, mean densities of gobies increased from 1.7 per square meter to 35 per square meter.

Swenson (1995) conducted sampling in the morning at high tide (plus 4.7 feet). Because the water was too deep to effectively sample the main creek, a second survey was conducted in the morning during low tide (plus1.8 feet), using a bag seine.

To detect seasonal changes in populations, Swift (1997) collected in lagoons bimonthly. Upstream tributaries were sampled for gobies intermittently to assess the degree to which tidewater gobies utilized these areas.

2.3.10 Density

Trihey and Associates (1996) reported tidewater goby density as extremely variable both across and within most sampling factors: method, location, vegetation and substrate. Mean density was 12.5 tidewater gobies per square meter for throw traps (standard deviation = 22.6, range 0 to 91, n = 70) and 2.0 tidewater gobies per square meter for seine samples (standard deviation = 3.6, range = 0 to 14.2, n = 26). Although the capture method alone did not significantly affect tidewater goby densities, the project's main objective was to test sampling methods and therefore the authors decided to treat trap and seine data separately for further analyses. Location within the lagoon significantly affected tidewater goby density for both methods. Substrate type and vegetation significantly affected densities of tidewater gobies caught with the throw traps but not with seine. Depth and distance from the shoreline also affected tidewater goby density. Tidewater gobies were more abundant in waters 50 to 100 centimeters deep and within 30 meters of the shore. Tidewater gobies were not collected in waters less than 20 centimeters deep or from nearshore sites. Swenson (1995) reported tidewater goby density varied tremendously among the five drop net samples (0 to 198 tidewater gobies per square decimeter). Density was greater in vegetated areas; the difference was not significant but the small sample size may have been too low to reject the null hypothesis (Swenson 1995).

2.3.11 Salinity

Swenson (1994) reported on the use of an Atago hand refractometer to measure salinity. Water temperature (degrees Celsius) and salinity (parts per thousand) were measured at the surface and on the bottom (approximately 50 to 70 centimeters deep).

2.4 Suitability of Habitat

Lafferty *et al*. (1999) reported known locations where apparent extirpations were followed by evidence of recolonization (Lafferty *et al*. 1999). Based on this information, we assume that all sites known to be previously occupied by gobies will be considered suitable and occupied without clear evidence that the site has been modified to the point where recolonization is highly unlikely, barring habitat restoration that successfully restores habitat conditions and ecosystem functions to conditions similar to a time of known tidewater goby occupancy.

3. Application of the Recommended Protocol

3.1 General Intent of the Protocol

The general intent of the protocol described in section 4 of this document is to provide a methodology of surveying for tidewater gobies in likely natural and human-made habitats at an intensity and effectiveness that ensures a high level of

confidence in finding gobies should they currently exist at the site. A secondary intent of the protocol is to prescribe a sampling regime or methodology that avoids placing an onerous and unreasonable burden on any project proponent who seeks to work in habitats likely to be suitable to the species.

The methodology described below is intended to document the presence or absence of tidewater gobies to a reasonable level of certainty, and to provide basic information on habitat affinity of the species. This methodology is not intended to be of sufficient intensity to estimate population levels, recruitment rates, or survival rates; habitat affinities more appropriate for research studies; population viability analyses; or other parameters associated with research-level activities. The parameter of interest in these surveys is a high likelihood of detecting gobies should they exist at the site.

We believe the following protocol will provide consistent results with a reasonable amount of effort. However, while we strongly recommend that potential surveyors adopt and implement our proposed protocol, we may consider other methods, on a case by case basis. The action agency or project proponent has the discretion to use any appropriate survey methodology to determine the presence or absence of tidewater gobies, provided they meet three conditions. First, any proposed protocol must meet or exceed the intended level of survey intensity and effectiveness of the protocol described herein. Second, surveyors proposing methods or intensities other than as prescribed here should seek concurrence on the proposed changes from our field office having jurisdiction over the proposed survey area. The proponent should seek this concurrence as early in the survey design as possible, and definitely prior to beginning actual field surveys. Finally, the surveyors must obtain any and all applicable Federal (described below) and State permits in advance of conducting the surveys.

3.2 Application of the protocol to projects

These guidelines are not intended for long-term monitoring or research projects or for determining the overall status of populations; guidelines for such monitoring and research efforts should be developed with our assistance on a case-by-case basis. We have worked with, and will continue to work with Federal, State, and local biologists; scientific and academic institutions; commercial organizations; and other interested parties to collect additional data on the distribution, ecology, and biology of the tidewater goby. We will revise this survey protocol as needed, using the best available data.

This protocol should fulfill the needs of landowners and managers to complete pre-disturbance surveys for tidewater gobies that provide a reasonable basis upon which to make effects determinations. Projects resulting in direct or indirect effects to tidewater gobies or their habitats should conduct surveys consistent with this protocol to document the presence or absence of tidewater gobies at their proposed project site. In addition, surveys conducted under this protocol may

provide useful information on the overall distribution of tidewater gobies within their range.

Extreme care must be taken when conducting surveys to avoid inadvertently injuring or killing tidewater gobies, or damaging their habitat (see Appendix F-3).

3.3 Peer Review of the Recommended Protocol

This protocol has been developed in conjunction with and reviewed by the Tidewater Goby Science Team, a group of agency and independent experts in tidewater goby biology and research. The protocol includes their comments. Any survey that uses a different methodology from this protocol should include a detailed description of the procedures used and an evaluation as to whether the conclusions drawn constitute the best available scientific and commercial information.

4. Recommended Protocol

We recommend the following survey guidelines be used to determine, with some reasonably high level of confidence, the presence or absence of tidewater gobies in habitat deemed suitable for the species.

4.1 Section 10(a)(1)(A) Recovery Permit Requirements

The survey methods prescribed in the following protocol require work within habitat likely to be occupied by tidewater gobies, and involves the handling of individuals for identification purposes. Although there is no requirement to preserve voucher specimens or otherwise directly kill individuals, the capture and handling of individuals has some risk of incidental mortality. Also, the methods proposed here require the surveyors to enter suitable habitat, and an unavoidable consequence of such activity is the trampling or other damaging of occupied burrows and mortality of eggs and possibly individuals. Therefore, all surveyors must obtain a recovery permit issued by us under section 10(a)(1)(A) of the Endangered Species Act of 1973, as amended. The permit application form and instructions for completion are available at the website http://forms.fws.gov/3-20055.pdf.

4.2 Survey Equipment

Surveys should be conducted using appropriate equipment. If other equipment is to be used, surveyors should contact our appropriate field office to determine if the other equipment is suitable for use under this protocol. The following equipment is the minimum necessary for conducting tidewater goby surveys under this protocol:

- U.S. Geological Survey quadrangle 7.5 minute series (topographic)

map(s);
- global positioning system unit or other method to identify latitude/longitude of tidewater goby and sampling locations to within 10 meters of actual location on topographic maps or aerial photos;
- refractometer or electronic salinity meter;
- a fish identification guidebook or field-ready identification card with pictures of similar species;
- long handled dipnet with a frame opening greater than 0.1 square meter and mesh size less than 3 millimeters;
- 3 meters length by 1 meter deep seine (approximately 3 millimeters mesh), recommended for small habitats (described below);
- 5 meters length by 1 meter deep seine (approximately 3 millimeters mesh), recommended for medium to large habitat areas;
- minnow traps with approximately 3 millimeters mesh, unbaited;
- field notebook;
- camera;
- thermometer;
- meter stick; and
- a goby viewing device (*e.g.*, clear plastic bag or small jar).

In order to prevent the unintentional introduction of nonnative organisms or disease, sampling gear should be thoroughly cleaned, and dried if possible, prior to use in different watersheds.

4.3 Site Assessment

The area to be sampled for tidewater gobies should include appropriate habitat consisting of slow moving water bodies, generally less than 3 meters (10 feet) in depth, with suitable substrate and appropriate water quality parameters. The size of the discrete water body (lagoon, pond, stream, ditch) under investigation will be used to determine the corresponding sampling effort to be carried out.

For the purpose of selecting appropriate equipment, and determining sampling effort, water bodies are categorized by size as large, medium, and small. Large water bodies are those meeting at least one of the following general physical parameters: streams with channel bankful widths in excess of 20 meters (66 feet) at any point and/or with estuarine (areas with salt water intrusion) habitats exceeding 1 kilometer (0.6 mile) in length; or lagoons and ponds larger than 2 hectares (5 acres) surface area. Medium sized water bodies include smaller streams less than 20 meters bankful width and/or estuaries longer than 100 meters (328 feet) but less than 1 kilometer in length. Medium sized lagoons and ponds are those with a surface area less than 2 hectare, but larger than 0.4 hectare (1 acre). Small water bodies are the remaining streams, ditches, sloughs, lagoons, and ponds of lesser dimension than as described for the medium size range.

Immediately prior to conducting in-water goby sampling activities, surveyors should complete the following actions:

1. Take one or more overview photos from a vantage point that provides an oblique view of the sampled habitat (when possible). The location(s) should be consistent from year to year if future surveys are anticipated.
2. Record the percent cover of aquatic vegetation and identify common plant species present in the area actually surveyed.
3. Categorize the water body, including size (as defined above).
4. Measure the average depth of the water using the meter stick for each sampling effort.
5. Record water temperature at a depth of half the average water depth in the survey area.
6. Take salinity measurements at both surface and bottom depths with the salinity meter or refractometer.
7. Note any unusual characteristics of the environment.
8. Record all other pertinent information describing date, time, location, names of surveyors, *etc*.

4.4 In-water Sampling for Tidewater Gobies

Before sampling, we recommend the surveyors review the literature and agency records for historical information and other available resources, and including communication with species experts. This review should determine whether populations have been previously identified at or near the site to be sampled, or whether suitable habitat for tidewater goby exists at the site. This information should be summarized in the survey report (see section 5, below).

In the absence of recent survey data, any site known historically to have been populated with tidewater goby should be assumed to be currently occupied by the species, unless clear evidence indicates that the habitat has been so modified as to be uninhabitable.

For the purpose of this protocol, the presence of one individual tidewater goby resulting from surveys constitutes evidence of an extant population. This determination is based on the annual life cycle of the species, the difficulty in detecting tidewater gobies, and the low likelihood of only one individual to be present in a watershed.

4.5 Survey Methods

Several methods can be effective in identifying, or capturing tidewater gobies. The following methods are recommended for conducting surveys, and each one is best suited to particular types of water bodies.

To maximize the probability of capture, and to ensure that the highest quality habitat within the area of interest is surveyed, sampling should be segmented into multiple locations within any water body. For purposes of this protocol, the "area of interest" is defined as that portion of the water body wherein the presence or absence of gobies is to be documented. For general surveys, the area of interest is likely to be the entire water body. For water bodies proposed to be altered by a project or other action, the area of interest is that portion of the water body likely to be affected (adversely or beneficially) by habitat loss, alteration, disturbance, sedimentation, or any other physical or biological factor directly or indirectly affecting suitable habitat of the species.

When surveying large water bodies, surveys should adequately cover all suitable habitat within the area of interest. We recommend surveying in a minimum of five distinct separate areas throughout the suitable habitat in large water bodies. When surveying small and medium water bodies, at least three distinct areas within suitable habitat should be sampled. In all water bodies, the saltwater/freshwater interface should be included in sampling locations, because gobies are often located in this zone. The following information should be used as a guide to complete the required amount of sampling effort. The effort categorized in the table below represents minimum acceptable numbers. In all size categories of water bodies, it is important to sample in the area where the impacts from the proposed project would be significant, and especially important in the large water bodies, where only a small percentage of the water body is surveyed. If the water body supports fishes, surveyors may begin sampling with the dip net if and where appropriate. Surveyors should record the presence of other identifiable fish and invertebrate taxa captured or observed, as part of general comments for each water body surveyed. Dip nets are especially important in those portions of suitable habitat where emergent and submergent vegetation or substrate limits or precludes the use of seine nets. For those habitats where seine nets cannot be used effectively, dip nets may be the only method that can be effectively employed. The table above indicates the amount of time that should be dedicated to the use of dip nets. Where seine nets can be used effectively, the amount of dip netting required is identified in the column labeled "Supplemental." In those water bodies where seine nets cannot be used, the dip netting may be the sole method that can be used effectively. The minimum time allocated to dip netting for sole method sampling is identified in the table below. For instructions in minimizing effects to gobies from sampling see Appendix F-3.

Water Body Size	Number of Minnow Traps per 24 hour sampling period/ number of sampling periods	Seine hauls (minimum effort required)	Dip Netting (minutes of effort)	
			Supplemental	Sole Method
Large	12/2 (minimum)	25 per 10 hectares	20	120 per 10 hectares
Medium	Not required	15 per water body	10	90 per water body
Small	Not required	15 per water body	5	60 per water body

Where site conditions allow effective use of a seine, surveyors should attempt to cover a minimum of 30 square meters per seine haul, with a recommended average of 50 square meters per seine haul. The number of seine hauls may be limited by suitable sites, and is dependent on the size of the water body.

For small and medium water bodies, conduct enough seine hauls to adequately cover suitable habitat. A minimum of 15 seine hauls is suggested to adequately cover these areas. Although some overlap between seine hauls is effective, they should have no more than 20 percent overlap in area. For any size water body, once tidewater gobies are detected, sampling may cease. In cases where the amount of suitable habitat within a water body can be covered completely by fewer than the prescribed number of seine hauls, sampling may cease when the water body is essentially 100 percent covered, or when tidewater gobies are first captured.

For large water bodies (as defined above), the number of seine hauls completed should be adequate to effectively sample the suitable habitat of interest. Since large water bodies may range from two to several hundred or more hectares, these water bodies only need to be sampled in the area of interest (as described above). Within the area of interest, the water body should be generally delineated into 10 hectare blocks of suitable habitat. The following survey recommendations apply within each 10 hectare block. We recommend a minimum of 25 seine hauls throughout a minimum of five sampling areas in each block. These 25 seine hauls should be distributed approximately uniformly across the five sampling areas (*i.e.*, five or more seine hauls across each of five or more sampling areas), or otherwise distributed among the five sampling areas to optimize the likelihood of detecting gobies within the suitable habitat of interest. For example, if two sampling areas are high quality habitat and three are lesser habitat, it may be best to complete eight seine hauls in each of the two best habitat areas, and three seine hauls in each of the three lesser habitat areas. Since conducting additional seine hauls in a sampling area represents relatively little additional work above that already necessary to do the minimum, additional seine hauls are encouraged whenever a question remains as to the possibility of tidewater gobies occupying the habitat.

If small fishes suspected to be tidewater gobies are found, surveyors should place them in viewing device and confirm the identification of tidewater goby (or other species) by looking for the clear tip of the first dorsal fin. If surveyors are in doubt, they should confirm fish identification by using a fish identification guidebook, and if possible, take photographs. Surveyors should record the location where gobies were sampled and the sampling effort expended to find them, to the nearest 10 meters. Surveyors should release the gobies promptly at site of capture and discontinue sampling (vouching new records or collections for other scientific purposes are appropriate if in accordance with the biologist's permits). Surveyors should also record the location of positive and negative survey results.

4.6 Sampling Period

Tidewater goby abundance fluctuates spatially and seasonally (Swenson 1999), due in part to their predominantly annual life cycle (see Background). Surveys must be conducted in two sampling periods between July 1 and October 31, due to this period being the time of highest abundance for the species in general, and therefore, the period of highest detection. The two sampling periods must be separated by at least 30 days to accommodate situations where changes in water level, seasonal movements, or other functions result in movement of gobies within the survey area. All surveys should be recorded and reported, including surveys that do not detect tidewater gobies. Surveyors should return to the same sites in sampling period 2 where tidewater gobies were not found in sampling period 1, but also include any suitable habitat that may have not been suitable during the first survey period due to changes in water level, *etc*. If tidewater gobies are found during the first visit, sites do not need to be sampled during the second period.

For surveys conducted as part of a project clearance, additional sampling may be needed prior to initiation of those project activities that may affect the tidewater goby. If gobies are not found within the two survey periods, and the project will not be completed within 60 days of the last survey, a pre-project survey may be required for any part of the proposed project area that may affect the tidewater goby. The need for this survey will be evaluated on a case-by-case basis between the applicant and our field office that has jurisdiction over the area of interest.

4.7 Area to Which Survey Protocol is Applicable

The survey protocol may be applied throughout the species range. Survey results are specifically applicable only to the actual body of water to which the survey is applied, but may be generally applied to similar water bodies contiguous to or immediately adjacent to the sampled habitats, provided a reasonable likelihood of connectivity between the sampled site and the sites to which the information is being extrapolated.

4.8 Effective Duration of Survey Results

Survey results are valid for 1 year. Based on input from several tidewater goby research scientists, due to the annual life cycle of the tidewater goby, documented population fluctuations, and their recolonizing ability, survey results are valid for a maximum of 1 year from the date surveys end.

Five consecutive years of negative survey results are needed to establish a history of absence. Proposed actions that span more than 1 year must be surveyed for each year of activity. Contact our appropriate field office (see Appendix F-1, below) for additional information before conducting surveys.

Surveys are not needed if surveys completed during the prior 10 years have confirmed the presence of gobies in waters with habitat contiguous to the habitat identified for survey AND the habitat where gobies were earlier found have not been substantially modified or impacted by human activities or natural events. That is, we presume that habitat previously occupied by gobies continues to be occupied unless clear evidence indicates that gobies have been extirpated.

The converse is not necessarily true. Habitats that have undergone sampling in the past, regardless of intensity, and been shown to be absent of gobies does not necessarily mean those habitats are currently devoid of the species. We will, however, consider the merits of scientific analyses on a case-by-case basis to analyze presumed absence of the species in otherwise suitable habitat. Those analyses should consider any past surveys done in that habitat, the intensity and coverage of those surveys, any modifications to the habitat since last known occupancy by the species, and the potential for the habitat to be recolonized by adjacent populations.

4.9 Other Permits and Permissions

Because this protocol (and tidewater goby surveys in general) involves capture, surveyors must have "take" authorization pursuant to section 7 or 10(a) of the Act to be exempt from the take prohibitions under section 9 of the Act. Surveys must be conducted by individuals possessing a 10(a)1(A) recovery permit from the Fish and Wildlife Service, specific to the tidewater goby. In addition, there may be permit requirements from the California Department of Fish and Game as well as other agencies to conduct surveys for gobies. Finally, surveyors should seek appropriate permissions from landowners or their managers to access or cross properties for their goby survey work, as needed. Nothing within this protocol should be construed as permission to enter, access, or cross any lands or waters not under the immediate control of the surveyor without specific permission from the affected landowner(s).

5. Reporting Requirements

Any permitted biologist observing a tidewater goby under this protocol is to notify our appropriate field office by phone (see Appendix F-1 for contact numbers) within 24 hours of such observation. Within 5 business days, the surveyor should fax or e-mail a copy of a U.S. Geological Survey quadrangle 7.5 minute series (topographic) map to the recovery permit coordinator in our appropriate field office, with the observation site clearly marked. Include a detailed description of the precise location of the tidewater goby(ies).

The permittee shall notify our appropriate field office in writing, at least 10 working days prior to the anticipated start date of survey work and receive approval prior to beginning work. Surveyors also should prepare a final report within 45 days that includes the following:

- Recovery permit number(s)
- Names of surveyors
- Location information, including county, watershed, GPS coordinates in either Latitude/Longitude or UTM NAD27 or indicated on a copy of a U.S. Geological Survey 7.5 minute topographic quadrangle map
- Photographs of the project site (photo points [locations and general direction] should be indicated on a map)
- A typed summary providing survey dates and times (both begin and end times)
- Habitat description (amount and quality of suitable habitat)
- The area sampled by a particular method (indicated on a map)
- Justification for areas not surveyed
- Effectiveness of seine hauls
- Number of tidewater gobies captured
- Photographs of tidewater gobies detected on site to verify species identification, (collection is not permitted without prior authorization)
- Other species detected
- Water temperature
- Salinity
- Whether area is currently tidally influenced
- A description of possible threats to tidewater gobies observed at the site including nonnative and native predators.

The report should be provided to our appropriate field office (see Appendix F-1).

Based on the results of surveys, we will provide guidance on how tidewater gobies should be addressed. If tidewater gobies are found, we will work with the project proponent through the section 7 (for Federal actions) or section 10 (for non-Federal actions) process. If tidewater gobies are observed but not identified to species, additional survey efforts may be recommended. If tidewater gobies are not found during the field surveys (conducted according to this protocol), we will consider the tidewater goby not likely to be currently present on the project site.

We may not accept the results of field surveys conducted under this protocol for any of the following reasons: 1) if our appropriate field office was not contacted prior to field surveys being conducted; 2) if field surveys were incomplete, or conducted in a manner that was inadequate for the area to be surveyed; or 3) if the reporting requirements were not fulfilled.

We encourage all surveyors to send any information on tidewater goby distribution resulting from surveys to the California Natural Diversity Data Base administered by the California Department of Fish and Game. Information about how to submit information to the California Natural Diversity Data Base is provided in Appendix F-2. Copies of the California Natural Diversity Data Base

form should mailed in a timely manner to the California Department of Fish and Game, as well as our appropriate field office.

These individual survey reporting results are separate from, and do not replace or supersede, the annual report required of each endangered species recovery [section 10(a)(1)(A)] permit holder to report activities conducted each year under his/her permit.

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Appendix F-1. USFWS Field Office and Regional Office Contacts

Please contact the appropriate Fish and Wildlife Service field office, for the counties indicated below, to obtain local information about the tidewater goby or application of this survey protocol:

For San Diego or Orange County, or Los Angeles County south of the Santa Monica Pier, contact:

Carlsbad Fish and Wildlife Office
Attn: Recovery Permit Coordinator
6010 Hidden Valley Road
Carlsbad, California 92009
Phone: (760) 431-9440
Fax: (760) 930-0846

For Sonoma, Marin, Solano, Contra Costa, Alameda, Santa Clara, San Mateo, or San Francisco County, contact:

Sacramento Fish and Wildlife Office
Attn: Recovery Permit Coordinator
2800 Cottage Way, Suite W-2605
Sacramento, California 95825
Phone: (916) 414-6600
Fax: (916) 414-6713

For Santa Cruz, Monterey, San Luis Obispo, Santa Barbara, or Ventura County, or Los Angeles County northwest of the Santa Monica Pier, contact:

Ventura Fish and Wildlife Office
Attn: Recovery Permit Coordinator
2493 Portola Road, Suite B
Ventura, California 93003
Phone: (805) 644-1766
Fax: (805) 644-3958

For Del Norte, Humboldt, or Mendocino County, contact:

Arcata Fish and Wildlife Office
Attn: Recovery Permit Coordinator
1655 Heindon Road
Arcata, California 95521
Phone: (707) 822-7201
Fax: (707) 822-8411

For information on ESA section 10(a)(1)(A) recovery permits, please contact:

Region 1, USFWS
Attn: Recovery Permit Coordinator
Eastside Federal Complex
911 N.E. 11th Avenue
Portland, OR 97232-4181
Phone: (503) 231-6241
Fax: (503) 231-6243

Appendix F-2. General instructions for filling out California Natural Diversity Data Base field survey forms

The California Natural Diversity Data Base is the largest, most comprehensive database of its type in the world. It presently contains more than 33,000 site specific records on California's rarest plants, animals, and natural communities. The majority of the data collection effort for this has been provided by an exceptional assemblage of biologists throughout the state and the west. The backbone of this effort is the field survey form. We are enclosing copies of California Natural Diversity Data Base field survey forms for species and natural communities. We would greatly appreciate you recording your field observations of rare, threatened, endangered, or sensitive species and natural communities (elements) and sending them to us on these forms.

We are interested in receiving forms on elements of concern to us; refer to our free publications: *Special Plants List*, *Special Animals List,* and *Natural Communities List* for lists of which elements these include. Reports on multiple visits to sites that already exist in the California Natural Diversity Data Base are as important as new site information as it helps us track trends in population/stand size and condition. Naturally, we also want information on new sites. We have enclosed an example of a field survey form that includes the information we like to see. It is especially important to include a photo copied portion of a U.S. Geological Survey topographic quad with the population/stand outlined or marked. Without the map, your information will be mapped less accurately, as written descriptions of locations are frequently hard to interpret. Do not worry about filling in every box on the form; only fill out what seems most relevant to your site visit. Remember that your name and telephone number are very important in case we have any questions about the form. If you are concerned about the sensitivity of the site, remember that the California Natural Diversity Data Base can label your element occurrence "Sensitive" in the computer, thus restricting access to that information.

The California Natural Diversity Data Base is only as good as the information in it, and we depend on people like you as the source of that information. Thank you for your help in improving the California Natural Diversity Data Base.

Appendix F-3. Techniques to Minimize Effects to Tidewater Goby from Surveys

General Guidelines

When conducting sampling for tidewater gobies, particular care should be taken when walking in suitable habitat to minimize disturbance to the area, especially during breeding periods, when gobies in burrows could be crushed as a result of being stepped on. Entry to the water should be slow, and where possible, visually scan for gobies before entry. This precaution should also be taken when launching and retrieving of boats as part of sampling efforts. When captured, tidewater gobies should never be completely removed from water, and should remain completely wetted at all times. All individuals captured should be released immediately after identification at the point of capture. Any tidewater gobies exhibiting signs of physiological stress shall be immediately released. As part of the presence/absence survey, measuring gobies is neither required nor recommended. Tidewater gobies shall not be anaesthetized, stained, dyed, or otherwise marked at any time. Electrofishing is not an authorized sampling method for tidewater gobies.

Seining

Disturbance and damage to burrows, eggs, and young should be minimized through use of the smallest and lightest weight seines practicable that meet protocol guidelines. It is important to avoid accidental injury or mortality to tidewater gobies, which may be caught and suffocated in vegetation such as algal mats or other debris when using seines. Rocks should be removed from seines immediately, otherwise tidewater gobies may be crushed by rocks tumbling and rolling in the seine. Bagged portions of seines must remain in the water until all tidewater gobies are removed. Temporary holding containers, if used, should be shallow, filled with clean water, and be placed in a location that will not result in exposure to extreme temperatures.

Dip Netting

When using dip nets, a container of water collected from the immediate vicinity of the tidewater goby capture should be available to immediately transfer gobies into when captured.

Traps

When setting minnow traps, place them in areas where anticipated tidal or upstream water volume fluctuations will not dewater the trap, or expose it to poor water conditions as a result of location. When checking traps, all contents should immediately be transferred to a container of water from the immediate vicinity before identifying fish species.

State of California
DEPARMENT OF TRANSPORTATION

California State Transportation Agency

M e m o r a n d u m

Serious drought.
Help Save Water!

To: GARY BLAKESLEY

Division of Structure Design
Office of Bridge Design North
Branch 6

Date: January 21, 2015

File: 01-DN-101-PM 22.9
EFIS ID: 0112000113
Hamilton 2 Slips
Bridge No: 01E0015

Attn: SEIJI MORIMOTO

From: DEPARTMENT OF TRANSPORTATION
DIVISION OF ENGINEERING SERVICES
GEOTECHNICAL SERVICES – OGDN

Subject: Foundation Report for the Soldier Pile Ground Anchor Wall at DN 101 PM 22.9

1. INTRODUCTION

This Foundation Report summarizes the results of the geotechnical investigation and provides geotechnical recommendations for the proposed Solider Pile Ground Anchor (SPGA) wall on Route 101 at post mile (PM) 22.9 in Del Norte County, CA (Figure 1- Vicinity Map). A SPGA wall is proposed at this location to restore the passing lane.

2. PROJECT DESCRIPTION

The project site is located in a rural area bordered by state parks and privately owned timberland. At the project location Highway 101 is a two-lane conventional highway with a passing lane that traverses mountainous terrain.

Winter rains in 2011 activated a translational slide at PM 22.9. The head scarp of the landslide destabilized the shoulder and a portion the southbound passing lane.

The proposed SPGA wall details are shown in Table 1.

Table 1- Description of the Proposed SPGA Wall

BEGIN			END			LENGTH (ft)	DESIGN HEIGHT (ft)	
Sta.	Latitude	Longitude	Sta.	Latitude	Longitude		Min.	Max.
205+76	41°43'31.8594"	-124°08'29.5662"	207+87.99	41°43'33.8032"	-124°08'30.5342"	212	0	31

The layout line of the SPGA wall is shown on Figure 2- Site Plan. Approximately 4,000 cubic yards (cy) need to be excavated for this project. A cable rail will be constructed on top of the wall.

3. SCOPE OF WORK

The recommendations contained in this report are based on a review of geotechnical and geologic literature, a subsurface investigation, field observations, laboratory testing of soil samples, and geotechnical calculations. Subsurface conditions were evaluated only at the boring locations and may deviate elsewhere within the Project Limits. The elevations reported in this memorandum are with respect to Mean Sea Level (MSL).

4. PERTINENT REPORTS AND INVESTIGATIONS

<u>FHWA Publications</u>

1. Sabatini, P. J. et. al. 1999, “Geotechnical Engineering Circular No. 4 - Ground Anchors and Anchored Systems” FHWA Report No. FHWA-IF-99-015.

<u>Caltrans Reports</u>

2. Wills, C. J., “Landslides in the Highway 101 corridor between Wilson Creek and Crescent City, Del Norte County, California,” California Geological Society, 2000

3. Caltrans Corrosion Guidelines Version 2.0, 11/2012

4. Caltrans Soil and Rock Logging, Classification, and Presentation Manual, 2010 Edition.

5. Memo to Designers 5-12 “Earth Retaining Systems Using Ground Anchors”, July 2012

Other Publications

6. Stark, Timothy D. et. al., “Drained Shear Strength Parameters for Analysis of Landslides” Journal of Geotechnical and Geoenvironmental Engineering ASCE May 2005

5. FIELD INVESTIGATION AND TESTING PROGRAM

Five vertical mud-rotary borings were drilled between August 28, 2012 and July 26, 2013 to characterize the subsurface conditions. The boreholes were advanced using a truck mounted Acker MPCA and a CS100 drill rig using a 94-mm HXB casing equipped with a diamond impregnated core bit. Soil and rock samples were logged in accordance to the Caltrans Soil and Rock Logging, Classification, and Presentation Manual 2010 Edition. The boring information will be provided in the Log of Test Borings (LOTBs) in the Project Plans.

Slope Inclinometers (SIs) with 2.75 inch diameter casings were installed in all the borings and backfilled with coarse sand and sealed with bentonite. The lower 20 feet of the casing was perforated to permit monitoring of water levels within the casing. Inclinometer readings were obtained between March 2012 and September 2013.

A summary of the boring information and the depth of movement is provided in Table 2. The SI data are included in Appendix A.

Table 2 - Summary of Geotechnical Borings

BORING I.D.	STATION AND OFFSET FROM “A2” ALIGNMENT	DEPTH OF BORING (ft, bgs)	SURFACE ELEVATION (ft, MSL)	DEPTH TO BEDROCK (ft, bgs)	BEDROCK ELEVATION (ft, MSL)	DEPTH FO FAILURE SURFACE (ft, bgs)
RC-12-001	206+70.44 27.78’ LT	100	327	43	284	17.5
RC-13-002	206+42.84 30.82’ LT	100	328	49	279	17.5
RC-13-003	207+38.18 25.86’ LT	100	322	41	281	--[1]
RC-13-004	Sta. 206+43.71 7.00’ RT	95	327	5	322	--[1]

BORING I.D.	STATION AND OFFSET FROM "A2" ALIGNMENT	DEPTH OF BORING (ft, bgs)	SURFACE ELEVATION (ft, MSL)	DEPTH TO BEDROCK (ft, bgs)	BEDROCK ELEVATION (ft, MSL)	DEPTH FO FAILURE SURFACE (ft, bgs)
RC-13-005	Sta. 206+49 72.76' LT	59.5	301	31.5	269.5	25

[1] – No failure surface

6. SITE GEOLOGY AND SUBSURFACE CONDITIONS

6.1. Site Description

The 2011/2012 storm season destabilized an existing stabilization trench and caused the loss of a portion of the southbound passing lane. This stabilization trench was built in 1984 in response to a storm event. As-builts of the existing trench indicate that the trench was approximately 217 feet wide and was approximately 40 feet deep (Figure 3- 1984 As-Builts). The trench drainage consisted of a 10 foot thick granular blanket at the base and a three foot wide blanket drain extending along the 0.75H:1V back slope to the road base. The embankment was constructed with 1.5H:1V side slopes. Rock slope protection was placed at the embankment toe.

6.2. Site Geology

The project is lies within the Coast Ranges Geologic province which is typically sedimentary rocks of Cretaceous through Tertiary ages (Figure 4- Project Geologic Map). The most widespread unit is the Franciscan Complex, composed of fine to medium grained Greywacke Sandstone, highly sheared Shale and several other rock types. The project site is underlain by the "Mélange" unit of the Franciscan complex and is composed mainly dark gray, highly sheared Siltstone and Shale. (Ref. 2). The Mélange unit consists of highly sheared Shale and Argillite.

6.3. Subsurface conditions

Boreholes RC-12-001, RC-13-002, RC-13-003 and RC-13-005 encountered materials from the Stabilization trench built in 1984. RC-12-001, RC-13-002 and RC-13-003 encountered a 5-foot thick layer of asphalt, which indicates that this area has been sinking for some time. This was corroborated by Crescent City Maintenance Supervisor Jamie Camden (personal communication, October 8, 2014).

In RC-12-001, a 15-foot thick layer of medium dense, Clayey Gravel with Sand fill was encountered above a 4-foot thick drainage blanket. Loose poorly-graded Gravel, Clayey Sand, Poorly Graded Sand, stiff and very stiff

Lean Clay and Lean Clay with Sand, interpreted to be roadway fill was encountered between 24 feet and 43 feet. Underlying the fill is Sandstone bedrock decomposed to a Clayey Gravel, Clayey Sand and a Clayey Gravel with Sand.

In RC-13-002, embankment fill was encountered under a 5-foot thick layer of asphalt and fill. The fill is composed of medium dense Silty Gravel with Sand, stiff to soft, Lean Clay with Sand and loose Clayey Gravels to 24.5 feet. The gravel blanket drain encountered below the fill, was 11.5 feet thick and was composed of loose Well-graded Sand with Gravel. The material below the drain was 3 feet thick and composed of stiff Lean Clay with Sand. The rock below this material was 10 feet thick and decomposed to a very dense Clayey Gravel. Sandstone bedrock encountered at 49 feet.

In RC-13-003, a 20 foot thick layer of embankment fill was encountered under a 5-foot thick layer of asphalt and fill. The embankment fill was composed of medium dense Silty Sand with Gravel and soft Sandy Clay. The gravel blanket below this fill was 7 feet thick. A 5 foot thick layer of very dense Clayey Gravel with Sand exists below the gravel blanket. Decomposed Sandstone was encountered between 37 to 63 feet. The Sandstone between 63 feet and the end of the borehole was decomposed to intensely fractured.

In RC-13-004, Sandstone was encountered 5 feet below the roadway surface.

Borehole RC-13-005 was drilled on the first bench below the roadway. A five foot diameter rock slope protection (RSP) boulder was immediately below the surface. Below the boulder was an approximately 20-foot thick layer of Poorly-graded Gravel and Cobbles that was interpreted to be the gravel drainage blanket. Underlying this material was a half a foot thick layer of medium stiff Lean Clay and a 6.5-foot layer of medium dense Clayey Gravel. Bedrock below the fill was decomposed and very intensely fractured Sandstone.

Data from the SIs in boreholes RC-12-001 and RC-13-002 indicate that the failure surface is within the Stabilization trench fill at a depth of 17.5 feet. The inclinometer in RC-13-004 showed no movement which confirms that the failure is confined to the stabilization trench. The upper 25 feet of the SI at RC-13-003 casing shows a deflection or tilting to the west which is likely due to the relaxation of the slope adjacent to the head scarp.

At the toe of the constructed embankment the failure plane extends into the decomposed bedrock as evidenced in the data from borehole RC-13-005.

Materials from boreholes RC-12-001 and RC-13-002 were tested for Particle Analysis and Atterberg limits. The results are included in Appendix B - Laboratory Test Data. Testing was performed by the District1 Materials Laboratory in Eureka, CA.

6.4 Groundwater conditions

Table 3 summarizes the recorded groundwater measurements at the project site. Except in RC-13-004, the measured groundwater elevations coincided with the gravel blanket drain. In RC-13-004 the groundwater elevation was encountered in Sandstone.

Table 3 -Summary of Measured Groundwater Elevations

BORING I.D.	GROUND SURFACE ELEVATION (ft)	GROUNDWATER TABLE OR PIEZOMETRIC ELEVATION		DATE MEASURED
		DEPTH BELOW GROUND SURFACE (ft)	GROUNDWATER ELEVATION (ft)	
RC-12-001	327	26.0	301	08-29-2012
		50.5	276.5	01-02-2013
		52.3	274.7	01-17-2013
		45.0	282	07-02-2013
		35.3	291.7	08-16-2013
		35.6	291.4	09-19-2013
RC-13-002	328	41.7	286.3	07-02-2013
		28.4	299.6	07-19-2013
		31.0	297.0	08-16-2013
		32.9	295.1	09-19-2013
		33.1	294.9	11-25-2013
RC-13-003	322	39.8	282.2	07-16-2013
		38.5	283.5	08-16-2013
		39.1	282.9	09-19-2013

BORING I.D.	GROUND SURFACE ELEVATION (ft)	GROUNDWATER TABLE OR PIEZOMETRIC ELEVATION		DATE MEASURED
		DEPTH BELOW GROUND SURFACE (ft)	GROUNDWATER ELEVATION (ft)	
RC-13-004	327	26.1	300.9	08-07-2013
		30.4	296.6	12-19-2013
RC-13-005	301	4.1	296.9	08-28-2013
		10.9	290.1	09-19-2013

7. CORROSION EVALUATION

Chemical analyses were performed on samples collected from borings to evaluate corrosion potential of the on-site soils. Testing was performed by the Caltrans Geotechnical Laboratory in Sacramento, CA and at the District1 Materials Laboratory in Eureka, CA. Table 4 summarizes the test results. The results of the corrosion tests are attached in Appendix B.

Table 4 -Summary of Soil Corrosion Tests

BOREHOLE ID	DEPTH (ft, bgs)	pH	MINIMUM RESISTIVITY (ohm-cm)
RC-13-001	34-36	6.06	5,029
	43-45	7.35	2,230
RC-13-002	20 - 25	7.33	4,104
	55-60	8.90	3,071

For structural elements, the Department considers a site to be corrosive if one or more of the following conditions exist for the representative soil and/or water samples taken at the site: Chloride concentration is 500 ppm or greater, sulfate concentration is 2000 ppm or greater, or the pH is 5.5 or less.

Based on the Caltrans Corrosion Guidelines (2012 version 2.0) and the laboratory test results, the site soils may be considered non-corrosive to steel and concrete.

As per Section 6.2 of the Guidelines (Survey of Site Conditions), it is noted that the project location is within one mile of the Pacific Ocean.

8. GEOTECHNICAL AND FOUNDATION RECOMMENDATIONS

8.1. Wall Location and Height

The wall layout line is shown on Figure 2 and the subsurface geology along the wall layout line is shown on Figure 5- Subsurface Geology along Wall Layout Line. The proposed wall is approximately 212 feet in length with a maximum height of 31 feet. There are four levels of ground anchors.

8.2. Slope Stability analysis and Design Parameters

Data from SIs RC-12-001 and RC-13-002 indicate that the failure plane is located within the stabilization trench at 17.5 feet below ground surface. The failure plane in RC-13-005 was encountered at 25 feet below ground surface in a lean clay seam within the decomposed Sandstone beneath the gravel blanket. It is inferred that the slope failure occurred due to a combination of two reasons: 1) the original stabilization trench was not deep enough to encompass the failure surface and 2) the increase in hydrostatic forces from the elevated pore water pressures due to the fines in the drainage blanket. The 30 year stabilization trench was essentially at the end of its design life.

The soil strength parameters for the design were initially determined by using the standard penetration test (SPT) N values obtained from the vertical boreholes, published correlations and laboratory data.

Given that it is an active slide, residual shear strength conditions prevail. Residual strengths were estimated based on a correlation of liquid limit, clay size fraction and effective normal stress at the failure zone (Stark et.al, 2005). Atterberg limits were obtained for several samples (Appendix B). Liquid limits ranged from 24 to 30 with an average of 27 and the average ASTM clay size fraction was 43 percent. Residual Friction angles calculated from this correlation ranged between 24 to 31 degrees.

These initial values were used in the slope stability program SLOPE/W 2012 on critical cross section A-A' (Figures 2 and 6). A factor of safety of 1.0 was assumed for the existing slope. Observed tension cracks and depths to the landslide failure plane (from inclinometer data) were used to fix the entry and exit points of the failure surface. The soil strength parameters for the stabilization trench fill and decomposed Sandstone were adjusted until the failure plane matched the field observations. The Morgenstern-Price Method of limit equilibrium that satisfies both force and moment equilibrium was used to compute the factor of safety (Figure 7-Stability Analysis for Existing Conditions).

The recommended soil and rock parameters for the retaining wall design are provided in Table 5.

Table 5 - Soil Design Parameters

LAYER	APPROXIMATE THICKNESS (ft)[1]	MOIST UNIT WEIGHT (pcf)	SATURATED UNIT WEIGHT (pcf)	ANGLE OF INTERNAL FRICTION (degrees)	COHESION (c, psf)
(1) Asphalt	5	120	--	34	0
(2) Embankment Fill	26	110	129	26	0
(3) Gravel Blanket Drain	10	115	142	33	0
(3) Decomposed Rock	11	115	133	26	0
(4) Sandstone	150[2]	130	--	38	500

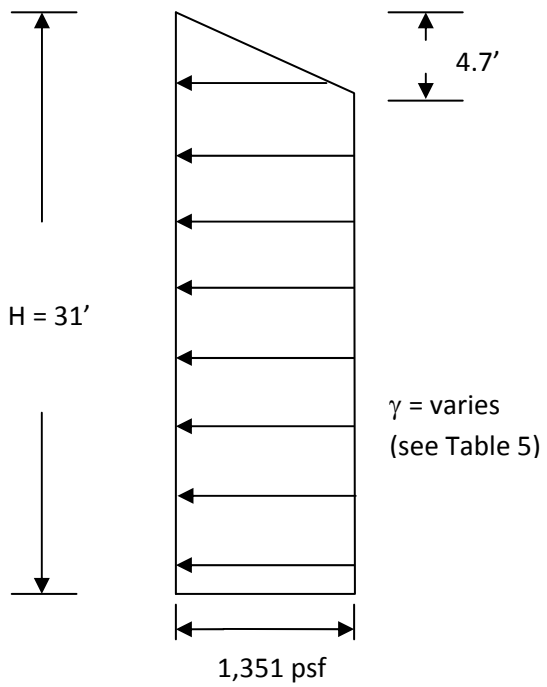
[1] – At wall layout line [2] – A thickness of 150 feet was chosen arbitrarily for the stability analysis

8.3. Hydrostatic Forces

The recommended design groundwater surface elevation was assumed to be 15 feet below top of the wall. A higher elevation than the measured groundwater elevation was assumed because the existing groundwater elevations were obtained during a drought year. The presence of hydrophytic vegetation down slope of the proposed wall also indicates that the ground water is high at the project site.

8.4. Lateral Earth Pressures

The active lateral earth pressure recommendation is based on Caltrans Memo to Designer 5-12, Earth Retaining Systems using Ground Anchors (July 2012). The following active lateral earth pressure distribution diagram was developed based on a soldier pile wall with a wall height of 31 feet and multiple rows of ground anchors.



Recommended Lateral Earth Pressure Distribution

Factored into the wall height are the projected actual slide surface, the failed stabilization trench materials and a traffic surcharge of 270 pounds per square foot (psf). It was determined that it would be prudent for the wall to retain the entire embankment fill. The lagging should extend two feet below the lowest tie-back level.

8.5. Seismic Recommendations

A shear wave velocity of 258 m/s (847 ft/s) was determined from soil types and corrected SPT numbers. Utilizing the Caltrans ARS online tool (V2.3.06), we recommend using the USGS 5% in 50 years hazard (2008) curve, which yields a spectral acceleration of 0.48g at period T = 0 seconds. The horizontal seismic coefficient (KHz) is

typically taken as $^1/_3$ to $^1/_2$ of the Peak Ground Acceleration (PGA). We recommend using KHz = 0.16 for LRFD Extreme Event analysis. We recommend a value for vertical seismic coefficient Kv = 0.

The ARS online data sheet utilized is attached to this report in Appendix C – Seismic Data.

8.6. Recommendations for Ground Anchors

The ground anchor forces (lateral force) required to resist the landslide force was evaluated using SLOPE/W 2012 per Memo To Designers (MTD) 5-12. A concentrated horizontal force (P_{TOTAL}) was then applied at the wall face at the mid-point of the wall height. P_{TOTAL} was then increased in the stability analysis until a factor of safety of 1.5 was achieved. The results of the stability analysis indicate that a total horizontal force of 38.7 kips per foot is required to stabilize the slope to a factor of safety of 1.5 (Figure 8- P_{TOTAL} Stability Analysis). The bonded zone of the ground anchors should be in the Sandstone bedrock. The recommended unbonded lengths are provided below.

Table 6- Ground Anchor Design Parameters

Recommended Ground Anchor Inclination	15º
Minimum Ground Anchor Unbonded Length (feet)	
Row 1	55
Row 2	48
Row 3	42
Row 4	35
Presumptive nominal unit bond stress (ksf)	14.6

The recommended finished grade elevation on the down slope side of the wall at approximately Sta. 206+70 is 304 feet. A factor of safety of 1.1 was obtained for the down slope stability (Figure 9-Downslope Stability Analysis).

8.7. Recommendations for Pile Tip Elevations

The following recommendations for minimum pile embedment depths are based on the elevations of the Decomposed Rock and Sandstone bedrock.

Table 7- Recommended Pile Tip Elevations

Wall Station Limits (ft)	Design Tip Elevations (ft)
0+00 to 16+00	315
16+00 to 41+00	294
41+00 to 92+00	279
92+00 to 188+00	270
188+00 to 192+00	274
192+00 to 212+00	282

8.8. Earth Work and Wall Backfill Recommendations

Along the face of the buried portion of the wall we recommend a two foot wide chimney of Class I Type B permeable material be constructed 2 feet below the finished grade elevation to the base of lagging. Filter fabric should be placed between the permeable material and backfill. A 12 inch perforated plastic pipe should be placed 6 inches above the base of the permeable material and connected to a 12 inch solid plastic pipe. The outlet of the pipe may be extended downslope.

9. CONSTRUCTION CONSIDERATIONS

9.1. Excavation and Drilling Difficulties

Caving conditions will likely be encountered during drilling for the piles and tiebacks due to the existing gravel drainage blanket and the intensely fractured nature of the decomposed rock. Temporary casing, drilling under slurry or placement of slurry cement backfill or concrete and re-drilling may be required to control caving and

should be performed in conformance with the provisions in Section 49-4.03B “Drilled Holes,” of the Standard Specifications.

The gravel drainage blanket may also be encountered during lagging installation at the base of the wall.

Structure backfill behind the wall shall conform to Section 19-3.03E(3) of the Standard Specifications.

Groundwater will likely be encountered in the pile and tieback holes. Pile and tieback installations may require dewatering or the placement of concrete and grout under water. If water is present and the holes are not dewatered, displacement of the water by means of a closed system using a concrete pump or tremie tube to place concrete and grout at the bottom of the holes will be required in conformance with the provisions in Section 51-1.03D(3) “Concrete Placed Under Water,” of the Standard Specifications.

Drill fluid circulation was lost during drilling of several of the exploratory borings and is interpreted to indicate the presence of cracks and voids in the subsurface materials. The potential for the loss of concrete and grout into voids should be expected. Controlling measures such as the use of a “grout sock,” could greatly reduce the potential for grout loss.

9.1.1. Hazardous Materials

The fill deposits and bedrock within the Project Limits do not contain Naturally Occurring Asbestos (NOA).

10. PROJECT INFORMATION

Standard Special Provisions S5-280, “Project Information”, discloses to bidders and contractors a list of pertinent information available for their inspection prior to bed opening. The following is an excerpt for SSP-280 disclosing information originating from Geotechnical Services. Items listed to be included in the information Handout will be provided in Acrobat (pdf) format to addressee(s) of this report via electronic mail.

Data and information attached with the project plans are:

Log of Test Borings for Hamilton 2 Slips

Data and information included in the Information Handout provided to the bidders and contractors are:

Foundation Report for Hamilton 2 Slips – 01-DN-101-PM 22.9 dated January 21, 2015

Data and Information available for observation at the District One Driller's Annex:

A. Borehole Core Samples

If you have any questions or require additional information, please contact June James at (707) 441-4692 or Charlie Narwold at (707) 445-6036.

JUNE JAMES
Transportation Engineer
Office of Geotechnical Design North
Branch B

CHARLES NARWOLD
Senior Engineering Geologist
Office of Geotechnical Design North
Branch B

List of Figures:

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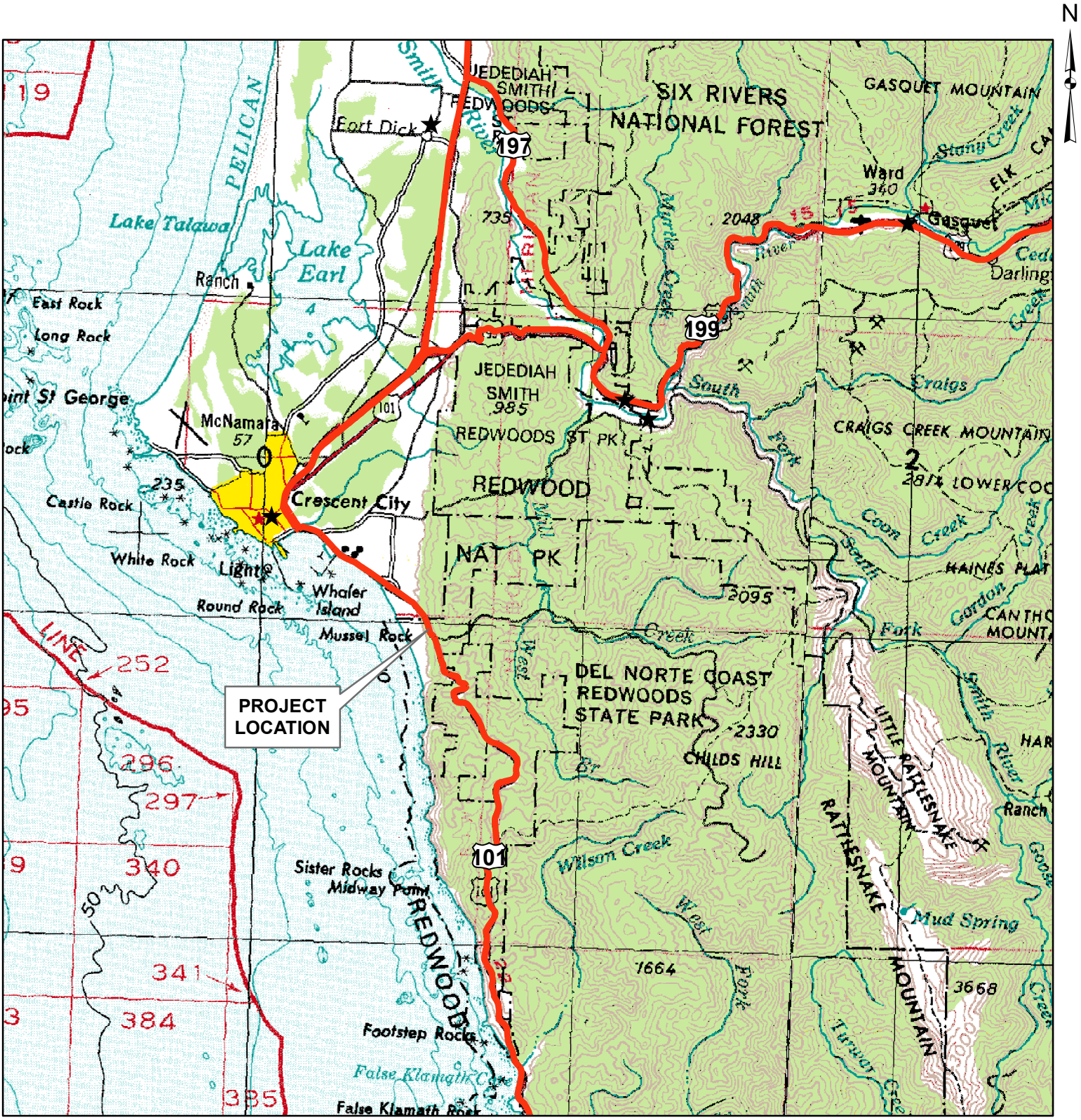
Figure 5- Subsurface Geology along Wall Layout Line
Figure 6- Design Cross-section A-A' Station 206+70
Figure 7- Stability Analysis for Existing Conditions
Figure 8 - P_{TOTAL} Stability Analysis
Figure 9 - Downslope Stability Analysis

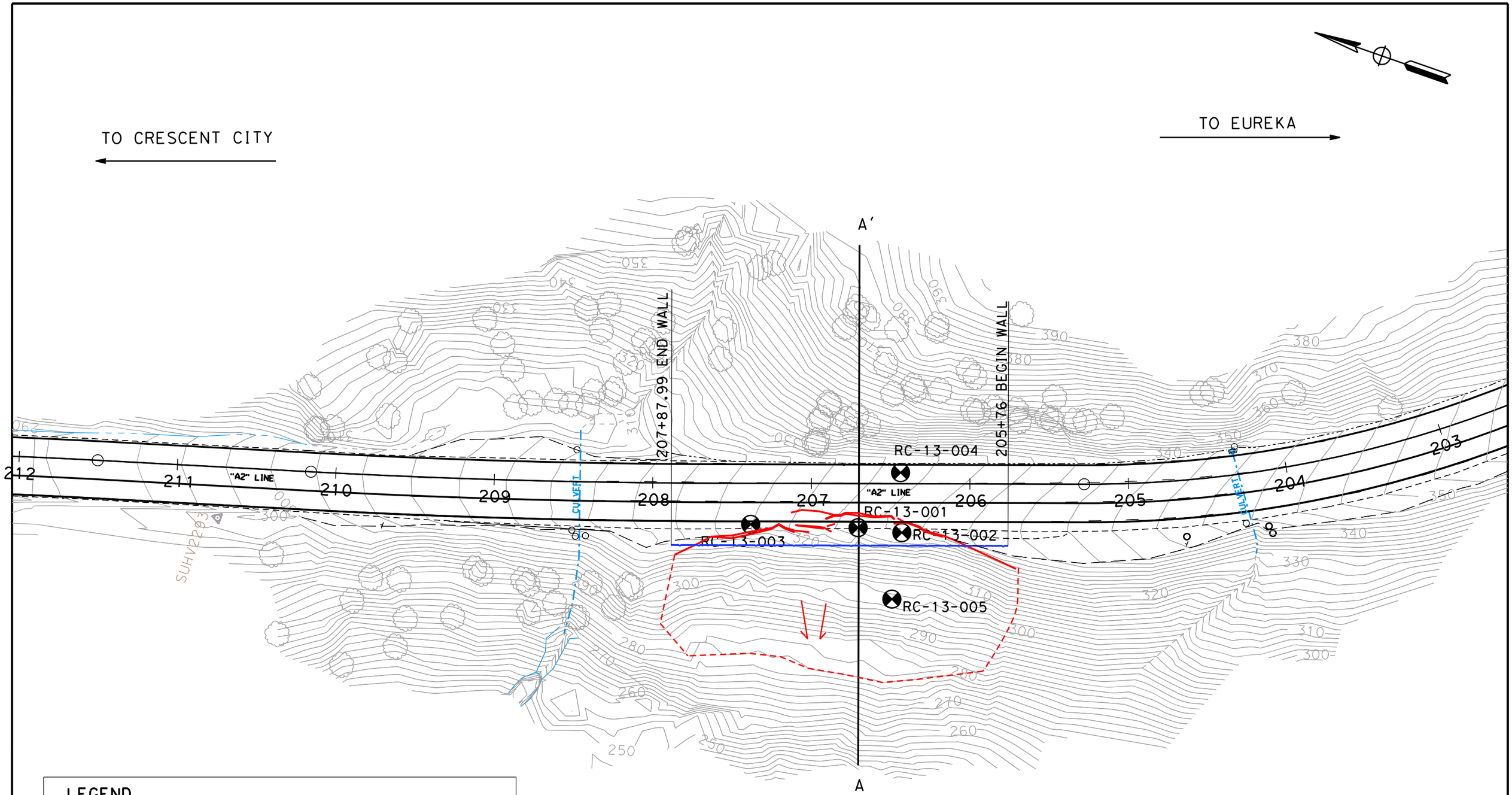
List of Appendices

Appendix A – Slope Inclinometer Data
Appendix B – Laboratory Data
Appendix C – Seismic Data

C: Traci Menard – GS
Talitha Hodgson – District 01



Department of Transportation Division of Engineering Services Geotechnical Services Office of Geotechnical Design North Branch B	EFIS: 0112000113 DATE: JANUARY 2015	**VICINITY MAP**
	01- DN 101 PM 22.9 HAMILTON 2 SLIPS	**FIGURE 1**



LEGEND

RC-12-001 BORING AND SI LOCATION

A ___ A' CROSS-SECTION LOCATION

LANDSLIDE, SOLID WHERE CERTAIN, DASHED WHERE APPROXIMATELY LOCATED IS UNCERTAIN. ARROWS INDICATE DIRECTION OF MOVEMENT.

Caltrans

Department of Transportation
Division of Engineering Services
Geotechnical Services
Office of Geotechnical Design North
Branch B

EFIS: 0110000113	SITE PLAN
DATE: JANUARY 2015	
01-DN-101-PM-22.9 HAMILTON 2 SLIPS	FIGURE 2

Dist	County	Route	Post Miles	Sheet No.	Total Sheets
01	DN	101	22.9	1	13

DEPUTY DISTRICT DIRECTOR OF TRANSPORTATION
REGISTERED CIVIL ENGINEER NO. 14011

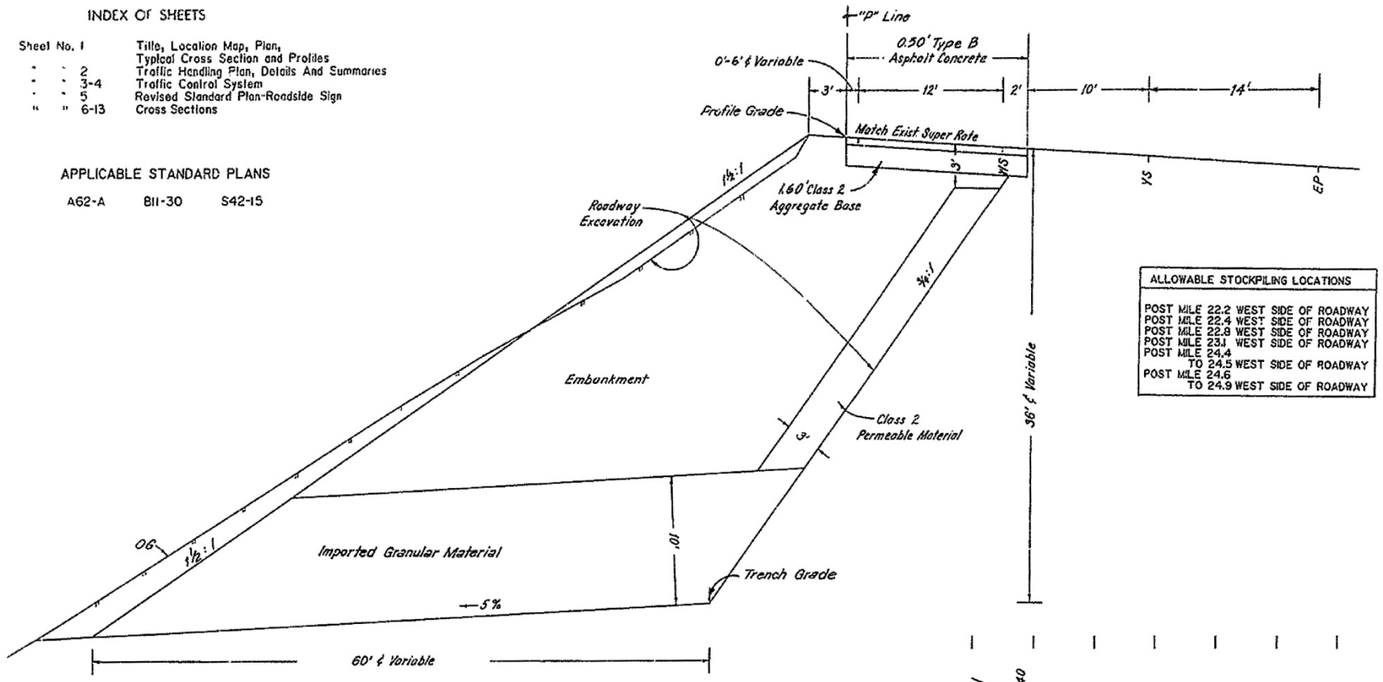
DATE APPROVED June 4, 1984

INDEX OF SHEETS

Sheet No. 1 Title, Location Map, Plan,
" " 2 Typical Cross Section and Profiles
" " 3-4 Traffic Handling Plan, Details And Summaries
" " 5 Traffic Control System
" " 6-13 Revised Standard Plan-Roadside Sign
" " 6-13 Cross Sections

APPLICABLE STANDARD PLANS

A62-A B11-30 S42-15



STA. 11+70 TO 13+30

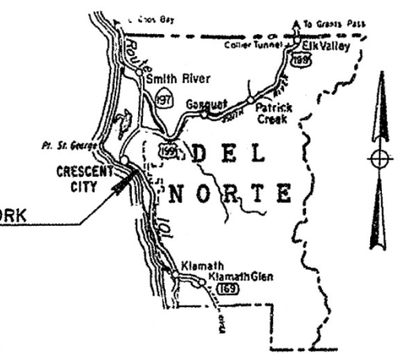
TYPICAL CROSS SECTION

SCALE: 1" = 5'

EARTHWORK SUMMARY	
ITEM	QUANTITY
IMPORTED GRANULAR MATERIAL	2,850 CY
EMBANKMENT*	5,100 CY
ROADWAY EXCAVATION	10,250 CY

*NOT A SEPARATE PAY ITEM

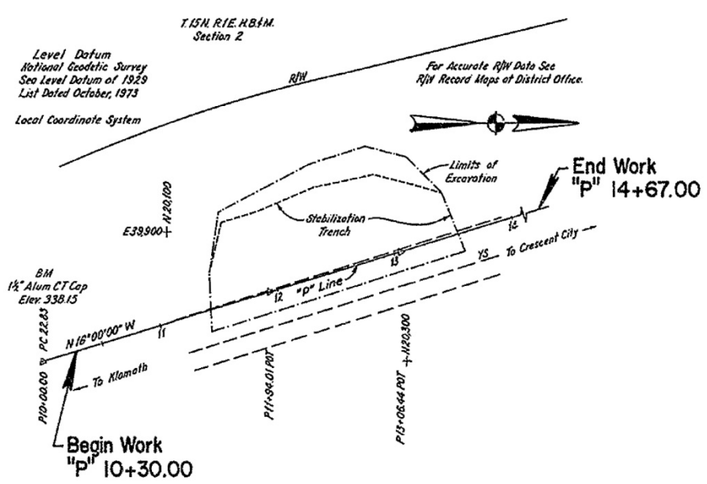
ALLOWABLE STOCKPILING LOCATIONS
POST MILE 22.2 WEST SIDE OF ROADWAY
POST MILE 22.4 WEST SIDE OF ROADWAY
POST MILE 22.8 WEST SIDE OF ROADWAY
POST MILE 23.1 WEST SIDE OF ROADWAY
POST MILE 24.4 TO 24.5 WEST SIDE OF ROADWAY
POST MILE 24.6 TO 24.9 WEST SIDE OF ROADWAY



LOCATION MAP

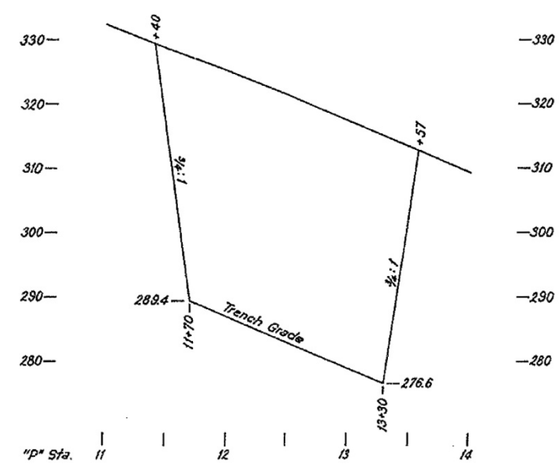
CONSTRUCTED AS PLANNED

CONT. 01-200204 1984
REPAIR SLIPOUT
CONTRACTOR-ROY A. BURKES
RES. ENGINEER-H.T. ZEIBAK



PLAN

SCALE: 1" = 50'



STABILIZATION TRENCH PROFILE

SCALE: 1" = 50' HORIZONTAL
1" = 10' VERTICAL

NOTES:

1.) Dimensions of the structural section are subject to tolerances specified in the Standard Specifications.
2.) Superelevation as shown or as directed by the Engineer.

STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION
PROJECT PLANS FOR CONSTRUCTION ON
STATE HIGHWAY

IN DEL NORTE COUNTY
ABOUT 3 MILES SOUTH OF CRESCENT CITY
AT 0.9 MILE SOUTH OF HUMBOLDT ROAD

to be supplemented by Standard Plans dated January, 1981

Contract No. 01-200204

Project Engineer	Design Engineer	Date	Approved Recommended By	Date
G.H. Beckman 12/84	D.L. Comstock 3/84		D.A. Brown	12/84

10-69-09

Department of Transportation
Division of Engineering Services
Geotechnical Services
Office of Geotechnical Design - North

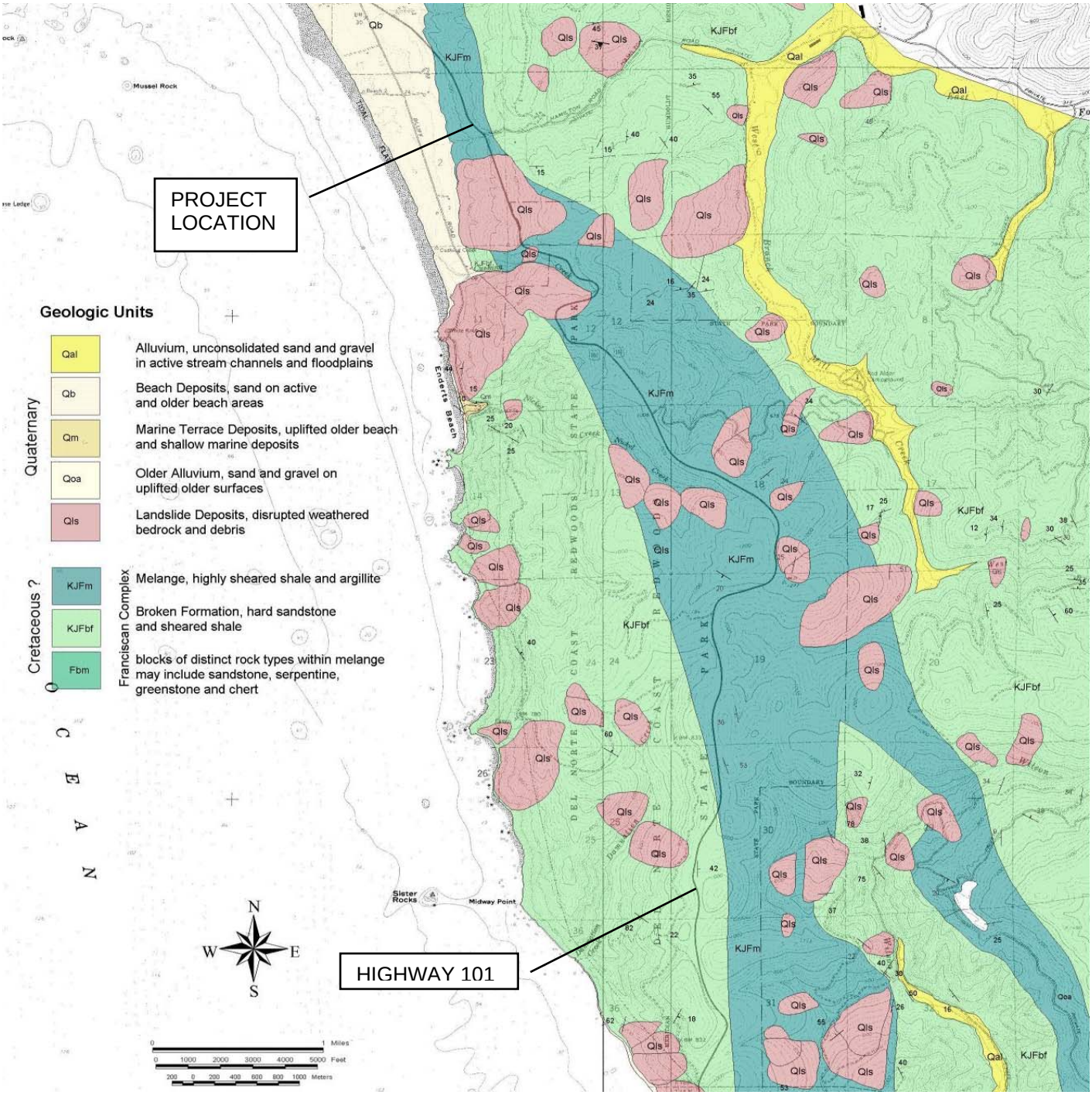
EFIS: 011200113

Date: JANUARY 2015

1984 AS-BUILTS

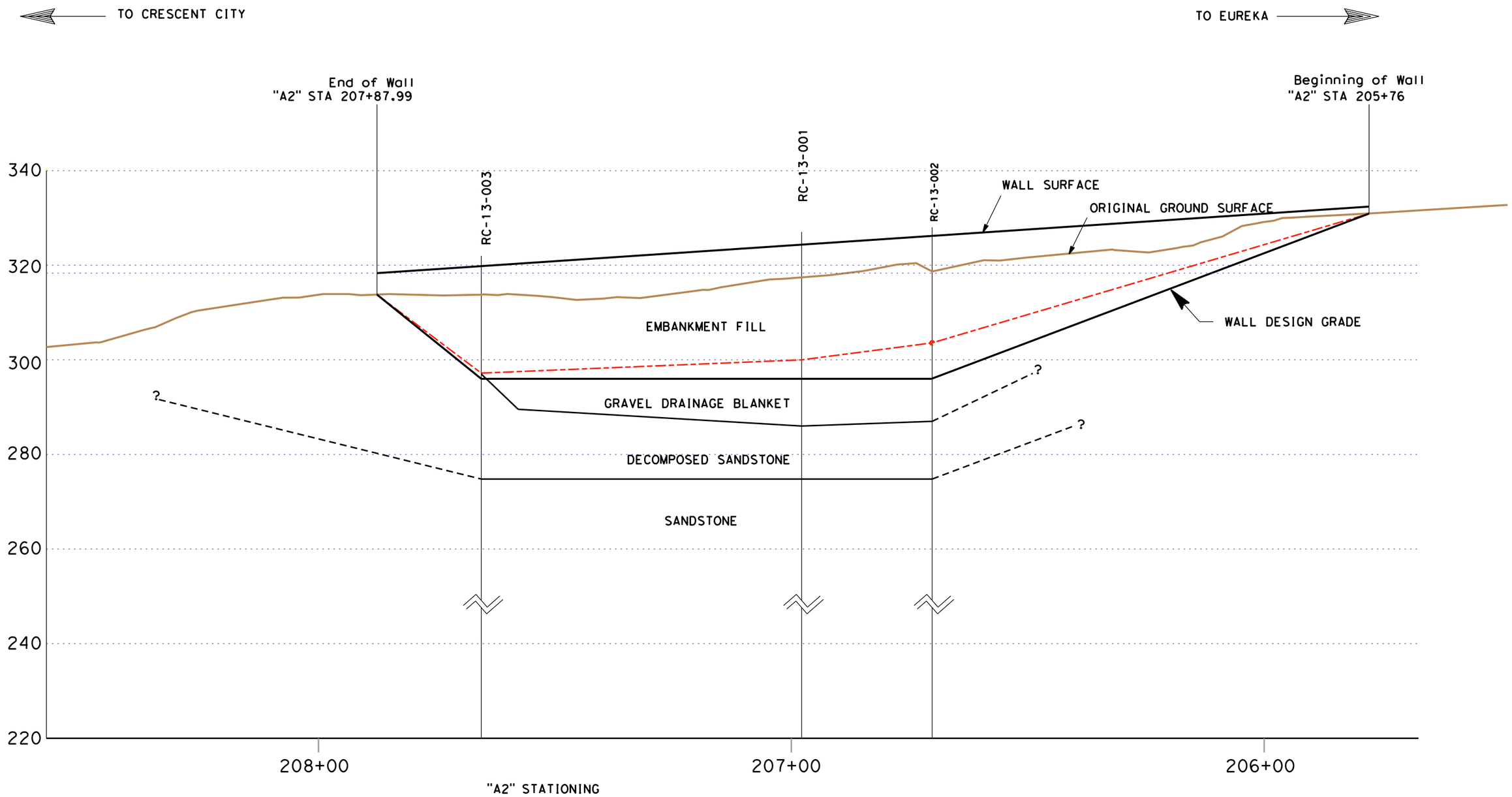
01-DN-101 PM 22.9
HAMILTON 2 SLIPS

Figure 3



Reference: Wills, C J., "Geology of the Highway 101 Corridor between Crescent City and Wilson Creek Del Norte County, California" 2000

Department of Transportation Division of Engineering Services Geotechnical Services Office of Geotechnical Design - North	EFIS: 011200113 Date: January 2015	**PROJECT GEOLOGIC MAP**
	01-DN-101 PM 22.9 HAMILTON 2 SLIPS	Figure 4



LEGEND

GEOLOGIC CONTACT, SOLID WHERE CERTAIN, DASHED WHERE APPROXIMATELY LOCATED AND QUERIED WHERE EXISTENCE IS UNCERTAIN

LANDSLIDE FAILURE SURFACE

Caltrans

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Geotechnical Services
Office of Geotechnical Design - North

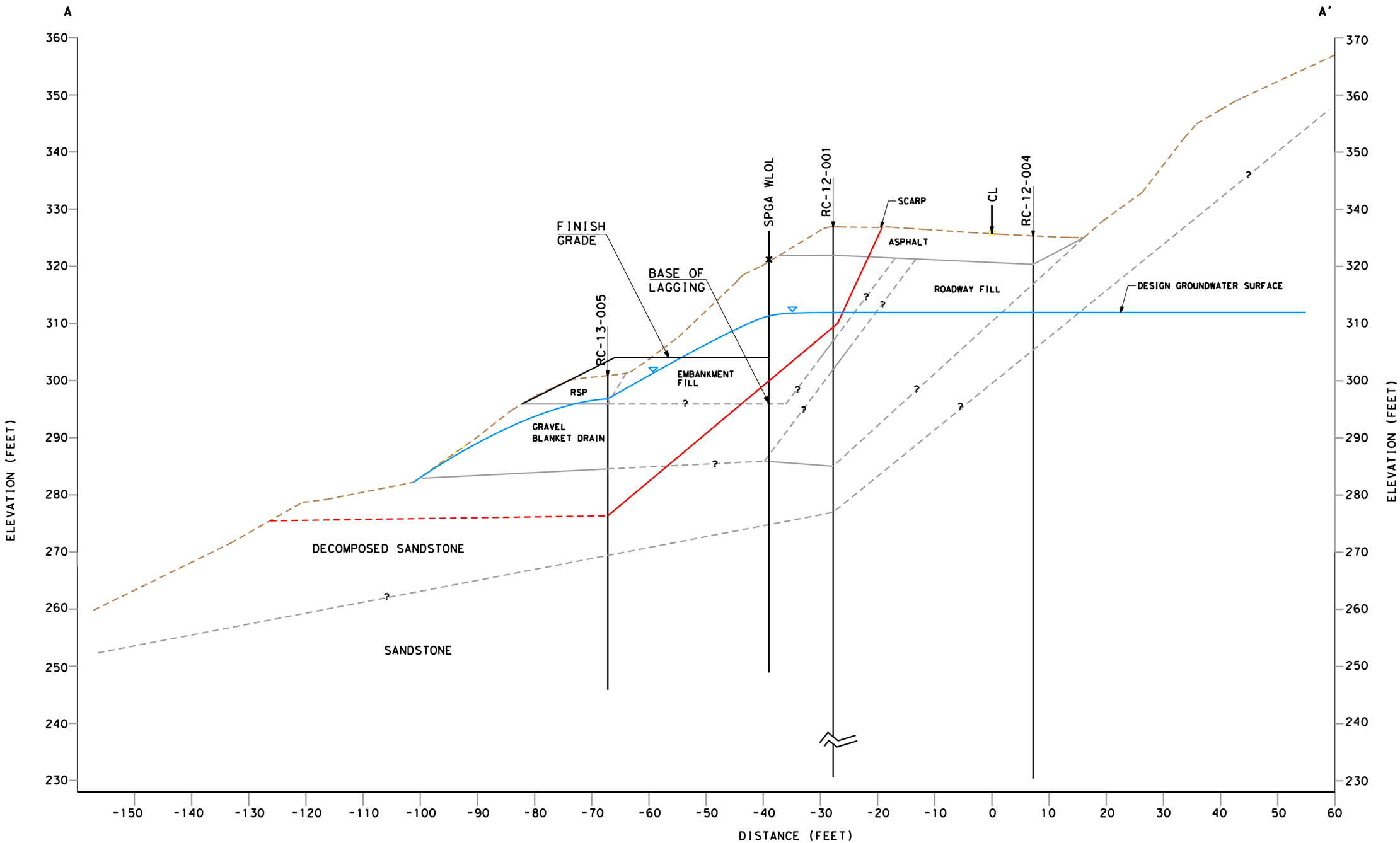
EFIS: 0112000113

DATE: JANUARY 2015

SUBSURFACE GEOLOGY
ALONG WALL LAYOUT LINE

01-DN-101 PM 22.9
HAMILTON 2 SLIPS

FIGURE 5



EXPLANATION

? GEOLOGIC CONTACT, SOLID WHERE CERTAIN, DASHED WHERE APPROXIMATELY LOCATED AND QUERIED WHERE EXISTENCE IS UNCERTAIN

? LANDSLIDE PLANE, SOLID WHERE CERTAIN, DASHED WHERE APPROXIMATELY LOCATED AND QUERIED WHERE EXISTENCE IS UNCERTAIN

Caltrans

Department of Transportation
Division of Engineering Services
Geotechnical Services
Office of Geotechnical Design - North

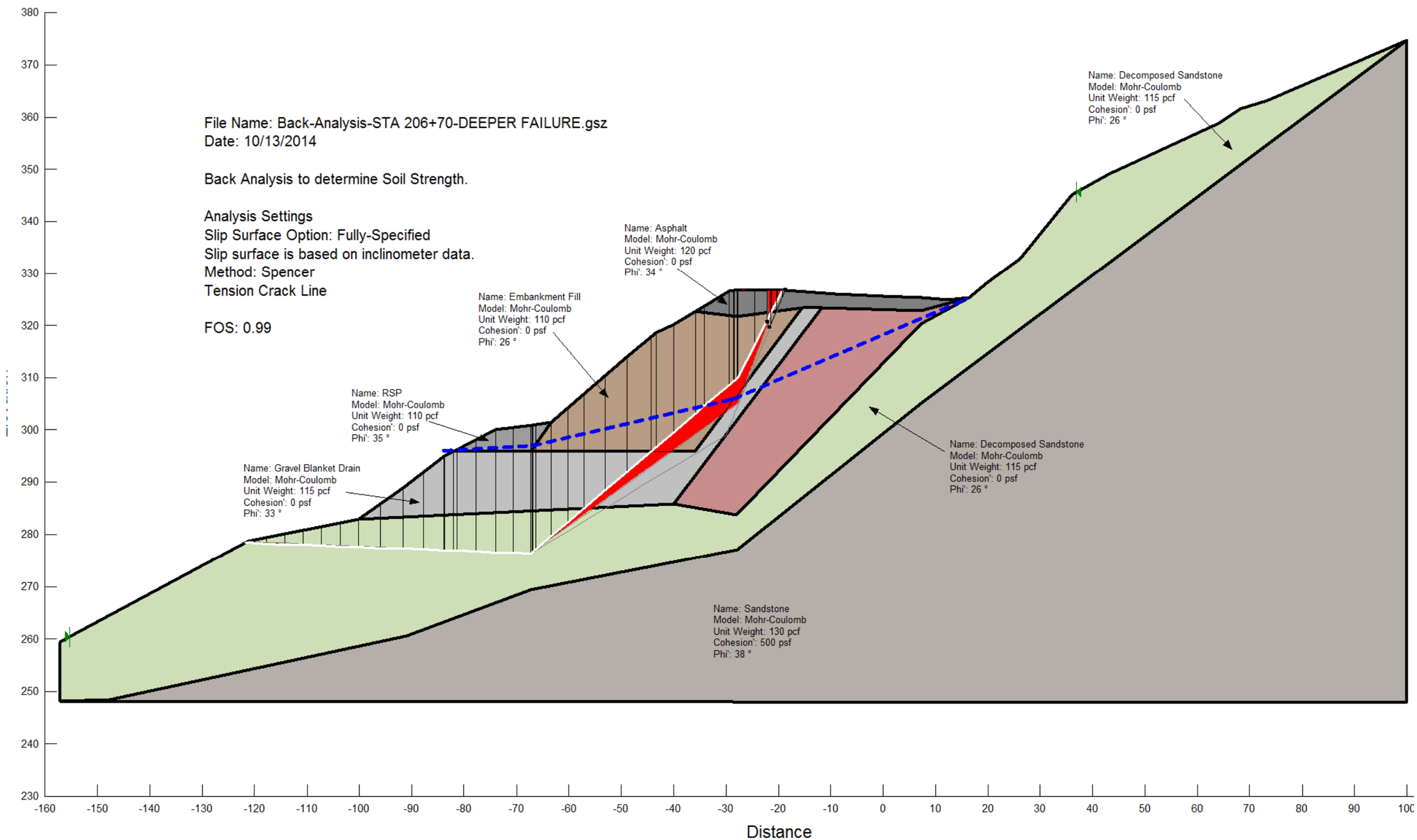
EFIS: 0112000113

DATE: JANUARY 2015

DESIGN CROSS SECTION A-A'
STA. 206+70

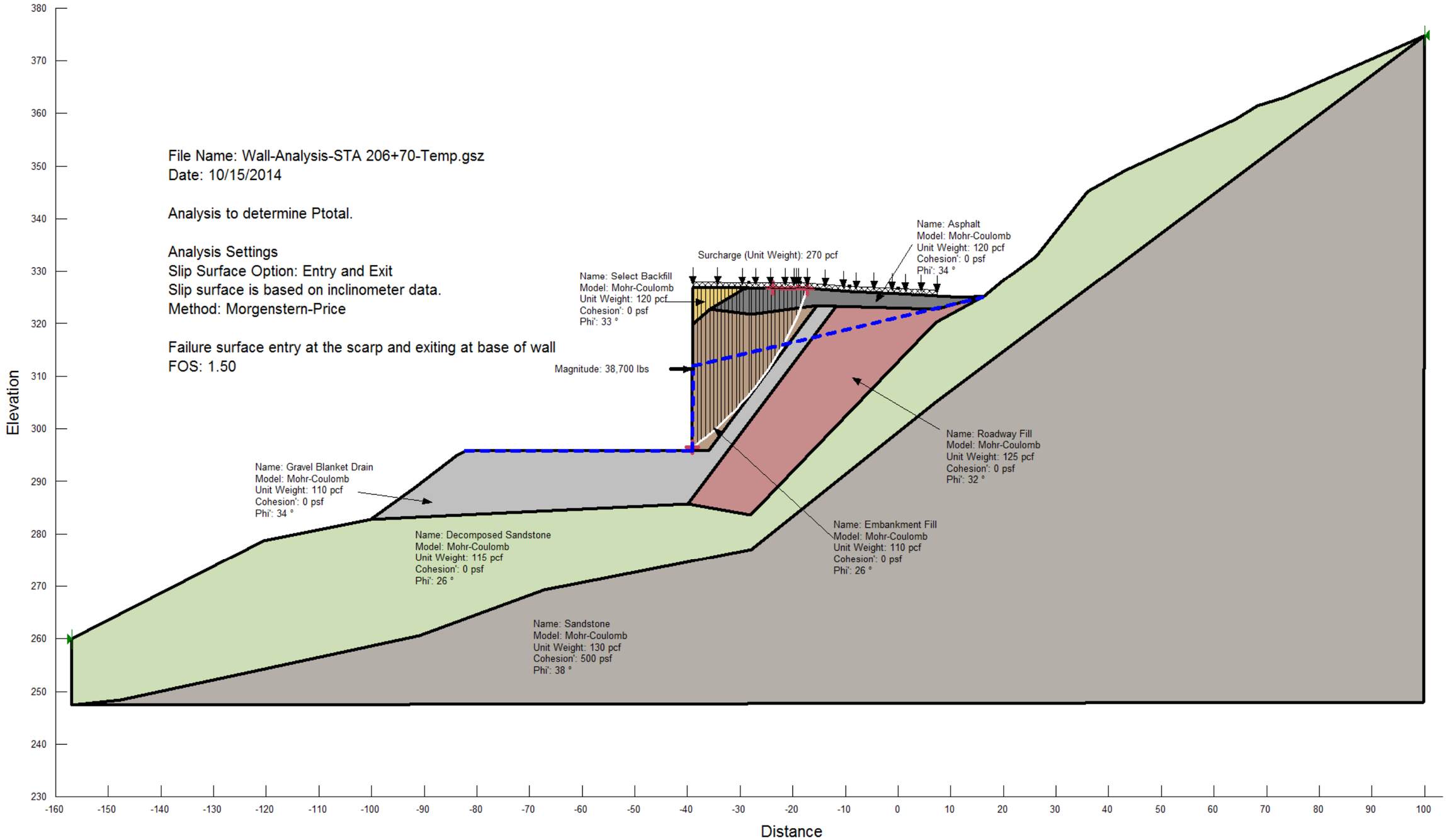
01-DN-101 PM-22.9
HAMILTON 2 SLIPS

FIGURE 6



Department of Transportation
Division of Engineering Services
Geotechnical Services
Office of Geotechnical Design - North

EFIS: 0112000113	STABILITY ANALYSIS FOR EXISTING CONDITIONS
Date: JANUARY 2015	
01-DN-101 PM 22.9 HAMILTON 2 SLIPS	Figure 7



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Geotechnical Services
Office of Geotechnical Design - North

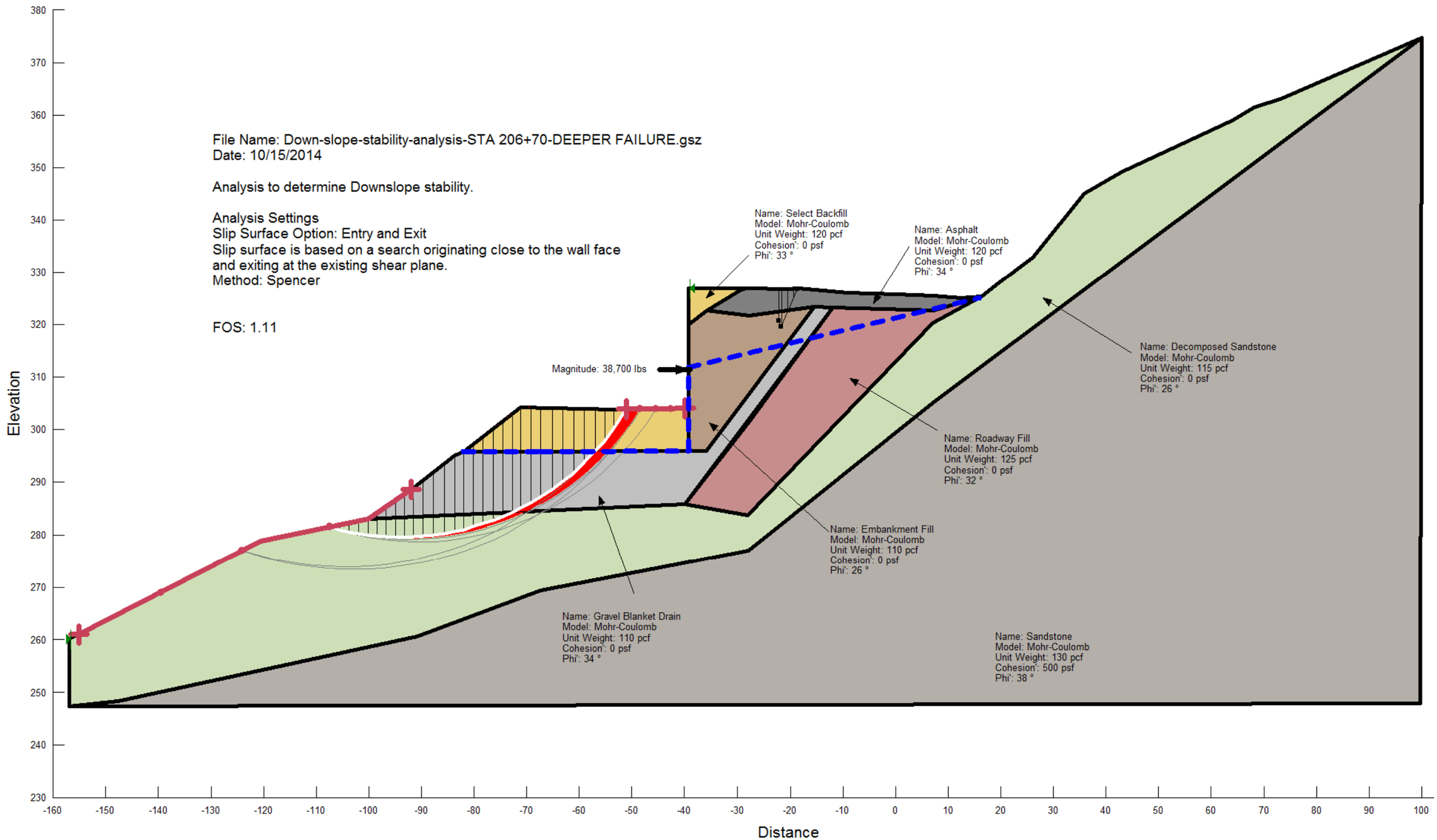
EFIS: 011000113

Date: JANUARY 2015

P_{TOTAL} STABILITY ANALYSIS

01-DN-101 PM 22.9
HAMILTON 2 SLIPS

Figure 8



Department of Transportation
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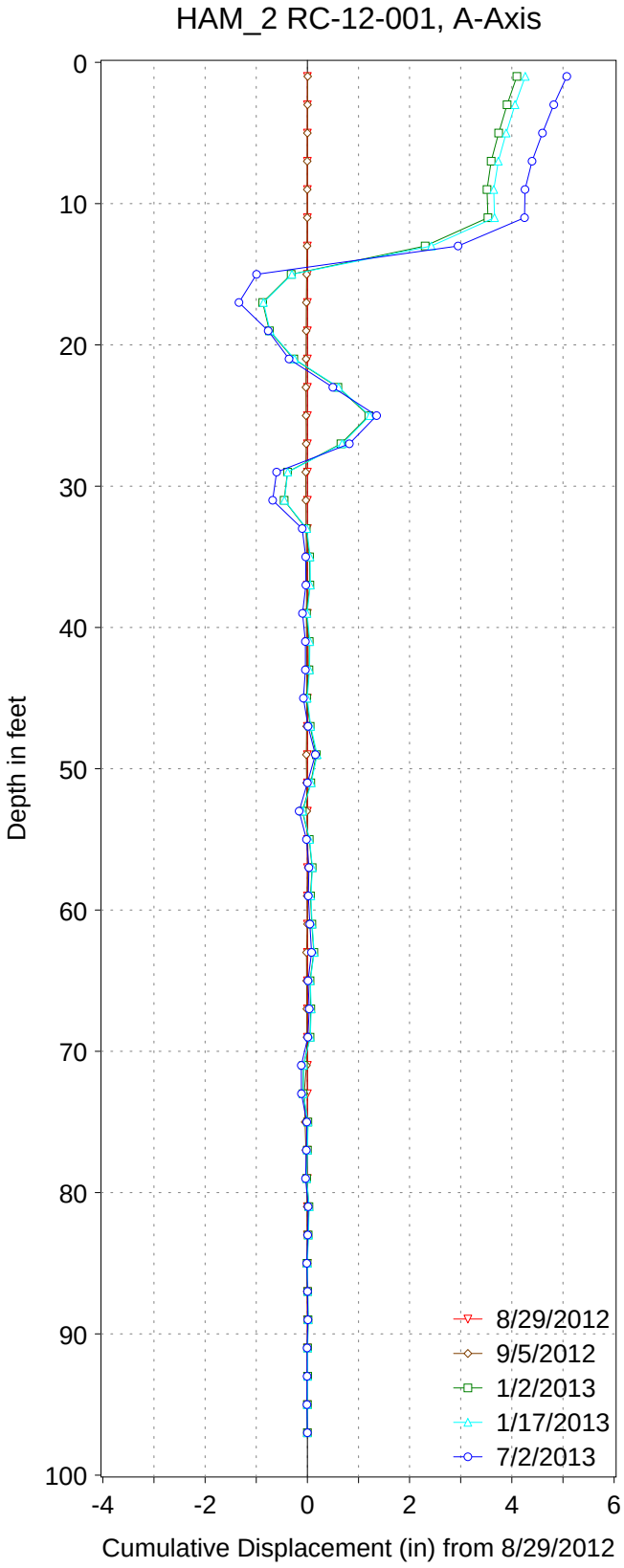
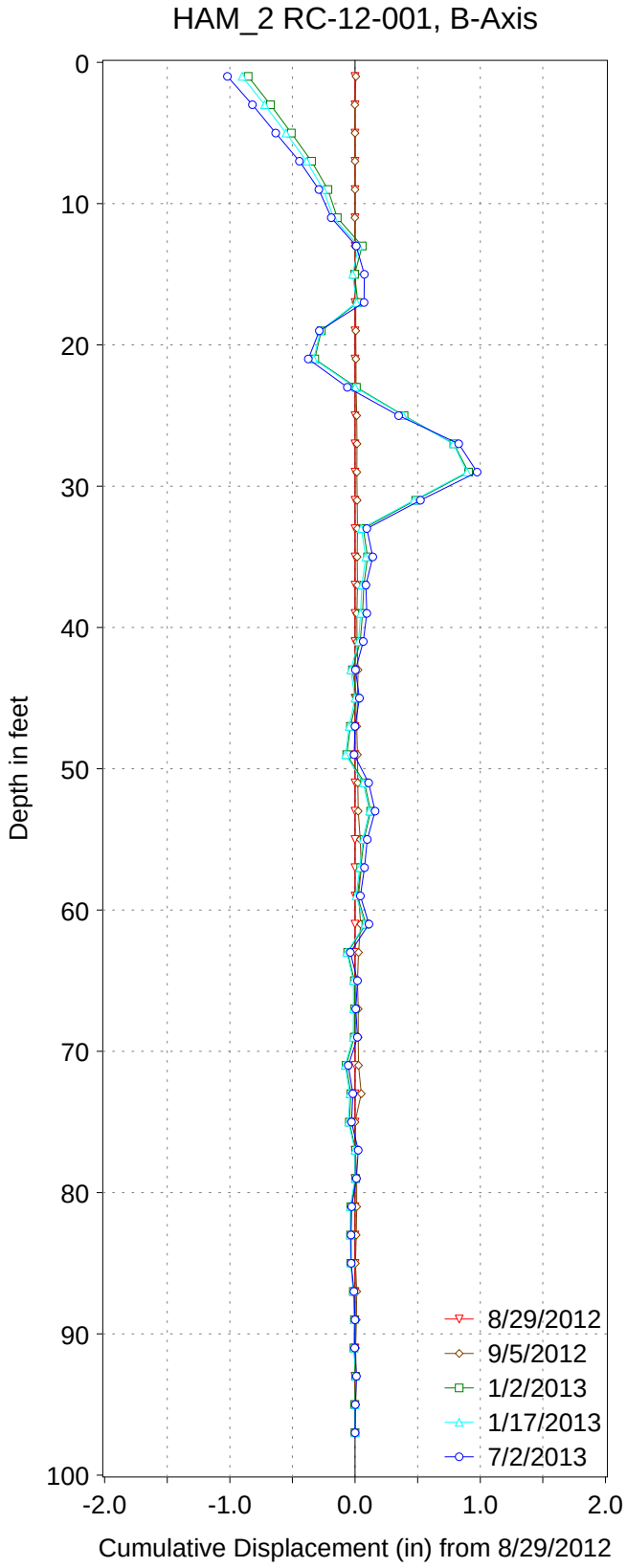
Geotechnical Services
Office of Geotechnical Design - North

EFIS: 011000113	**DOWNSLOPE STABILITY ANALYSIS**
Date: JANUARY 2015	
01-DN-101 PM 22.9 **HAMILTON 2 SLIPS**	**Figure 9**

APPENDIX A

SLOPE INCLINOMETER DATA





RESULT OF SI MONITORING

01-DN-101-PM22.9

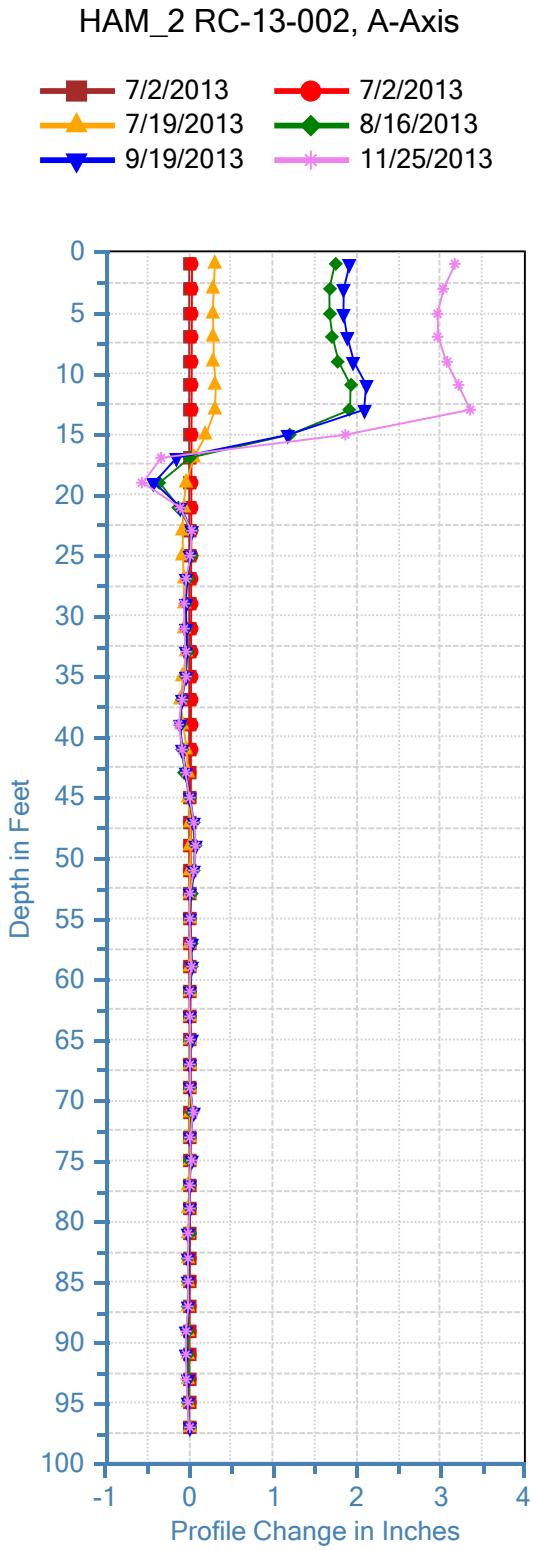
Site: Ham-2 RC-12-001

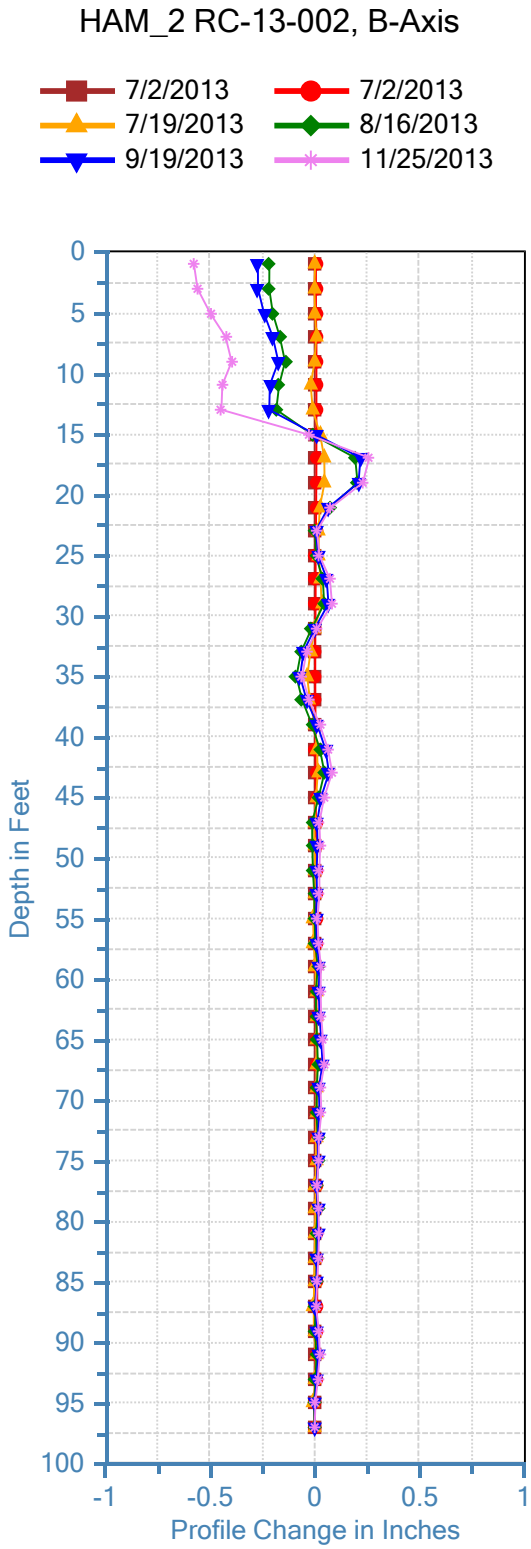
E.A.: 0112000113/230

Depth of Casing: 99.5 ft

A0 Direction:

Location:

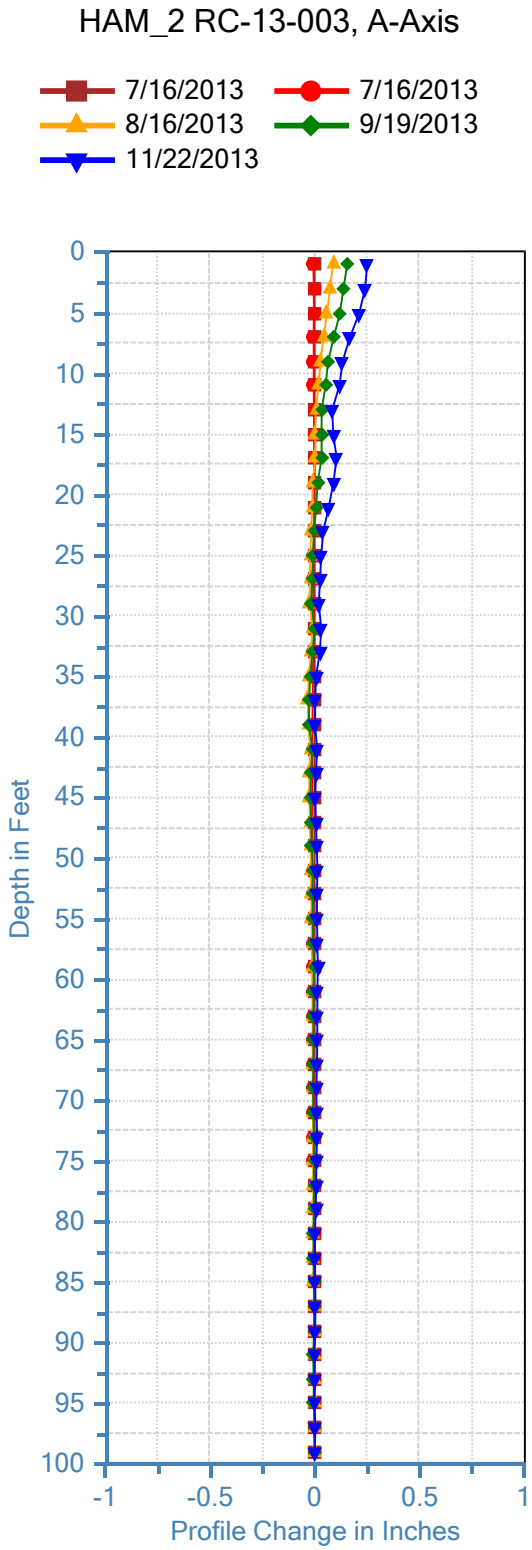


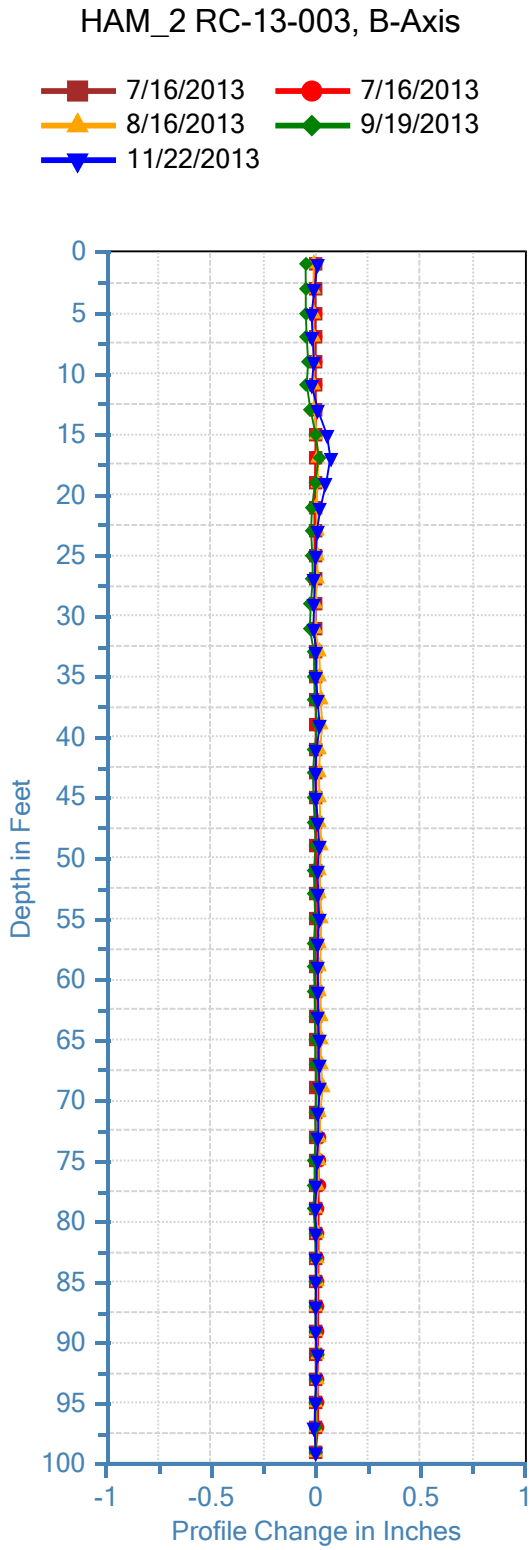


RESULT OF SI MONITORING

01-DN-101-PM22.9
Site: Ham-2 RC-13-002
E.A.: 0112000113/230

Depth of Casing:
A0 Direction (magnetic north): 242 deg
Location: N41°43'32.5",W124°08'29.8"



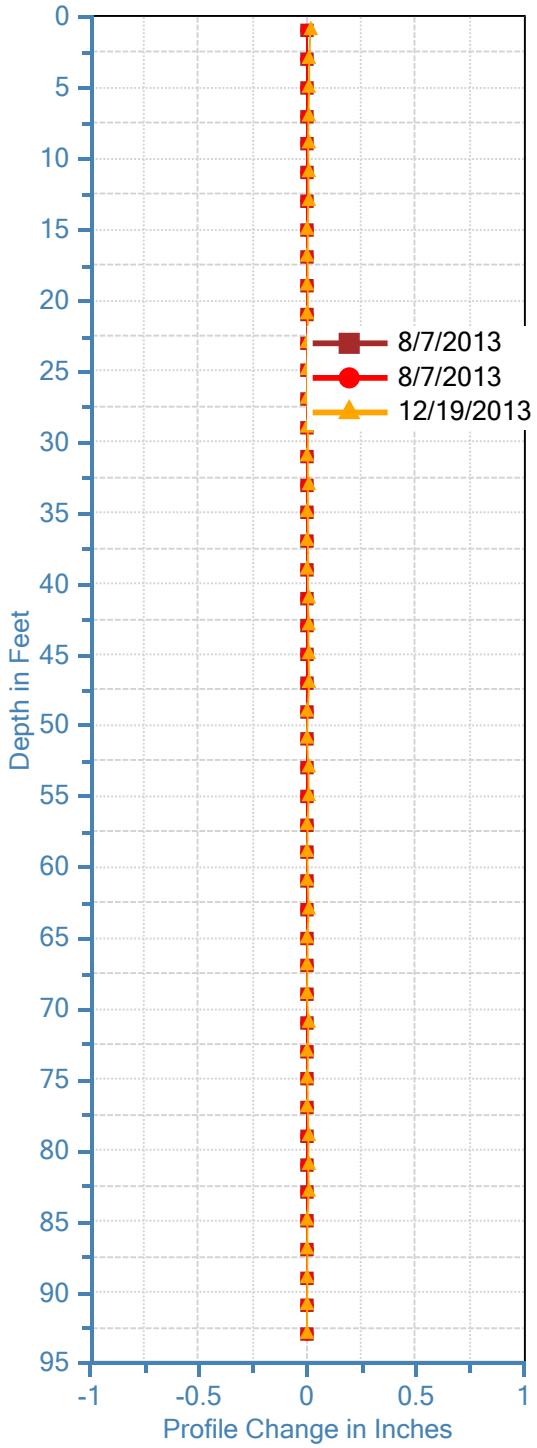


RESULT OF SI MONITORING

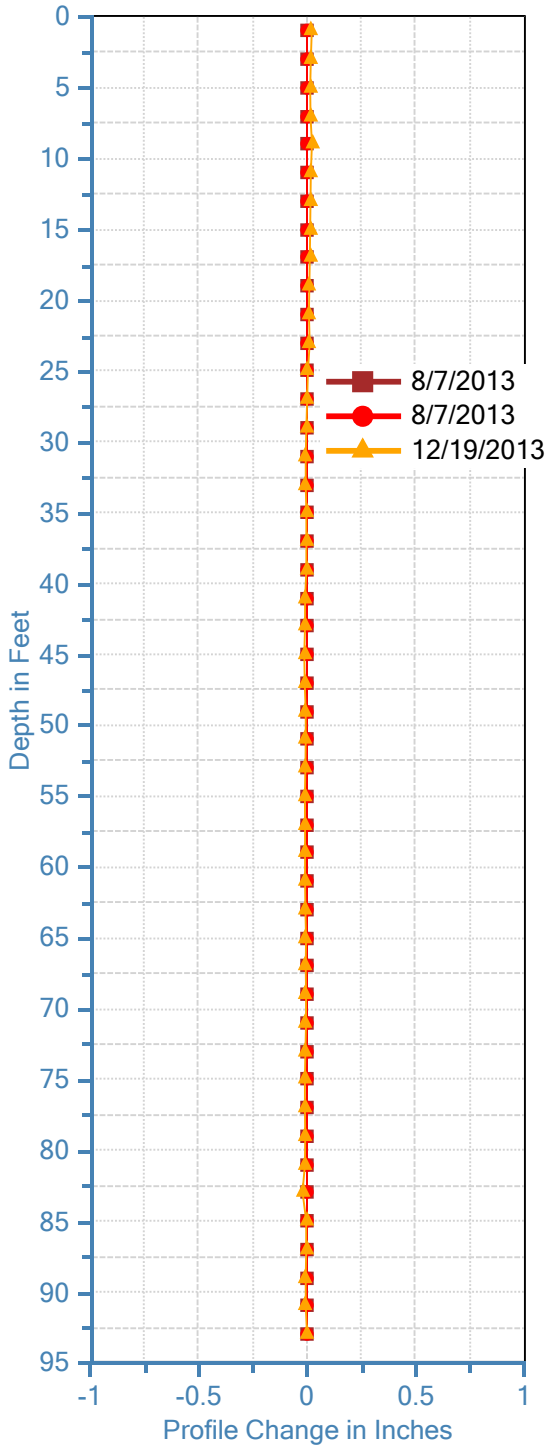
01-DN-101-PM22.9
Site: Ham-2 RC-13-003
E.A.: 0112000113/230

Depth of Casing: 102 ft
A0 Direction (magnetic north): 214 deg
Location: N41°43'33.0",W124°08'30.0"

HAM_2 RC-13-004, A-Axis



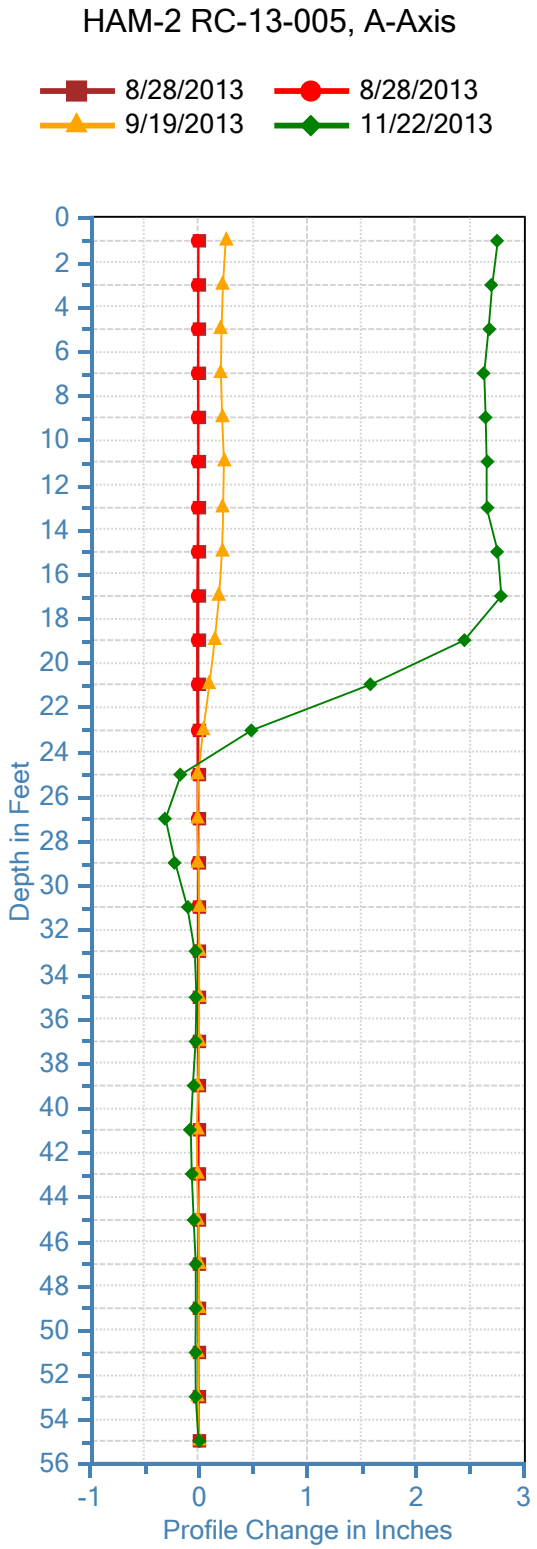
HAM_2 RC-13-004, B-Axis

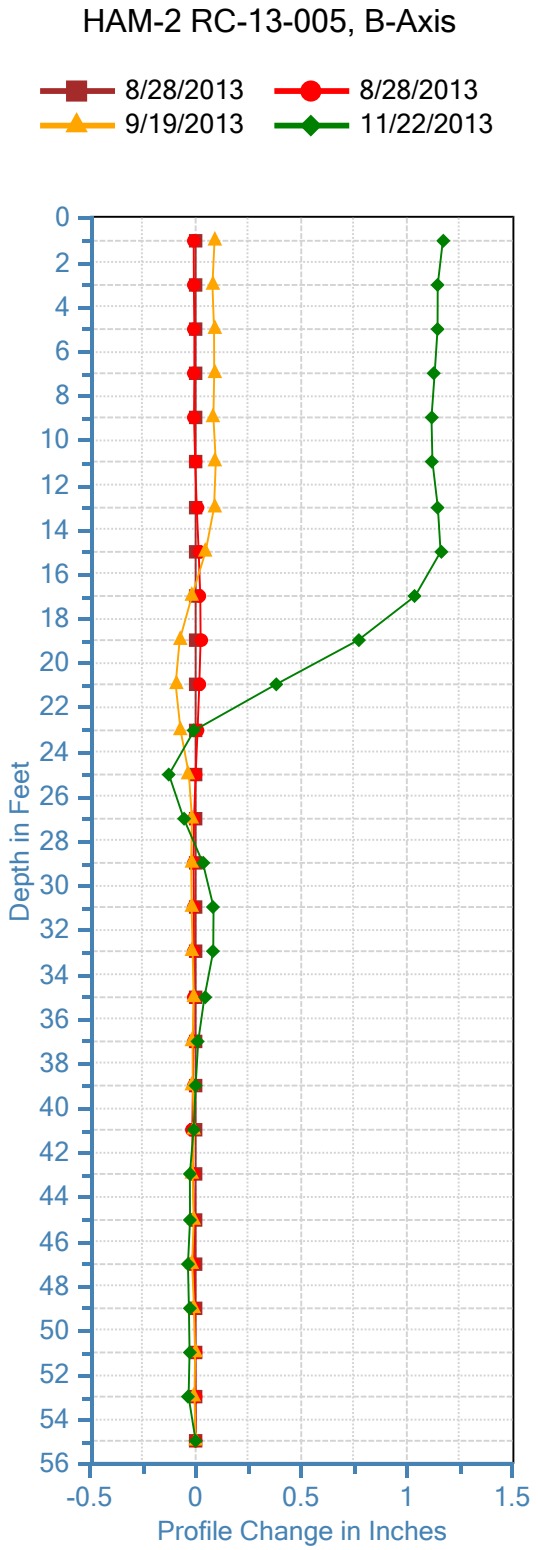


RESULT OF SI MONITORING

01-DN-101-PM22.9
Site: Ham-2 RC-13-004
E.A.: 0112000113/230

Depth of Casing: 95 ft
A0 Direction (magnetic north): 242 deg
Location: N41°43'32.7",W124°08'29.4"





RESULT OF SI MONITORING

01-DN-101-PM22.9
Site: Ham-2 RC-13-005
E.A.: 0112000113/230

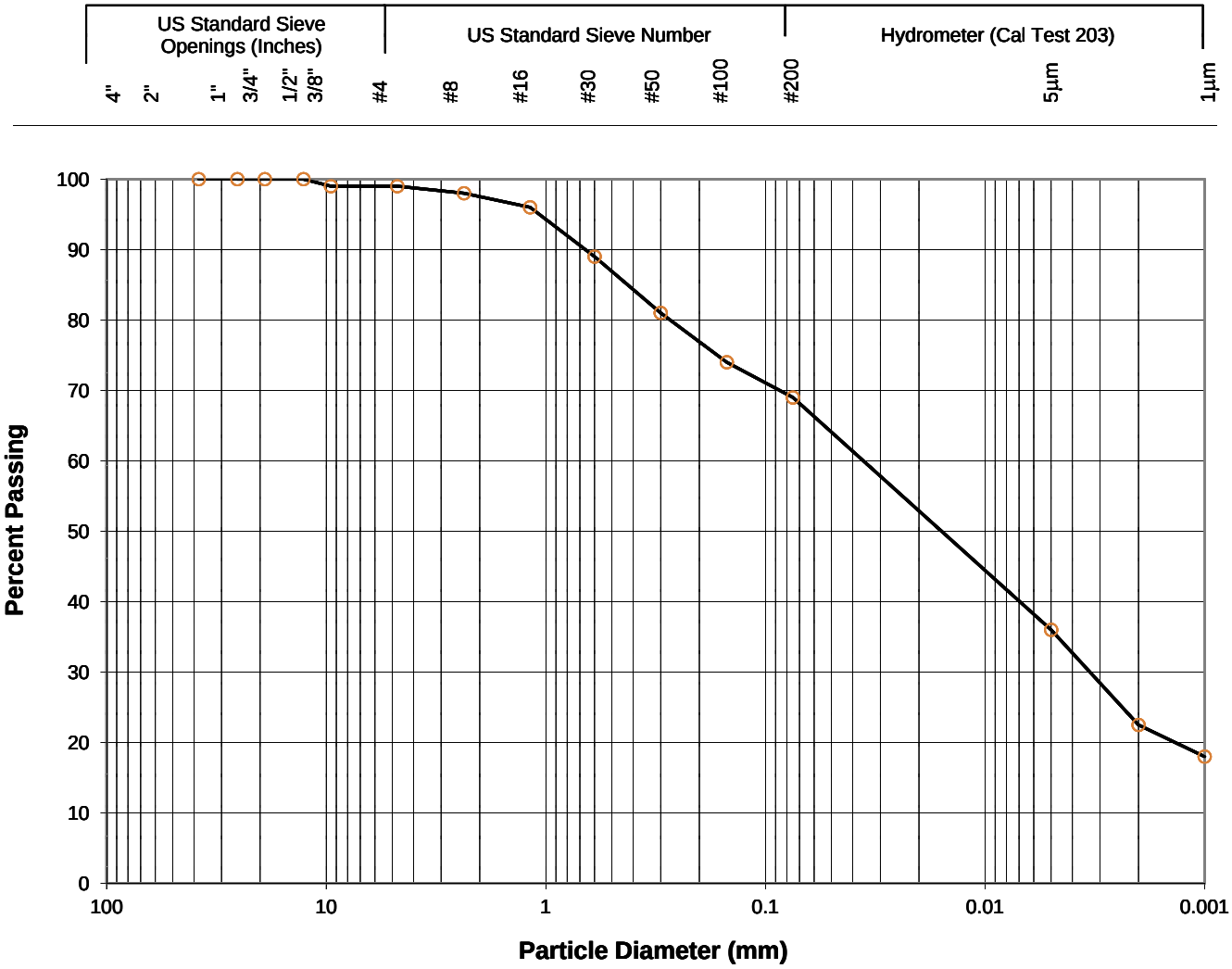
Depth of Casing: 57.8 ft
A0 Direction (magnetic north): 226 deg.
Location: N41°43'32.4",W124°08'30.7"

APPENDIX B

LABORATORY DATA

SUMMARY OF PARTICLE ANALYSIS AND ATTERBERG LIMIT TESTS						
Boring ID	Depth (ft, bgs)	USCS	Description	ASTM Atterberg Limits		
				LL	PL	PI
RC-12-001	25.5 - 26.5	SM	SILTY SAND with GRAVEL	27	24	3
RC-13-002	20 - 25	SC	CLAYEY SAND with GRAVEL	28	10	18
RC-13-002	55 - 60	SC	CLAYEY SAND with GRAVEL	24	13	11
RC-12-001	43-45	SC	CLAYEY SAND	26	16	10
RC-12-001	34-36	CL	SANDY Lean CLAY	30	16	14

Gradation Analysis Test Results



GRAVELS		SANDS			SILT	CLAY
Coarse	Fine	Coarse	Medium	Fine		

Sample ID: RC-12-001 25.5'-26.5'

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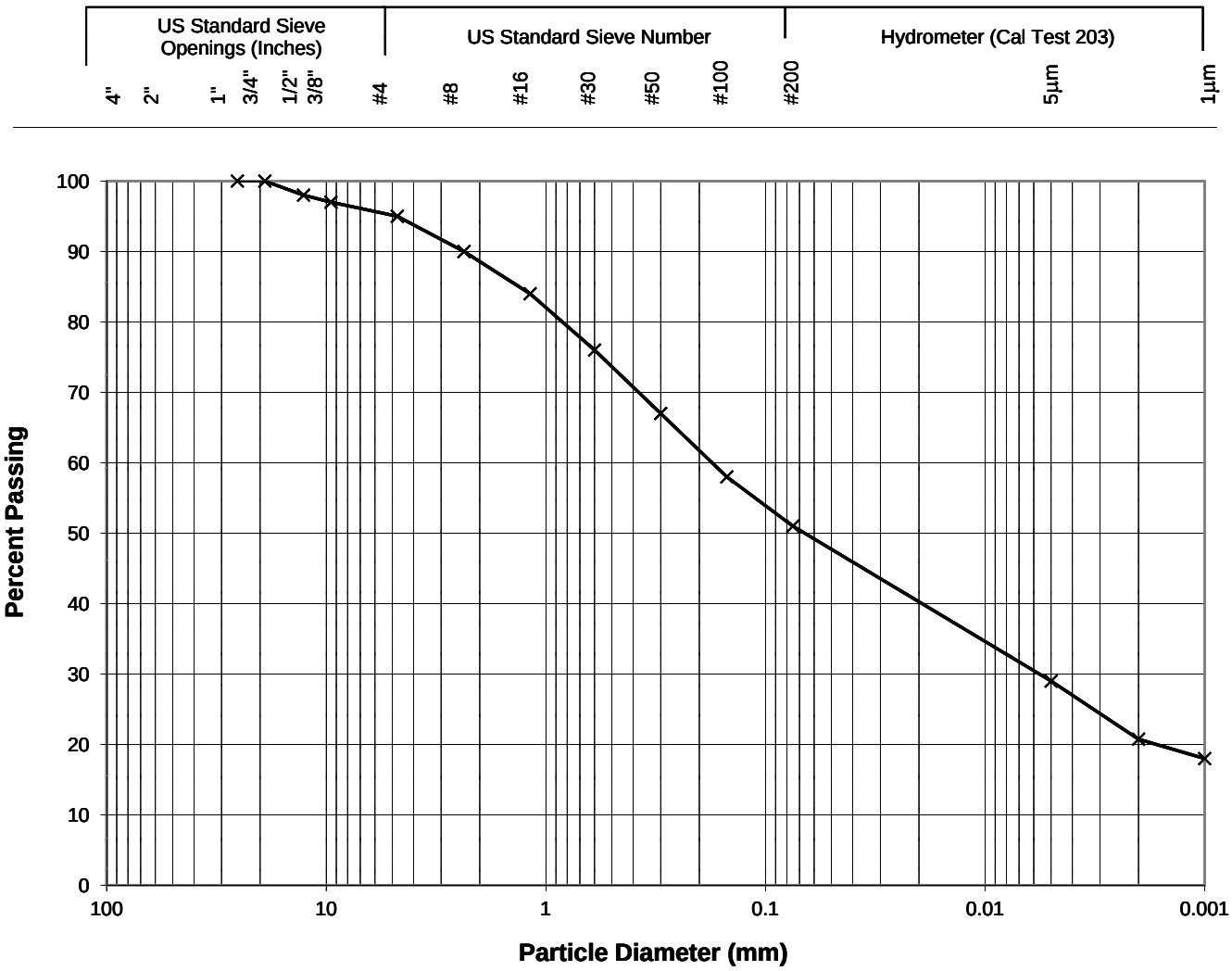
Project: Hamilton 2

EA: 112000113

D.-Co.-Rt.-: 01-DN-101-PM 22.9

2/5/2013

Gradation Analysis Test Results



GRAVELS		SANDS			SILT	CLAY
Coarse	Fine	Coarse	Medium	Fine		

Sample ID: RC-12-001 34'-36'

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Geotechnical Services
Office of Geotechnical Engineering North - Branch B

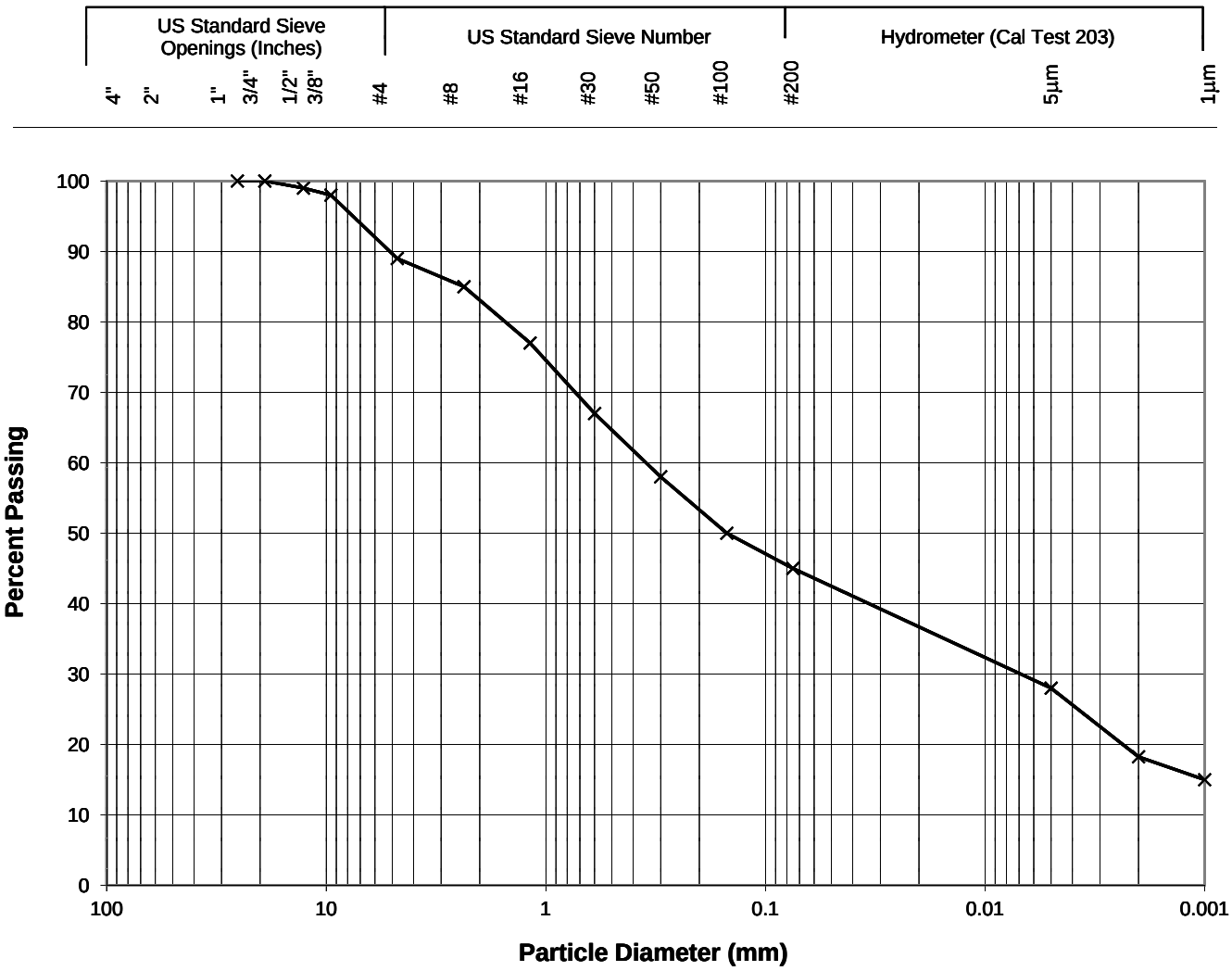
Project: Hamilton 2

EA: 112000113

D.-Co.-Rt.-: 01-DN-101-PM 22.9

2/5/2013

Gradation Analysis Test Results



GRAVELS		SANDS			SILT	CLAY
Coarse	Fine	Coarse	Medium	Fine		

Sample ID: RC-12-001 43'-45'

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Geotechnical Services
Office of Geotechnical Engineering North - Branch B

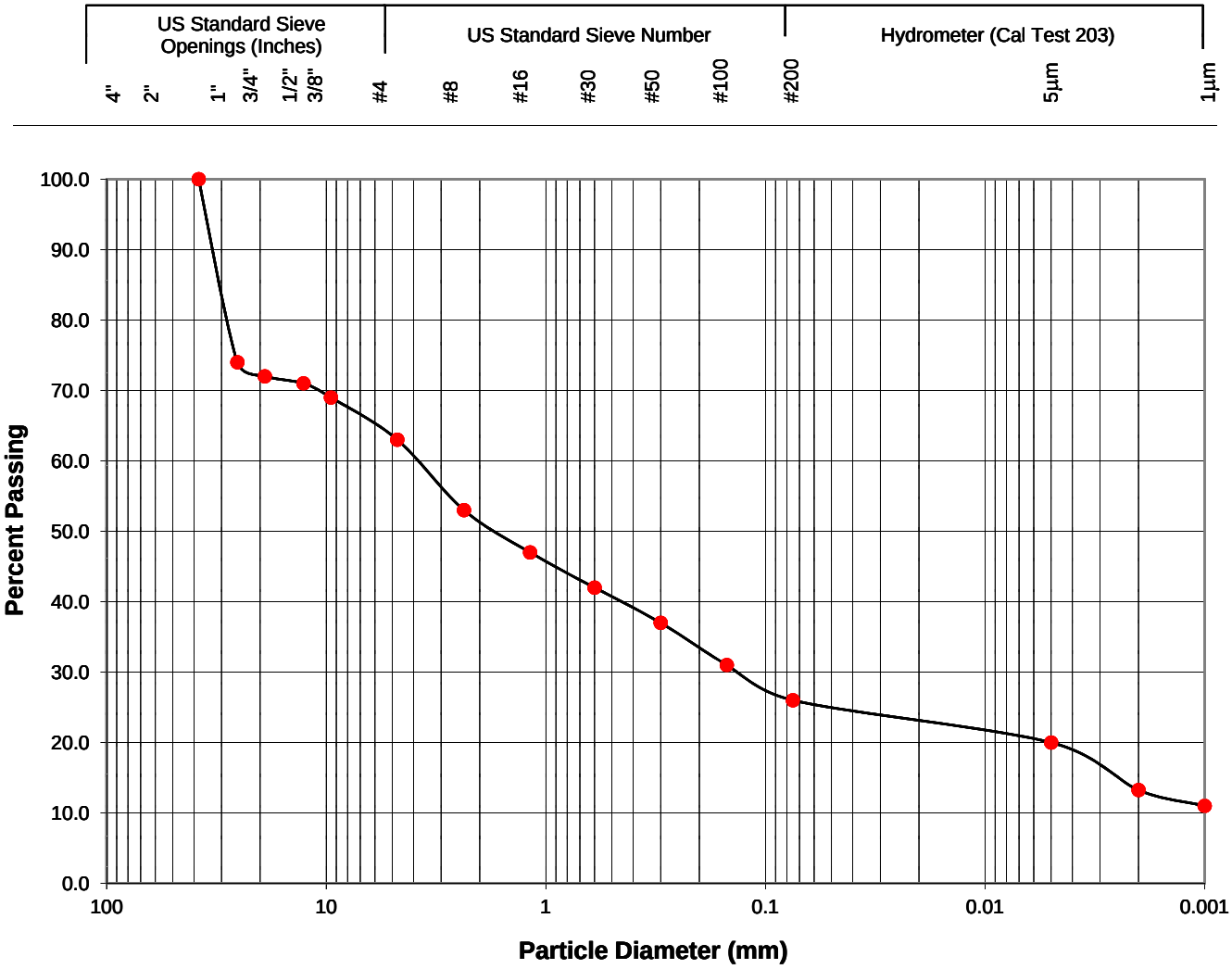
Project: Hamilton 2

EA: 112000113

D.-Co.-Rt.-: 01-DN-101-PM 22.9

2/5/2013

Gradation Analysis Test Results



GRAVELS		SANDS			SILT	CLAY
Coarse	Fine	Coarse	Medium	Fine		

Sample ID: RC-13-002 20'-25'

CALTRANS
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Geotechnical Services
Office of Geotechnical Engineering North - Branch B

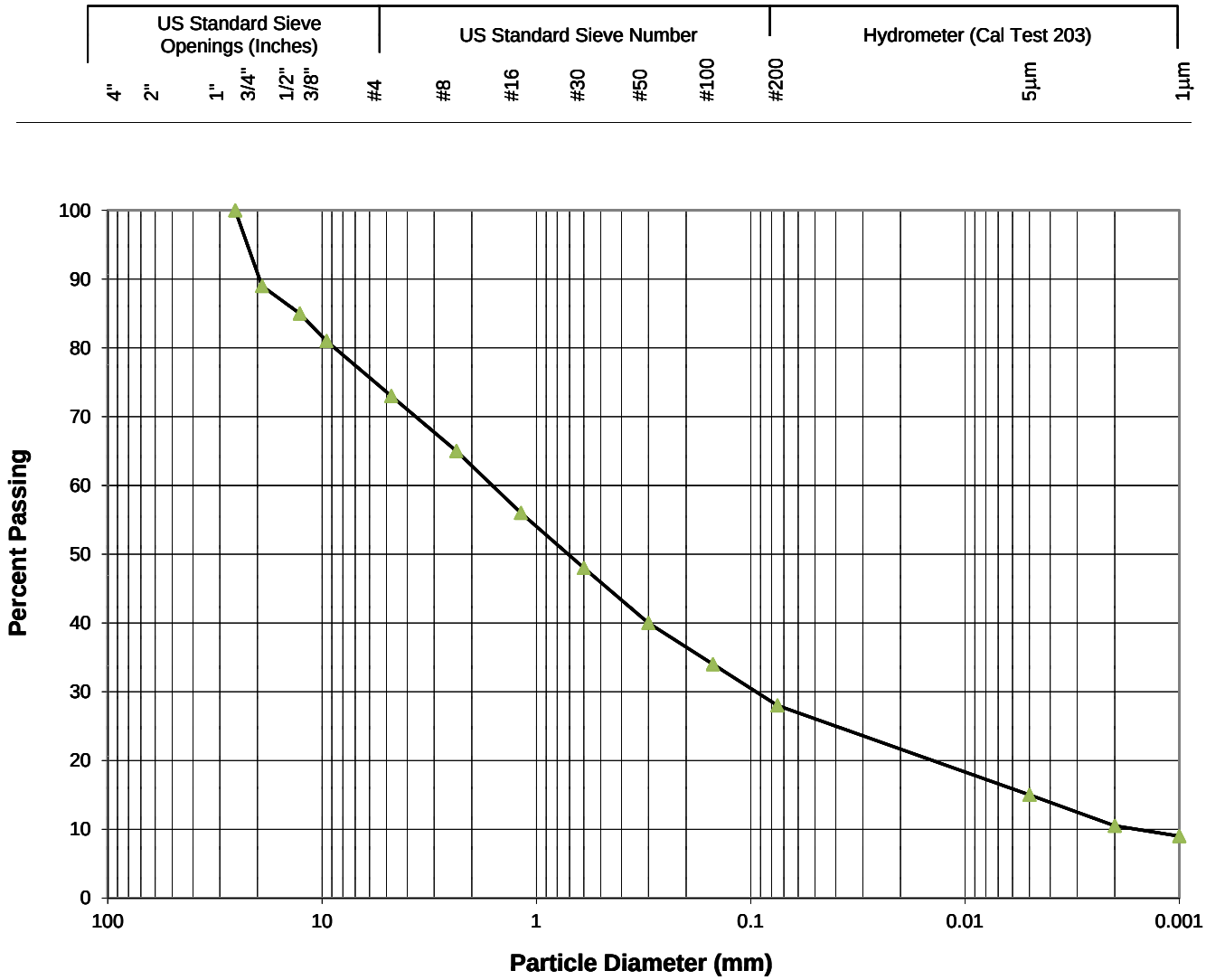
Project: Hamilton 2

EA: 112000113

D.-Co.-Rt.-: 01-DN-101-PM 22.9

8/27/2013

Gradation Analysis Test Results



GRAVELS		SANDS			SILT	CLAY
Coarse	Fine	Coarse	Medium	Fine		

Sample ID: RC-13-002 55'-60'

CALTRANS
Division of Engineering Services
Geotechnical Services
Office of Geotechnical Engineering North - Branch B

Project: Hamilton 2

EA: 112000113

D.-Co.-Rt.-: 01-DN-101-PM 22.9

8/27/2013

APPENDIX C

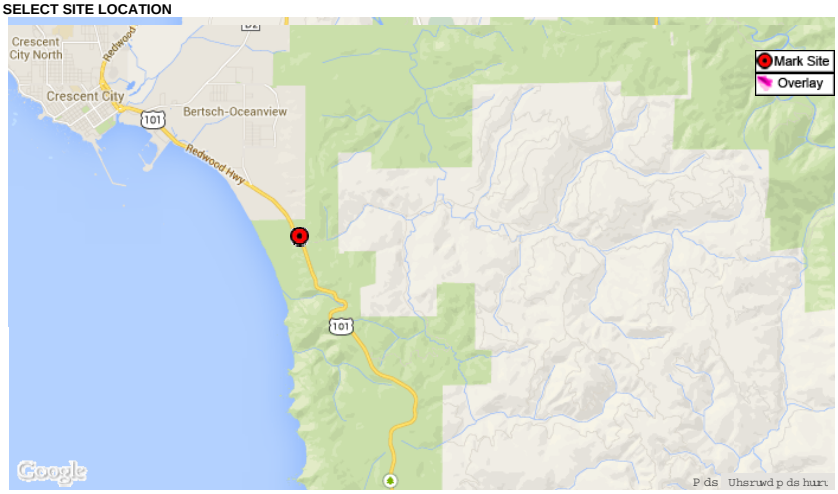
SEISMIC DATA

CALIFORNIA DEPARTMENT OF
TRANSPORTATION

Caltrans ARS Online (v2.3.06)

This web-based tool calculates both deterministic and probabilistic acceleration response spectra for any location in California based on criteria provided in *Appendix B of Caltrans Seismic Design Criteria*. More...

SELECT SITE LOCATION

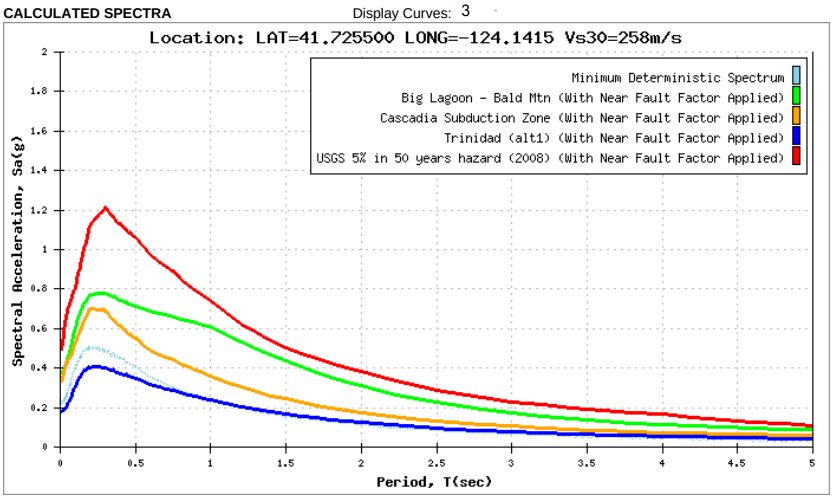


Reference Vs30 Values(From NEHRP):

B=760m/s
C=560m/s
D=270m/s

Latitude: 41.7255 **Longitude:** -124.1415 ***Vs30:*** 258 m/s Calculate

CALCULATED SPECTRA Display Curves: 3



Tabular Data Envelope Only Hide Near Fault Axis Scale Show Basin

Apply Near Fault Adjustment To:
NOTE: Caltrans SDC requires application of a Near Fault Adjustment factor for sites less than 25 km (Rrup) from the causative fault.

☑ Deterministic Spectrum Using

14.03 Km Big Lagoon - Bald Mtn
36.13 Km Cascadia Subduction Zone
29.33 Km Trinidad (alt1)

☑ Probabilistic Spectrum Using

14.03 Km (Recommend Performing Deaggregation To Verify)

◉ Show Spectrum with Adjustment Only
○ Show Spectrum with and without near fault Adjustment

OK

State of California Business, Transportation and Housing Agency

DEPARMENT OF TRANSPORTATION

M e m o r a n d u m

Serious drought.
Help Save Water!

Date: January 8, 2016

To: GARY BLAKESLEY

Division of Structure Design
Office of Bridge Design South
Branch 6

File: 01-DN-101-PM 22.9
EFIS ID: 0112000113
Hamilton 2 Slips
Bridge No:01E0015

Attn: SEIJI MORIMOTO

From: DEPARTMENT OF TRANSPORTATION
DIVISION OF ENGINEERING SERVICES
GEOTECHNICAL SERVICES – OGDW

Subject: Addendum for the Foundation Report for the Soldier Pile Ground Anchor Wall at DN 101 PM 22.9

This memorandum was prepared in response to a request from Design Branch 06 to update the Final Foundation Report for the Soldier Pile Ground Anchor Wall at DN 101 PM 22.9, dated January 21, 2015.

The information provided in this memorandum supersedes the information provided in the Final Foundation report in Table 1, and portions of Sections 8.1, 8.4 and 8.8.

Table 1 – Description of the Proposed SPGA Wall is modified as follows:

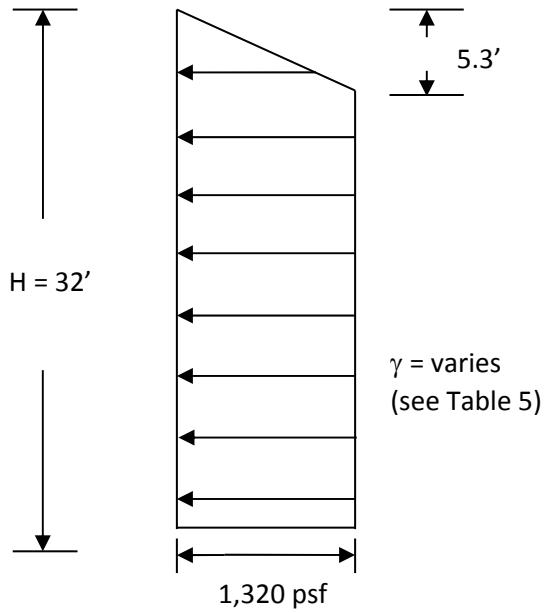
BEGIN			END			LENGTH (ft)	DESIGN HEIGHT (ft)	
Sta.	Latitude	Longitude	Sta.	Latitude	Longitude		Min.	Max.
205+76	41°43'31.8594"	-124°08'29.5662"	207+87.99	41°43'33.8032"	-124°08'30.5342"	212	0	32

Section 8.1 Wall Location and Height

The proposed wall is approximately 212 feet in length with a maximum height of 32 feet. There are three levels of ground anchors.

Section 8.4 Lateral Earth Pressures

The following active lateral earth pressure distribution diagram was developed based on a soldier pile wall with a wall height of 32 feet and multiple rows of ground anchors.



Recommended Lateral Earth Pressure Distribution

Factored into the wall height are the projected actual slide surface, the failed stabilization trench materials and a traffic surcharge of 270 pounds per square foot (psf). It was determined that the wall should retain the entire embankment fill. The lagging should extend a minimum of two feet below the lowest tie-back level.

Section 8.8 Earth Work and Wall Backfill Recommendations

A 6-inch perforated plastic pipe should be placed 6 inches above the base of the permeable material and connected to a 6 inch solid plastic pipe.

If you have any questions or require additional information, please contact June James at (707) 441-4692 or Charlie Narwold at (707) 445-6036.

JUNE JAMES
Transportation Engineer
Office of Geotechnical Design West
Branch F

CHARLIE NARWOLD
Senior Engineering Geologist
Office of Geotechnical Design West
Branch F

C: Tim Pokrywka – GS