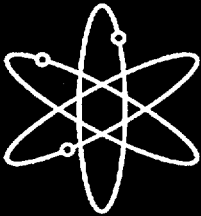
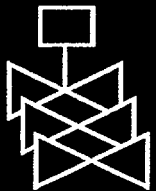


Environmental Assessment

San Bernardino National Wildlife Refuge Well 10



Oak Ridge National Laboratory



U.S. Nuclear Regulatory Commission
Office of Nuclear Material Safety and Safeguards
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Environmental Assessment

San Bernardino National Wildlife Refuge Well 10

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ABSTRACT

The U.S. Geological Survey (USGS), at the request of the U.S. Fish and Wildlife Service, evaluated the water production capacity of an artesian well in the San Bernardino National Wildlife Refuge, Arizona. Water from the well initially flows into a pond containing three federally threatened or endangered fish species, and water from this pond feeds an adjacent pond/wetland containing an endangered plant species. USGS received a source license from the U.S. Nuclear Regulatory Commission (NRC) for the radioactive ($^{241}\text{Am-Be}$) source used in a neutron emission/detection tool commonly used in well loggings of this type. The source was inadvertently lost in the well in 1986; and after several unsuccessful attempts to retrieve the source, the USGS has requested that the Am-Be source license be terminated and has attempted to seal the source in place with cement as required by NRC license termination regulations. Because of uncertainties related to the condition of the stainless steel source container, the effectiveness of a cement plug already installed, and concerns about the potential for future contamination, NRC decided to prepare this environmental assessment to analyze the potential water quality, ecological, and human health impacts of three alternatives for final disposition of the Am-Be source: (1) the proposed action, abandonment in place; (2) Am-Be source retrieval; and (3) the no-action alternative. The assessment found that the proposed action would result in no significant water quality or human health impacts and would produce only temporary and minor ecological impacts associated with emplacement of the cement plug. The source retrieval alternative—under a worst case scenario—could result in adverse impacts (radiation) on the three fish species of concern. The no-action alternative would be unlikely to produce significant adverse impacts but would require continued monitoring to ensure that unexpected contaminant concentrations do not occur in water or pond sediment.

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ACRONYMS AND ABBREVIATIONS

Am	americium
Be	beryllium
Bq	becquerel (1 nuclear disintegration per second; 1 Ci = 3.7×10^{10} Bq)
CFR	<i>Code of Federal Regulations</i>
Ci	curie
cm	centimeter
d	day
DOE	U.S. Department of Energy
EA	environmental assessment
EPA	U.S. Environmental Protection Agency
°F	degrees Fahrenheit
ft	foot
FWS	U.S. Fish and Wildlife Service
g	gram
gal	gallon
gpm	gallons per minute
h	hour
ha	hectare
in.	inch
k_d	sorption distribution coefficient
kg	kilogram
km	kilometer
L	liter
Lpm	liters per minute
M	mole
m	meter
m^3	cubic meter
MeV	mega electron-volt
mGy	milligray (used in measurements of absorbed dose of ionizing radiation)
mil	one-thousandth of an inch, or 0.0254 mm
mm	millimeter
mrem	millirem (used in measurements of ionizing radiation received)
Np	neptunium
NRC	U.S. Nuclear Regulatory Commission
ORISE	Oak Ridge Institute for Science and Education
ORNL	Oak Ridge National Laboratory
pCi	picocurie
rad	a unit used in measuring absorbed doses of ionizing radiation (1 rad = 0.01 Gy)
s	second
SBNWR	San Bernardino National Wildlife Refuge
USGS	U.S. Geological Survey
y	year
yd ³	cubic yard

SUMMARY

The U.S. Geological Survey (USGS) currently holds a license issued by the U.S. Nuclear Regulatory Commission (NRC) for a radioactive (^{241}Am -Be) well logging source that has been lost in an artesian well (#10) in the San Bernardino National Wildlife Refuge, Arizona, since 1986. The source, which contains about 2.5 Ci ^{241}Am , is lodged in the lower aquifer at approximately 183 m (600 ft) depth. At this depth the water is essentially stagnant with very little lateral flow and very little (if any) interaction with the upper water column of the well. Artesian flow enters the well column between the 90 m (300 ft) and 123 m (410 ft) levels. The well feeds an area called Twin Pond [0.10 ha (0.25 acres)], which is home to two endangered and one threatened fish species and one endangered plant. The USGS has requested that the Am-Be source license be terminated, ending their responsibilities related to Well 10, and has attempted to seal the source in place with cement as required by NRC license termination regulations.

Following attempted sealing of the source in the well, USGS performed sampling and analysis of groundwater discharging from Well 10. Samples collected during 1989 and 1990 produced some indication of traces of ^{241}Am dissolved in the water. Subsequent sampling in 1990 did not indicate the presence of contamination. However, additional samples collected in 1993 again suggested low concentrations of ^{241}Am may have been present. Consequently, uncertainties related to the condition of the stainless steel source container, the effectiveness of the cement plug installed, and concerns about the potential for future contamination resulted in the decision to prepare an environmental assessment (EA). This EA addresses the potential water quality, ecological, and human health impacts of three alternatives for final disposition of the Am-Be source: (1) the proposed action, abandonment in place; (2) Am-Be source retrieval; and (3) the no-action alternative. The key findings for each of the three alternatives are summarized below.

Proposed action: abandonment in place: Video logging of the well produced no evidence that the cement plug previously installed by USGS exists. Therefore, under NRC regulations, this alternative would require additional sealing of the Am-Be source to inhibit vertical movement of the Am, and emplacement of a permanent plaque at the well head as specified in 10 CFR Part 39. In the case of a release of Am from the stainless steel container in the lower aquifer of the well, the combination of very low groundwater flow and geochemical retardation processes would inhibit lateral movement of the Am. The distribution coefficient for Am of 10^4 to 10^6 means that 10,000 to 1,000,000 times more of the Am would be adsorbed to the clay, sand, and silt found in the geological environment than would remain in solution in the water. Under this alternative, no adverse impact is expected to either the water quality of Well 10 or other wells in the area.

Using a U.S. Department of Energy (DOE) methodology for evaluating radiation effects on aquatic biota and a conservative concentration of 10 pCi/L ^{241}Am in water entering Twin Pond, a potential dose rate of 0.0035 mGy/h was calculated. This is three orders of magnitude below the DOE recommended dose rate limit of 0.4 mGy/h. Thus, no effects would be expected to aquatic biota. There would be minor and temporary short-term ecological impacts associated with the process of cement plug emplacement. These would result from transportation of equipment and personnel to the site and preparation of the site for the set up and operation of equipment.

A highly conservative k_d of 1000 was used for assessment of the migration of Am through the complex geological/hydrological environment of the region to a location where it might reach an off-site well used for drinking or irrigation. This was assumed to be a distance of 1,000 m (3,300 ft). Upon failure of the stainless steel Am-Be container, the Am would be dissolved at an estimated maximum concentration of 8×10^6 pCi/L in about 290,000 L (75,400 gal) of water. Assuming that 1 percent of the contaminated plume annually mixes with faster moving water supplying the well, the average concentration in irrigation water would be 0.077 pCi/L. If this concentration entered into the soil-to-plant pathway or into drinking water, the annual dose would be less than 0.3 mrem/y. Therefore, essentially no radiation dose would be received and no health effects would be expected. At the maximum concentration of 1.36 pCi/L ^{241}Am that has been detected in the lower part of Well 10, consumption of 2 L of water per day on an annual basis would result in a dose of 3.6 mrem/y. This is still below the 4 mrem/y EPA dose limit and far below the NRC standard for unrestricted use of decommissioned sites of 25 mrem/y.

Source retrieval alternative: Under this alternative, Well 10 would be re-drilled to a larger diameter and all liquids and solids removed would be contained and disposed of off-site. If the source has already been breached, the drill cuttings, particularly those from the deeper part of the well, would be expected to be contaminated with Am released from the source. If the source has not been breached, the potential exists that it could be breached during the retrieval process resulting in Am being dissolved in the drilling fluid and the water.

An accidental breach of the source container while conducting this alternative would be completely or at least partially controlled by the containment procedures that would be implemented. However, the potential for an accidental release at or near the ground source is a negative factor for this alternative. There would be opportunity for occupational doses and the potential for this area to be restricted from public access.

As a highly conservative, worst case scenario for this assessment, it has been assumed that the entire contents of the source are lost directly into Twin Pond. Using the DOE methodology for evaluating radiation effects on aquatic biota, a dose rate of 0.610 mGy/h was calculated. This is higher than the 0.4 mGy/h DOE dose rate limit; therefore, adverse effects could be expected to the three fish species of concern.

No-action alternative: Under the no-action alternative, the potential would remain for discharge of Am contaminated water or particulate material from Well 10 into the adjacent ponds and wetlands. In addition, in the future, someone could inadvertently drill into the source in an effort to redevelop the well. Estimation of the likely concentrations that would be expected to result from this discharge suggests that the discharge would occur at low concentration over a long period of time since the Am is expected to adsorb to soil and other particulate materials in the ground or in the well. Under this condition, no acute water quality, ecological, and human health effects would be expected. However, because the Am-Be source would not be sealed in the lower part of the well, continued monitoring would be necessary to ensure that unexpected contaminant concentrations do not occur in water or pond sediment. If ^{241}Am were subsequently detected in the water, the well would be plugged with cement as described under the proposed action.

1. INTRODUCTION

The U.S. Geological Survey (USGS) currently holds a license for the use of a radioactive source composed of americium (^{241}Am) and beryllium (Be) for well logging in the San Bernardino National Wildlife Refuge (SBNWR) in Arizona (Figure 1). The Refuge is located in extreme southeastern Arizona and is managed by the U.S. Fish and Wildlife Service (FWS). The radioactive source has been lost at a depth of about 183 m (600 ft) in an artesian water well adjacent to Twin Pond within the SBNWR since 1986 (Figure 2). This environmental assessment (EA) is being prepared to evaluate the potential impacts of alternatives for final disposition of the source and safe termination of the source license.

1.1 PURPOSE AND NEED

The radioactive source has been underwater in the well for almost 12 years. During that time, intermittent monitoring by USGS has not conclusively indicated whether or not water from the well has been contaminated by the source. USGS has requested from the Nuclear Regulatory Commission (NRC) permission to cease activities and end USGS responsibilities related to the Am-Be source. USGS took action to fulfill its obligation under current NRC regulations by attempting to seal the source in place with cement. However, follow-up visual examination of the well with a downhole camera produced no evidence that the cement plug actually formed. Termination of the license would require successfully sealing the source in place and placement of a permanent plaque at the well head containing information about the source. However, because of uncertainties about the condition of the stainless steel source container, the effectiveness of the cement covering, and concerns about the potential for future contamination, the NRC determined that an EA addressing the impacts of alternatives for final disposition of the source is warranted.

1.2 BACKGROUND

In 1986 the FWS requested that USGS log an artesian well (Well 10) that feeds Twin Pond (Figure 2) within the SBNWR in order to assess the water production capacity of the well. Water from the well initially flows into a pond containing three federally threatened or endangered fish species—the endangered Yaqui chub (*Gila purpurea*) and Yaqui topminnow (*Poeciliopsis occidentalis*) and the threatened beautiful shiner (*Cyprinella formosa*). Water from this pond, in turn, feeds an adjacent pond/wetland containing the endangered plant species Huachuca water umbel (*Lilaeopsis schaffneriana* subspecies *recurva*). Thus, the FWS is interested in ensuring an adequate long-term water supply for the ponds.

The USGS used an NRC-licensed radioactive source to conduct well logging for the purpose of quantifying the water production capacity of the artesian well. The source is composed of ^{241}Am (originally 2.53 Ci) and Be compressed into a cylindrical pellet, within a double-walled stainless steel container. The radioactive material in the source, ^{241}Am (half-life of 432 years), emits alpha radiation which dislodges neutrons from Be. The Am-Be source is part of a larger neutron emission/detection tool commonly used in well logging.

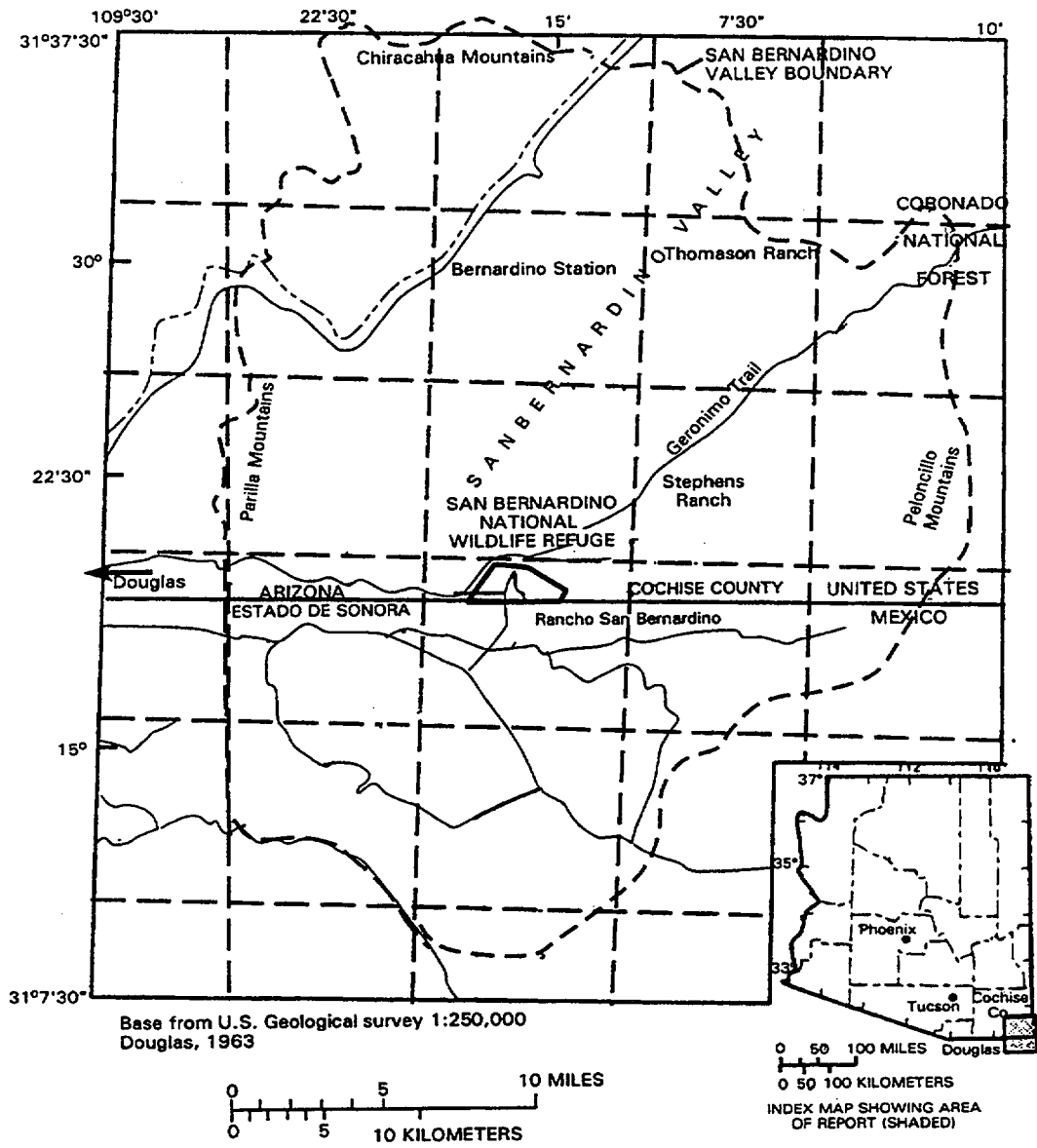


Figure 1. Location of the San Bernardino National Wildlife Refuge and approximate boundary of San Bernardino Valley.

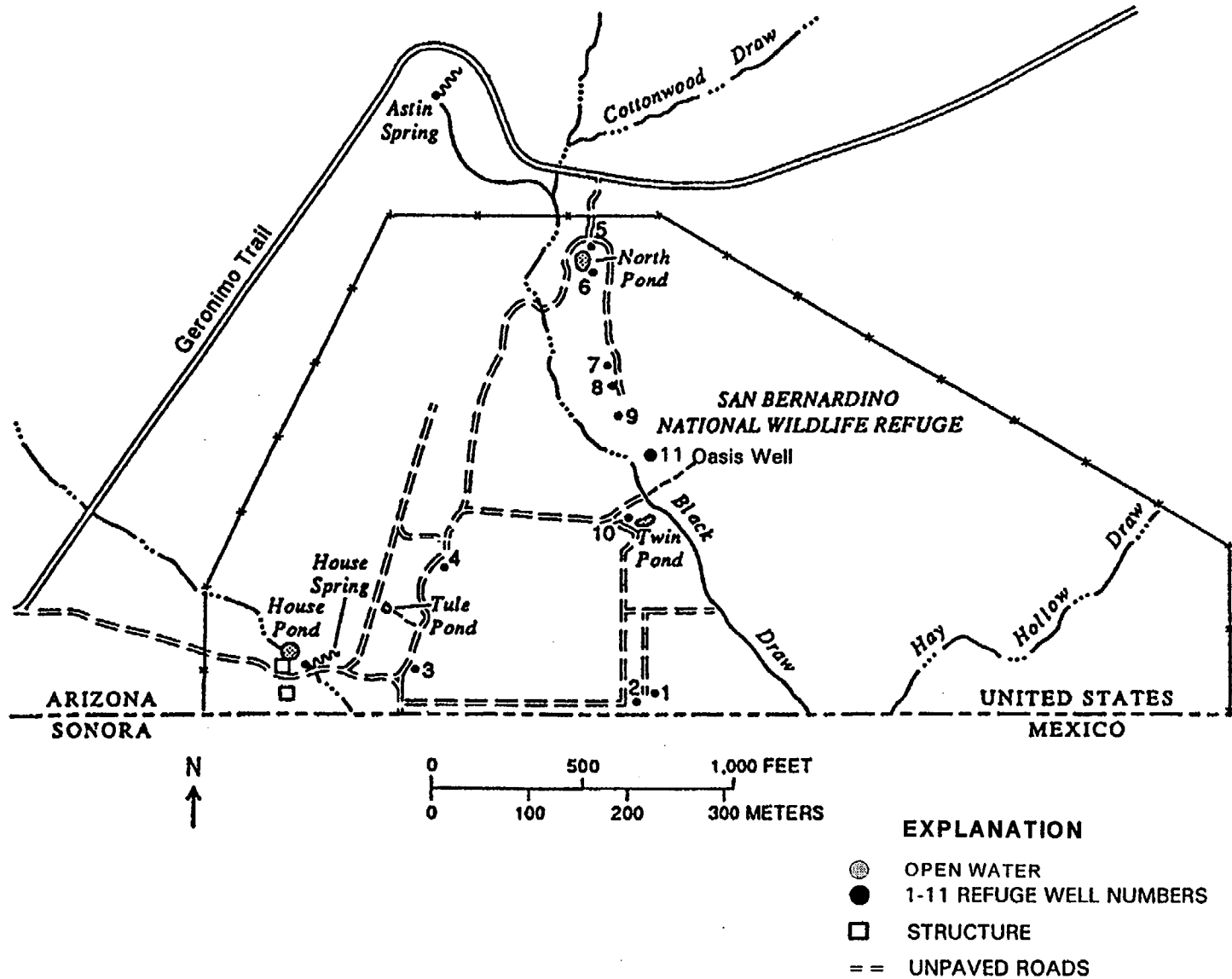


Figure 2. Layout of the San Bernardino National Wildlife Refuge and location of Well 10.

On July 15, 1986, the Am-Be neutron well-logging source was lost by USGS in Well 10. The Am-Be tool was torn from the logging cable as it was being returned to the surface during a logging run. The logging probe containing the source fell back down the well. A video log made immediately after loss of the source did not show its location. The USGS notified the NRC and the FWS that the source had been lost in Well 10.

Three series of attempts were made to recover the source between July 15, 1986, and October 21, 1987. During these recovery attempts, the logging probe was damaged and the source was separated from the body of the well logging tool. In consultation with the NRC and the FWS, USGS declared the source irretrievable on October 20, 1987. After this decision was reached, a 0.76 m³ (1 yd³) cement plug was emplaced around and above the source (that was presumed to be at the bottom of the well) and an inverted tricone drill bit with a 5-ft drill pipe subassembly was placed in the well at the top of the cement to prevent intrusion into the source. One cubic yard of cement would fill about 15 m (50 ft) of the well, assuming that the borehole diameter below the 152 m (500 ft) depth is about 3.9 cm (10 in.). It is inferred from project records that the bottom of the well was tagged at a depth of 162 m (531 ft) after placement of the cement and drill bit/subassembly. On March 30, 1988, USGS returned to the site to inspect the well and respond to a report that well discharge had been diminished by the source abandonment procedure. Although the well was flowing at about 76 Lpm (20 gpm) (the same rate as prior to source abandonment), video logging of the well found the bottom of the well at a depth of 176 m (577 ft)—some 14 m (46 ft) deeper than the well depth sounded after emplacement of the cement and drill bit in 1987.

The unexpected depth at which the well bottom was located after source abandonment and the lack of cement at the depth where it was expected to be encountered might be explained in two ways: (1) the fact that the original total drilled depth of the well is unknown and (2) the possibility that drill cuttings or collapsed borewall material may have formed a bridge in the well at the 178 m (583 ft) depth. If the original depth of the well was significantly deeper than the 186 m (611 ft) maximum depth sounded, and if a porous debris bridge existed in the well at the 178 m (583 ft) depth, the source would presumably have come to rest on top of it; but the cement, being of relatively low viscosity, could have seeped down through the bridge and come to rest in the deeper part of the well. This process may have occurred over a period of several hours after emplacement of the cement but prior to the cement hardening. If the inverted drill bit and subassembly were resting on the top of the cement mass, they could have gradually settled to rest directly on the Am-Be source and debris bridge as the cement filtered down through the bridge. Another explanation, considered less plausible, is that the cement dispersed in fractures located near the base of the well. Presumably if there were fractures capable of taking a cubic yard of cement, there would be water flow in the zone. However, well flowmeter tests indicate that there is no groundwater flow in the well below a depth of 152 m (500 ft).

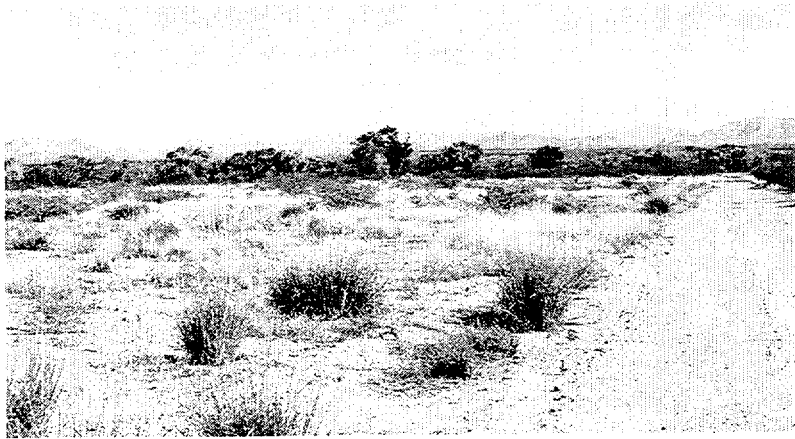
The USGS has sampled the Well 10 water for ²⁴¹Am. The results of the sampling are presented in Section 3.1.3. Three samples collected in 1989 and 1990 indicated traces of ²⁴¹Am in the well water, while the last four samples taken in 1990 did not show the presence of ²⁴¹Am. Based on the results of sampling for ²⁴¹Am in the well, USGS believes that continued monitoring is unwarranted and is requesting that the licence for the source be terminated. However, because of the uncertainties concerning the condition of the Am-Be source and the ineffectiveness of the attempt to seal it in place with cement, there is a need to assess the potential for significant

doses to persons who might use the well for drinking water in the future, or to nearby populations who might use the aquifer for drinking water or agriculture.

1.3 LOCATION, TOPOGRAPHY, AND CLIMATE

The SBNWR is located approximately 30 km (19 miles) east of Douglas in southeastern Arizona immediately north of the Mexican border (Figure 1). The nearest city in Mexico is Agua Prieta, approximately 35 km (21 miles) to the southeast. The 930-ha (2,300-acre) SBNWR lies near the center of the San Bernardino Valley, a surface water drainage basin that straddles the U.S.-Mexican border (Figure 1). Land surface elevations north of the international border range from a low of about 1,130 m (3,700 ft) where Black Draw crosses the border, to elevations of about 2,440 m (8,000 ft) in the Chiricahua Mountains at the northern end of the San Bernardino basin. The valley floor slopes gently to the south along the stream valleys, and the margins of the valley rise through rugged terrain to the uplands of the Pedregosa and Perilla Mountains to the west, the Chiricahua Mountains to the north, and the Peloncillo Mountains to the east.

Photographs of the local environs are provided in Figure 3. Although the area is arid, annual rainfall in the area surrounding the SBNWR varies in relation to the general area elevation, with more precipitation in the mountains than in the valley floor area. In the vicinity of the refuge, annual rainfall is about 33 cm (13 in.), while in the Chiricahua Mountains to the north, rainfall increases to about 46 cm (18 in.) at the 1,615 m (5,300 ft) elevation and about 63 cm (25 in.) at the 2,135 m (7,000 ft) elevation (USGS 1991). Climatological data for Douglas, elevation 1,220 m (3,990 ft), indicate that between 1951 and 1980 the mean daily minimum and maximum temperatures were 7.5 and 25.4°C (45.5 and 77.7°F), and the temperature extremes were -20 and 41.7°C (-4 and 107°F) (NOAA 1985).



Arid Regional Environment



Twin Pond



Twin Pond Vicinity

Figure 3. Environment of the San Bernardino National Wildlife Refuge and Twin Pond area.

2. PROPOSED ACTION AND ALTERNATIVES

This EA evaluates the potential impacts of alternatives for safely terminating activities at the well. The proposed action is abandonment of the source in place subsequent to compliance with all NRC requirements for termination of the USGS licence for the source. Two other potential alternatives for final disposition of the source are (1) undertaking an additional attempt at source retrieval by overdrilling the borehole and overcoring the cement plug and (2) no-action, which would mean that the license would not be terminated and monitoring would continue indefinitely. The proposed action and alternatives are described in the following subsections at a level of detail sufficient for assessment of the potential impacts of each in Section 3.

2.1 THE PROPOSED ACTION: ABANDONMENT IN PLACE

The proposed action is to abandon the radioactive source in place consistent with the requirements of 10 CFR Part 39.15. This regulation requires sealing the source in place with a cement plug, installing a mechanical device to prevent inadvertent intrusion, and posting a permanent sign with detailed descriptions of the source and borehole conditions. Under this alternative, abandonment procedures implemented by the licensee would be evaluated with respect to the requirements of 10 CFR Part 39.77. If these proposed procedures are found to comply with that regulation, NRC may terminate the source license. The regulation requires compliance with the procedures of Part 39 and preparation of a written report of those actions to the NRC and other appropriate state and federal agencies.

Because the initial USGS attempt to plug the well appears to have been unsuccessful, this alternative would require placing additional cement to plug the well and installing an appropriate plaque as specified in Part 39. The plaque would be made of a long-lasting material such as stainless steel, would be at least 17 cm (7 in.) square, and would be mounted at the well head. To install the plaque, a one to two-person work crew would drive to the well and then walk to the wellhead and mount the plaque with hand tools.

The installation of a cement plug in the bottom portion of the well would provide for the positive sealing of the well below a depth of 152 m (500 ft) to ensure isolation of the source from the upper part of the well. The plug would prevent future mixing of ^{241}Am in water at the bottom of the well and would further reduce the likelihood of contaminant migration up the well column. Pressure grouting of the bottom of the well using low pressure pumps would force cement down into the low permeability region of the well, encapsulating the lost Am-Be source, the drilling subassembly and bit (intrusion preventer) previously placed in the well, and filling the wellbore to the desired level. Emplacement of this plug would effectively seal the logging source and drill bit assembly in place permanently and seal the ^{241}Am contamination within the inactive groundwater flow zone.

The process of well grouting would entail transporting necessary equipment and personnel to the site in the wildlife refuge via existing roadways and upgraded trails. Some access ways to the well would require at least temporary improvement to allow the required vehicular access, and a work pad would have to be constructed around the well to support a workover rig that

would be capable of extending piping and a packer down the well to at least 152 m (500 ft). A leveled area would be required at a nearby location to support either a vehicle-mounted grout mixing plant and pumping equipment or portable mixing and pumping equipment. Grout would be delivered to the workover rig and well head via flexible hose. Because the well is immediately adjacent to the pond, a water-tight and bermed work area would be constructed around the well. To keep displaced water from entering the pond, a liquid containment system would be required to collect all water discharged from the well during grouting, and a brief well flushing period would be needed after emplacement of the cement plug. The collected water would require sampling and analysis prior to disposal because there is a chance that particulates entrained in the displaced water may contain ^{241}Am or may be of high pH from the chemical effect of cement grout. It is assumed that water from the well could be used for mixing of grout, otherwise water from another nearby well may be used.

2.2 SOURCE RETRIEVAL ALTERNATIVE

An alternative to the proposed action is to remove the source from the borehole. Under this alternative, aggressive actions to retrieve the source would be undertaken by the licensee. Source retrieval, while perhaps difficult and costly, is technically feasible. Activities to implement this alternative would involve overdrilling the existing borehole to a larger diameter and to a depth just above the existing cement plug. A coring tool of larger diameter than the existing borehole would then be used to incrementally overcore the cement plug and retrieve the source.

The process of source retrieval would entail transporting necessary equipment and personnel via existing roadways and trails into the wildlife refuge and preparing a site for the drill rig, support vehicles, and personnel vehicles. The drill rig would be backed up to the well and made level at the pond's edge in preparation for drilling. Because the well is immediately adjacent to the pond, a water-tight and bermed drilling work platform would be constructed from the bank, extending out over the pond to allow the work crew to perform the drilling. To keep potentially contaminated soil, rock chip, and drilling fluid wastes from entering the pond, these materials would be delivered in a closed system from the well head to a large truck-mounted container through a large diameter flexible hose. When full, the container would be emptied off-site. Drilling fluid would be trucked to the site as well.

If the source is not breached upon retrieval, it would be removed from the site, and a larger diameter well would be constructed in the borehole. This would include a well screen, sand pack, and riser cemented in place. Because the borehole would be of large diameter and therefore require more cement than can be readily prepared by hand or with a small mixer, a cement truck would be brought to the site to stabilize the well in place. If the new well were properly installed, it could supply more water than at present because of the larger diameter.

If the source has been breached and contamination is found in the lower zone of the well, it would be necessary to plug the lower part of the well as described above in the proposed alternative. The newly constructed Well 11, Oasis well, near Twin Pond (Figure 2) could be used to maintain water supply to the pond during the source removal process. This could be accomplished by simply attaching a hose to the well head and delivering the water to the pond. However, prior to use, the well water would be tested to be certain that its chemistry is

adequately similar to that of Well 10. At completion of the drilling process, the site and access road would be revegetated as necessary.

2.3 NO-ACTION ALTERNATIVE

Under this alternative, the USGS license for the Am-Be source would not be terminated. The initial effort by USGS to plug the well was not successful; therefore, the no-action alternative would require continued monitoring of the well and USGS would retain the license for the Am-Be source indefinitely.

3. ENVIRONMENTAL EFFECTS

The following sections describe the relevant environmental conditions and address the potential long- and short-term environmental impacts of implementing the alternatives described in Section 2.

3.1 GEOLOGY/HYDROLOGY

This section describes the physical aspects of the SBNWR with respect to geology, groundwater occurrence, and surface water features. A detailed discussion of the history of Well 10 is included. Subsequently the short- and long-term water quality impacts of the three alternatives are addressed.

3.1.1 Geology

Southeastern Arizona lies in the southernmost extent of the Basin and Range Province in the United States. The dimensions of the San Bernardino Valley watershed are approximately 48 km (30 miles) north/south by 32 km (20 miles) east/west. The term Basin and Range refers to the alternating valleys and mountain ranges that are common through much of the area west of the Rocky Mountains and the Colorado Plateau. The Basin and Range landforms were formed when movement of bedrock occurred along faults causing uplift of bedrock to form mountain ranges and relative subsidence of land between the mountains to form geologic basins. At the time that the faulting, uplifting, and subsidence were in progress, erosion of soil and weathered bedrock from the rising mountain blocks provided sediment that partially filled the subsiding basins between the mountain ranges (USGS 1991).

In the San Bernardino Valley area, volcanic activity accompanied the formation of the Basin and Range and basalt flows from the local volcanoes interfingered with the sediment mass in the basin (Figure 4). At least eight basalt flows have been reported in drilling records in the basin (USGS 1991). The upper basin fill was deposited after most of the geologic structures of the area formed, thus these deposits are draped over underlying faults and older sediment layers. However, in the San Bernardino Valley several minor faults displace the upper basin fill sediments (USGS 1991).

The sedimentary and layered volcanic basin fill materials are quite heterogeneous in composition and texture (Figure 5). In southern Arizona, basin-fill sediments have been subdivided into lower and upper units on the basis of structural and stratigraphic characteristics (USGS 1991). The lowest part of the basin fill sediment is generally finer grained than the upper unit, presumably because the source of the lower (older) material was the ancient soil that laid above the bedrock in areas that were rising along the basin margins. These sediments consist of mudstone and siltstone that contain 80 percent or more silt and clay and locally include disseminated gypsum. Sediments in the upper part of the lower basin fill are somewhat coarser than the lowermost fill material and contain 55–80 percent silt and clay and lenses of sand and gravel, but no known evaporite minerals (USGS 1991).

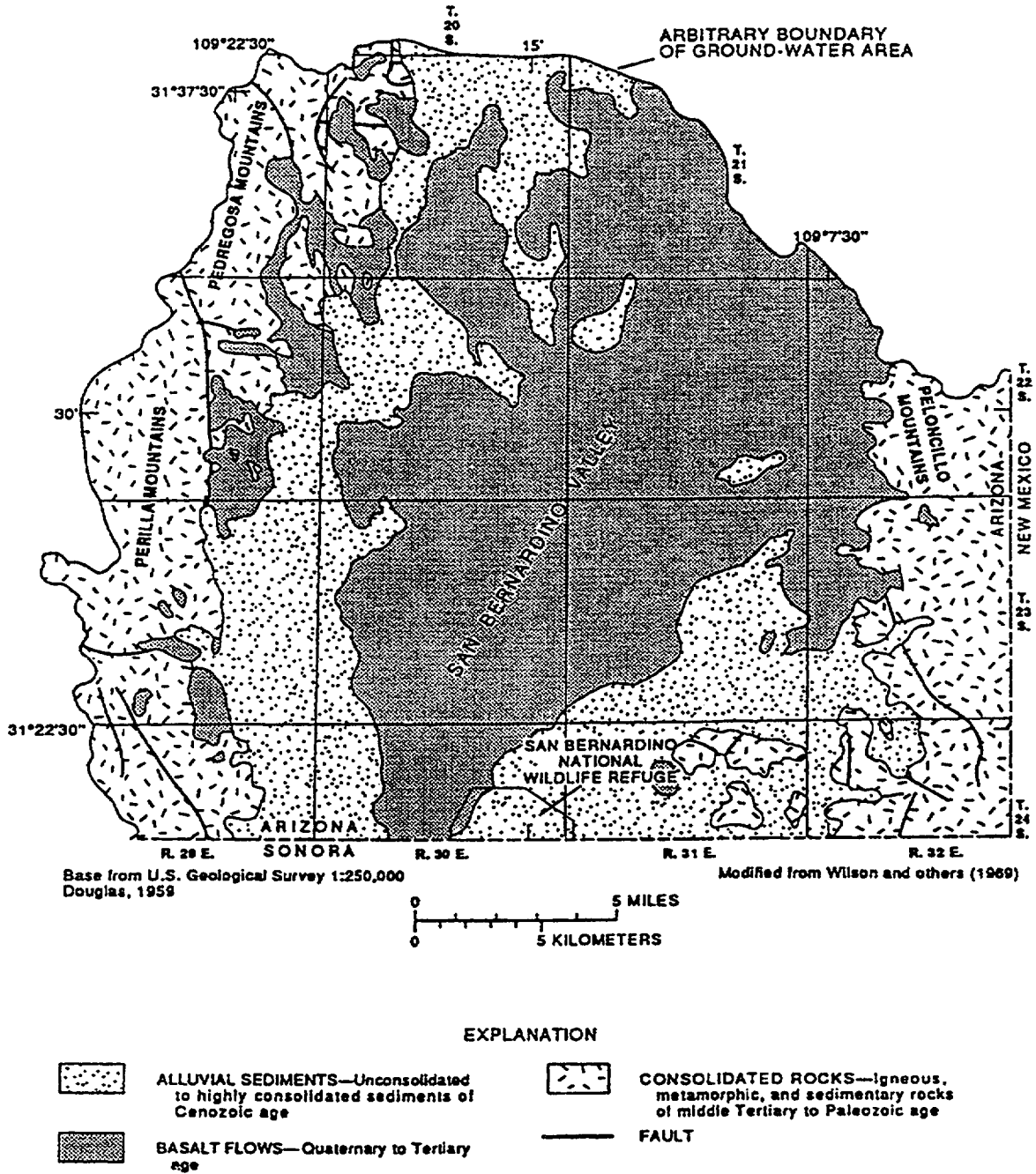
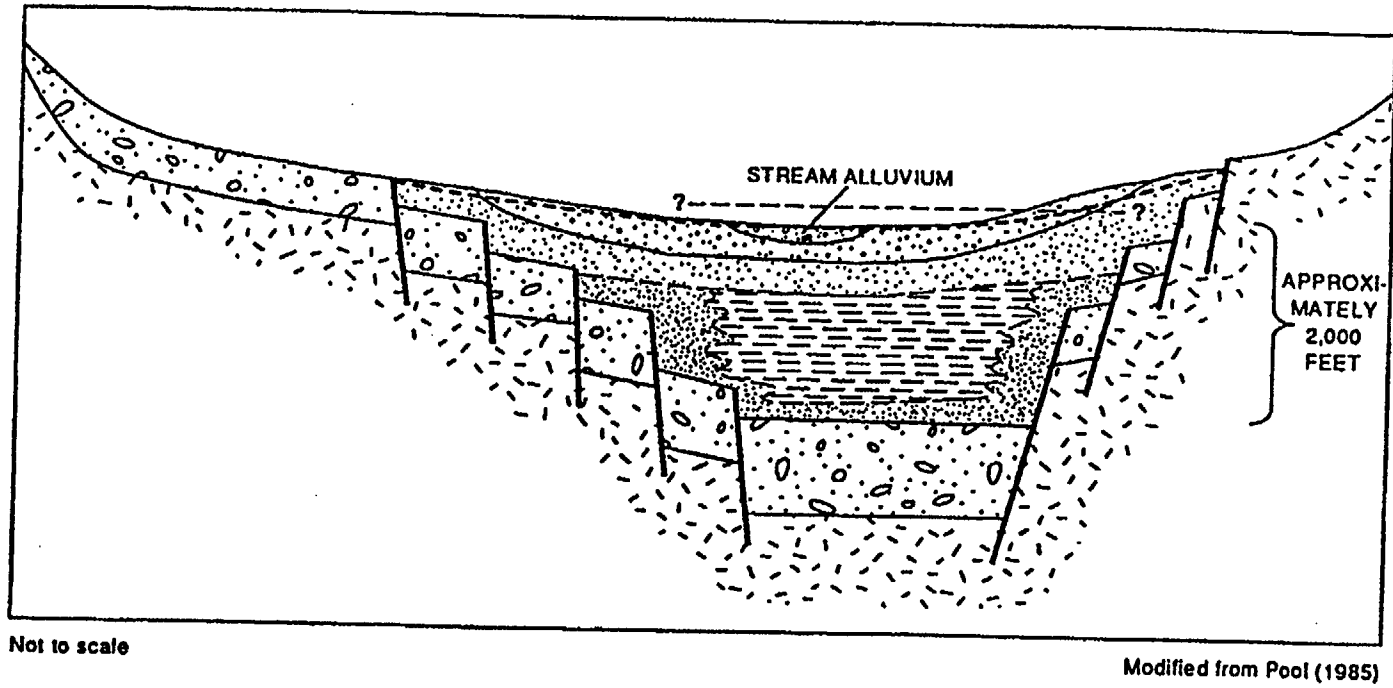


Figure 4. Geologic features of the San Bernardino Valley. Source: USGS 1991.



EXPLANATION








-  UPPER BASIN FILL
-  LOWER BASIN FILL WITH FACIES CHANGES GRADING TO FINE-GRAINED MATERIAL (MUDSTONE AND EVAPORITES)
-  PRE-BASIN AND RANGE DEPOSITS
-  BEDROCK
-  WATER TABLE
-  POTENTIOMETRIC SURFACE FOR LOWER BASIN FILL—Queried where uncertain
-  FAULT

Figure 5. Typical geologic cross section of the San Bernardino National Wildlife Refuge region.
 Source: USGS 1991.

The sedimentary materials near the center of the basin, where the SBNWR is located, are generally finer grained in both the lower and upper units than the materials near the basin edges because the sediment was derived from the uplifted mountainous blocks surrounding the basin. Much of the San Bernardino basin surface is covered by weathered basalt flows less than 3 million years old (USGS 1991).

3.1.2 Hydrology

The primary water-bearing units in the San Bernardino Valley aquifer system are the basin-fill sediments and alluvium in incised stream valleys. The depth to water ranges from less than 6 m (20 ft) in the vicinity of Black Draw in the SBNWR to several hundred feet beneath upland areas east, west, and north of the SBNWR (Figure 5). Confined zones occur in the basin fill portions of the aquifer where dense basalt layers or less permeable sediment layers occur in the basin fill sequence. Permeable sediment layers and basalt beds make up the lesser part of the aquifer matrix in the valley, and their occurrence is discontinuous. It is possible that preferential groundwater flow pathways are present in or around the basalts either as fractures or highly porous zones. Such features may be capable of transmitting groundwater and dissolved constituents rapidly over long distances. The distribution of permeable sediment lenses and basalt beds in the basin fill materials produces a 3-dimensionally complex interfingering of permeable, water-bearing zones in a larger mass of relatively less permeable sedimentary material (Figure 5).

SBNWR groundwater occurs under confined conditions deep in the lower basin fill sediment. Nine of the ten wells near the refuge wetlands discharged artesian flows in 1985 (USGS 1991). Discharges from these flowing wells provide a supply of fresh water to a number of ponds and a wetland area. Water-bearing units in the lower basin fill in the refuge area are confined by lower permeability sediment layers or basalt beds. Springs occur in several areas in the western part of the refuge where basalt flows terminate or are eroded by local stream valleys, exposing permeable sediment layers of the upper basin fill. Groundwater discharged from the springs is not derived from the deep groundwater aquifer beneath the area.

The source of groundwater recharge to the aquifer in the San Bernardino area is precipitation that falls on the higher elevation portions of the basin and in the adjacent mountains. Less rainfall occurs in the valley floor area than in the adjacent highland areas. Although much of the precipitation is returned to the atmosphere through evapotranspiration, some water percolates through the unsaturated soil zone to reach the water table as recharge. Surface water infiltration occurs in the coarse alluvial sediments along the mountain fronts and throughout the valley in stream channels when surface flows are present. The absence of extensive alluvial deposits along the base of the Peloncillo Mountains at the eastern edge of the valley allows recharge of water-bearing units beneath the weathered basalt flows by direct percolation of water through the fractured basalt (USGS 1991).

The general groundwater flow pattern in the San Bernardino Valley is from recharge areas that border the valley at the edges of the mountains toward the center of the basin and then southward beneath the valley axis toward Mexico. The groundwater flow directions are inferred to be generally similar to the drainage pattern of surface water flow in the basin with the groundwater flow being restricted to those subsurface zones with sufficient permeability to transmit significant flow. Groundwater that discharges to the surface via springs in the refuge

wetland area is inferred to originate as relatively shallow flow associated with near-surface basalt beds. Groundwater that discharges from artesian wells in the refuge or that may be pumped from deep wells elsewhere in the basin originates from the regional groundwater recharge and flow system.

Most groundwater withdrawn in the San Bernardino Valley area is used for watering livestock, with lesser amounts used for domestic water supply. Although no groundwater was withdrawn for irrigation purposes in the valley at the time of USGS investigations in the area (USGS 1991), it is reported that at least one high capacity irrigation well [15,200 Lpm (4000 gpm)] has been developed in Mexico near the U.S.-Mexican border in the southern portion of the San Bernardino Valley (Longsworth 1991).

Groundwater quality is generally acceptable for livestock and domestic uses. The geochemical makeup of the dissolved constituents varies spatially depending on the type of geologic material in which the water has resided during its storage in the aquifer and the duration of storage. Most of the wells sampled by USGS (1991) were of a calcium bicarbonate water type with a subordinate fraction showing a sodium bicarbonate water type.

3.1.3 Conceptual Model of Well 10

Well Number 10 in the SBNWR was drilled in the early 1900s using the cable tool drilling method. The exact original depth of the well is undocumented although logging and other activities in the well during the mid and late 1980s indicate that well depth could have ranged from 178 to 186 m (583 to 611 ft). A schematic diagram of SBNWR Well 10, shown in Figure 6, illustrates the approximate well configuration, zones of groundwater inflow to the well based on USGS information (1991), the estimated location of the lost Am-Be source, and potential contaminant migration pathways away from the Am-Be source location. The well contains a metal casing from the ground surface to a depth of 63 m (207 ft). This casing is presumed to be 3.2-cm (8-in.) in diameter based on the minimum well diameter of 3.2 cm (8 in.) reported by USGS (1991).

The USGS performed various tests that contribute to the conceptual model of the well developed in this section. A key test from the standpoint of understanding groundwater behavior in the vicinity of the well is the flowmeter test. USGS flowmeter results indicate that groundwater enters the well in several depth intervals, with about half the artesian flow entering the well near a depth of 149 m (488 ft). Based on the previous descriptions of basin fill materials and aquifer conditions in the San Bernardino basin, it is presumed that intervals of Well 10 where no groundwater inflows occur are low permeability layers that confine the water-bearing zones. The flowmeter test also indicates that below a depth of about 152 m (500 ft) the well contains essentially stagnant groundwater as indicated by no flow of water in the wellbore. Based on the large inflow of artesian groundwater only a few feet above the top of a stagnant zone, the staff infers that a local groundwater capture zone is formed by the continual discharge of water up the wellbore to the ground surface (Figure 6). If Well 10 were completely plugged, it is assumed that this local groundwater capture would cease to occur and groundwater near the bottom of the well would flow slowly to the south toward Mexico along with the bulk of the water in the San Bernardino basin.

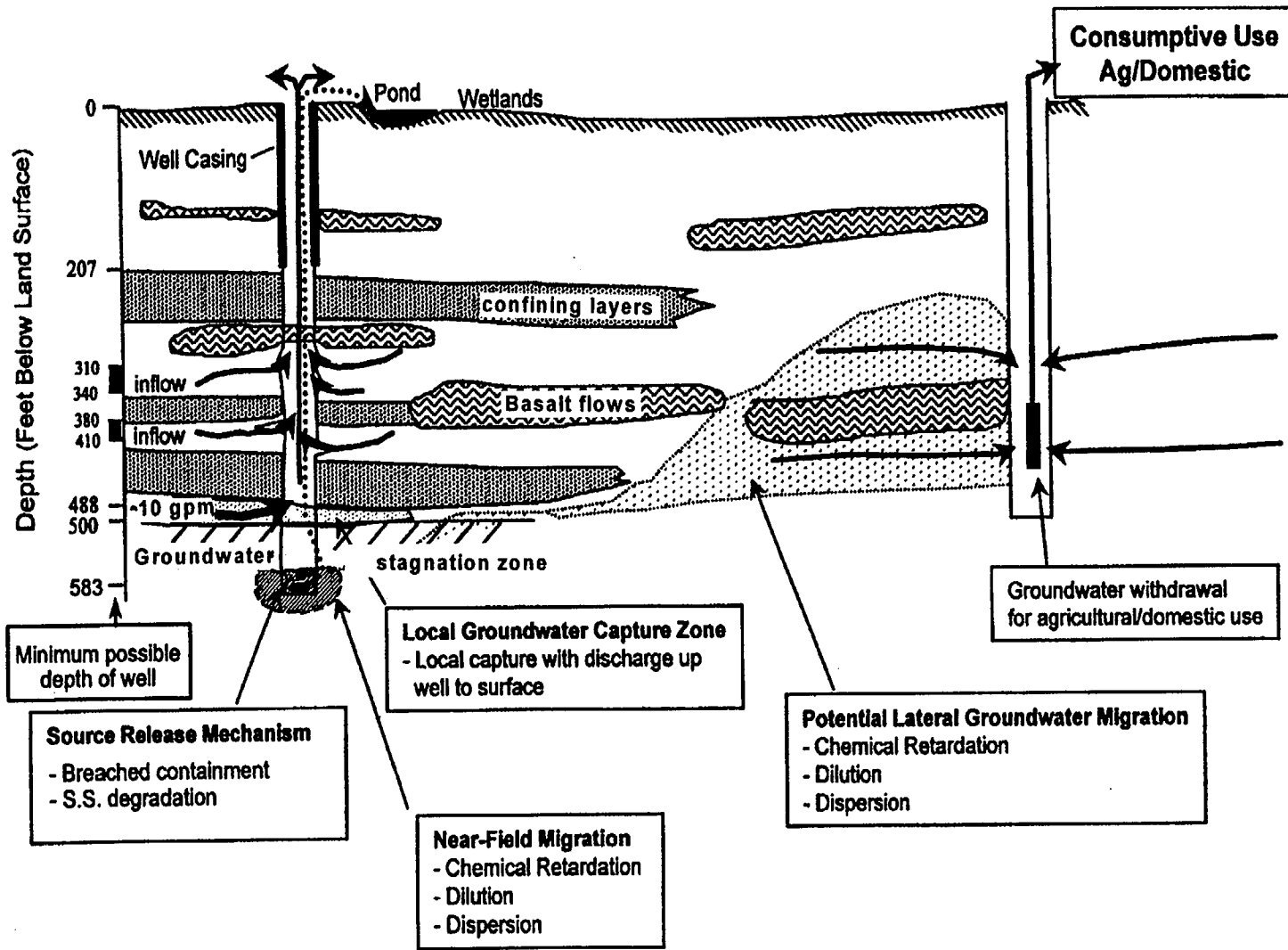


Figure 6. Conceptual model of the San Bernardino National Wildlife Refuge Well 10 and contaminant migration.

Following the loss of the logging source and events described in Section 1.2, USGS performed sampling and analysis of the groundwater discharging from Well 10 to determine if ^{241}Am was being released from the source. Table 1 includes the analytical results for ^{241}Am in water samples collected from Well 10. The table includes results for samples collected quarterly during 1989 and 1990 as well as final samples collected in 1993. The samples collected during the first three quarterly sampling rounds in 1989 and 1990 showed traces of ^{241}Am dissolved in the well water. The last of the four quarterly samples collected in 1990 did not show the presence of ^{241}Am .

Table 1. Results of ^{241}Am analyses on water samples from Well 10

Sample date	^{241}Am and 2-sigma counting uncertainty (pCi/L)		
	Bottom	Other	Top
8-15-89	1.36 ± 0.28	0.59 ± 0.386^a	0.085 ± 0.065
11-30-89	0.187 ± 0.102^b	0.081 ± 0.062^c	0.053 ± 0.053
2-28-90	0.037 ± 0.103^b	0.038 ± 0.091^c	0.781 ± 0.293
6-7-90	0.0204 ± 0.0157^b	0.0054 ± 0.0143^c	0.0696 ± 0.0304
8-21-90	0.00065 ± 0.0088^b	0.0115 ± 0.0127^c	0.0099 ± 0.016
10-14-93	0.07 ± 0.04 (MDA ^d 0.02)		0.04 ± 0.015 (MDA ^d 0.27)
10-14-93	-0.11 ± 0.01 (filtered)		0.08 ± 0.05 (filtered)

^a1.8 m (6 ft) above bottom

^bBottom early

^cBottom late

^dMDA = minimum detectable activity

Sources: Transmittal letter from Robert D. MacNish (District Chief, U.S. Geological Survey Water Resources Division, Tucson, Arizona) to Ms. Beth Riedlinger (U.S. NRC Region 5), July 8, 1993, attached to data table containing results of quarterly sample analyses. Transmittal letter—Analysis of USGS Well Water Samples (RFTA #94-01), William L. Beck, Oak Ridge Institute for Science and Education (ORISE), to Jim Montgomery, NRC, Dec. 7, 1993.

Additional samples were collected in 1993 and analyzed at a different laboratory. These final sample results again suggest that low concentrations of ^{241}Am may have been present; however, the sample analyst stated that even though the printed result suggests a low activity of ^{241}Am , activity levels so close to the minimum detectable activity may actually represent a false positive indication of ^{241}Am (Beck 1993).

The detection of ^{241}Am at concentrations as much as 10 times its analytical detection limit indicates that some part of the previous attempts to recover the source probably breached the canister containing the source. Recovery of part of the logging tool but not the source suggests serious damage to the device may have occurred.

3.1.4 Conceptual Model of Contaminant Release from Well 10

As shown on Figure 6, the migration of contamination from the bottom of Well 10 to potential receptors involves movement through several physical zones, each of which may have varying capabilities to attenuate dissolved ^{241}Am concentrations. The principal components of the contaminant migration model for the Am-Be source in Well 10 include (1) near-field processes and conditions related to source release, solubilization, and interaction with borehole geologic materials; (2) local groundwater capture and discharge processes as influenced by the hydrogeologic conditions of the aquifer materials and the documented flow regime in the well; (3) partitioning in surface water and pond sediment/biota following discharge from the well; and (4) potential migration in the aquifer away from the well.

3.1.4.1 Near-Field Processes

The first step in a release from the source at the time of canister failure is dissolution of the AmO_2 powder in the source and geochemical attenuation in the near-field region within the well bore. The solubility limit of AmO_2 is approximately 1×10^{-8} M (at the solubility limit there would be a concentration of about 8×10^6 pCi/L) (Kowalzyk 1998). Americium hydrolyzes rapidly as the source dissolves, forming poorly soluble hydrolysis products that are subject to formation of particulates or adsorption to naturally occurring particulates. The range of published sorption distribution coefficients (k_d) for ^{241}Am on mineral surfaces such as quartz, feldspars, and clay minerals in natural environments is between 10^4 to 10^6 (10,000 to 1,000,000 times more americium adsorbed to the solid phase than remaining in solution) (PNL 1981) indicative of strong adsorption of americium onto sediment or soil particles. The consequence of these high k_d values on the release and movement of ^{241}Am away from the Am-Be source in Well 10 is strong retention of the americium in the sedimentary materials that form the lower basin fill surrounding the well.

Because the source was lost and possibly partially cemented into the stagnant groundwater zone at the base of the well, the americium is expected to adsorb strongly onto the clays, silts, and sands of the borehole wall within a short distance of the source. The rate of americium movement in the stagnant zone is expected to be very slow with the adsorption to the borehole walls further slowing its movement.

In order to verify the role of contaminant adsorption in limiting americium concentration in Well 10, the maximum measured americium concentration in the groundwater can be compared to the order of magnitude one might expect if the source were breached and americium was dissolved into the groundwater stagnation zone. Under this scenario, a theoretical maximum dissolved ^{241}Am concentration would have been on the order of 8×10^6 pCi/L. Reduction of this concentration by k_d sorption to the well wall materials by a factor of 10^6 would result in a dissolved concentration ranging from 1 to 10 pCi/L. This range includes the 1.36 pCi/L concentration measured in water sampled immediately above the well bottom some 3 years after abandonment of the source (Table 1).

3.1.4.2 Local Groundwater Capture and Discharge Processes

In the conceptual model for migration of americium away from the source, initial dissolution and attenuation of americium in the near-field region is followed by capture of dissolved constituents

near the well bottom in the upwelling artesian groundwater flow in the well. In this part of the contaminant transport pathway, dissolved materials undergo mixing and dilution by the water flowing into the well. Flowmeter tests performed in Well 10 indicate that about half the total flow in the wells enters the wellbore at a depth of 149 m (488 ft), the other half entering in two approximately 9 m (30 ft) thick intervals that lie between 90 and 120 m (300 and 400 ft) below the ground surface. In this part of the conceptual model, the americium concentration is expected to diminish as water flows up the well because of both dilution in the inflowing water volume and some further adsorption onto the borehole wall material. No quantitative estimate of the amount of water that may rise from the stagnation zone into the basal artesian flow region is available. However, for purposes of this assessment it is assumed that 1 percent of the total flow from the well originates from the stagnation zone. Further assessment of the human health and environmental effects of americium discharge to the surface under this scenario is presented in following sections.

3.1.4.3 Partitioning in Pond Water, Sediment

Any AmO_2 that dissolved in water would be expected to adsorb onto any clays, silts, and sands present in and near the water column, the range of k_d being between 10^4 and 10^6 . For a k_d of 10^5 , for instance, any ^{241}Am in solution which reached Twin Pond (which is fed by Well 10), would therefore reach equilibrium at 1:100,000 (i.e., 1 part ^{241}Am in solution to 100,000 parts sorbed to sediments). This value is consistent with that found in a study of the ecological behavior of ^{241}Am in a radioactive waste pond on the Hanford Reservation which received plutonium and americium wastes over a period of about 30 years (Emery et al. 1975). The Emery study stated, "These concentrations of ^{241}Am in pond water were 1.08 pCi/L (1 pCi/L \approx .001 pCi/g) while concentrations in sediments averaged 53 pCi/g (wet)." The resulting k_d is approximately 10^5 . The Hanford pond is similar to Twin Pond in that it is shallow, allowing light penetration to the bottom of the entire pond, and has a simple food web, consisting of small fish, rooted aquatic vegetation, algae, detritus, and various insects.

3.1.4.4 Potential Migration in the Aquifer Away from Well 10

With the well flowing, the hydrogeology in the immediate vicinity of Well 10 favors capture and local surface discharge of any dissolved americium that is not adsorbed to borewall geologic materials. Based on the understanding of regional groundwater occurrence and flow in the San Bernardino basin (USGS 1991), if Well 10 were completely plugged with cement (from bottom to top), groundwater in the vicinity of the well would be expected to flow slowly southward toward the Mexican border. Under a scenario in which Well 10 was plugged and abandoned, the near-field geochemical retardation processes would be enhanced by forcing any dissolved constituents from near the well bottom to migrate through the low permeability sediments that surround the well below the 152 m (500 ft) depth. Based on the strong adsorption of americium in geologic materials, particularly those containing fine silts and clays, very small amounts of americium are expected to ever reach the productive part of the aquifer. If americium reaches a flowing zone in the aquifer, the adsorption and dilution processes previously discussed would act to slow its movement and reduce its concentration. Under a far-field migration scenario, contaminated groundwater from the vicinity of Well 10 would be subjected to a large amount of longitudinal dispersion and sorption in the large volume of porous sedimentary material along its flowpath.

3.1.5 Assessment of Alternatives

Taken collectively, the results of analyses from the Well 10 water (Table 1) leave a degree of uncertainty with regard to the integrity of the Am-Be source canister. It is possible that attempts to recover the source damaged the metal canister, allowing dissolution of the AmO₂ and BeO source material. On the other hand, the analytical results are somewhat uncertain since the latest, and most reliable, measured ²⁴¹Am concentrations in the well water lie in a range of potential false positive contaminant detection (Beck 1993).

3.1.5.1 Proposed Action: Abandonment in Place

Abandonment of the Am-Be source in place through pressure cementing of the well from the 152 m (500 ft) depth to the total depth of 183 m (about 600 ft) would encapsulate all materials in the borehole below 152 m (500 ft). This action would eliminate the possibility of potential mixing of contaminated water at the well bottom with the discharging artesian flow. With completion of the cementing of the well base, the contaminant release scenario for the Am-Be source would be limited to diffusion of the contaminant upward through approximately 30 m (100 ft) of cement grout or through the native silts and clays of the geologic formation surrounding the well. If it is assumed that the source has been breached, emplacement of an improved cement plug below the 152 m (500 ft) depth, which is the base of active groundwater flow in the vicinity of Well 10, would retain ²⁴¹Am in the geologic materials at the base of the well. The combination of very low groundwater flow in this region and geochemical retardation processes would contain the americium beneath the useable aquifer. Under this alternative no adverse impact would be expected to either the water quality of Well 10 or other wells in the area. After plugging the basal portion of the well, continued discharge of the artesian flow to the ponds and wetlands could continue.

3.1.5.2 Source Retrieval Alternative

Removal of all materials in Well 10, including the Am-Be source, the drill bit and subassembly, and residues of the cement previously placed in the well is technically feasible. The well would essentially be re-drilled to a larger diameter and all liquids and solids removed would be contained and disposed of off-site (Section 2.2).

With respect to the release of americium, this alternative could have potential short-term impacts during the retrieval operation. If the source has already been breached, the drill cuttings from the retrieval operation, particularly those from the deeper part of the well, would be expected to be contaminated with the americium released from the source. These cuttings would require characterization and some type of processing to prepare them for disposal at an approved facility. If the source has not been breached, the potential exists that it could be breached during the retrieval process, in which case americium would be expected to dissolve in the drilling fluid. In either case, the drilling fluid and cuttings would require containment, sampling and analysis prior to disposal, and offsite disposal as dictated by the presence or absence of contamination after the retrieval operation. Upon completion of the retrieval operation the well could be re-completed to continue providing water to the local ponds and wetlands.

3.1.5.3 No-Action Alternative

Under the no-action alternative, the potential would remain for discharge of americium-contaminated water or particulate material from Well 10 into the adjacent ponds and wetlands. Estimation of the likely concentrations that would be expected to result from this discharge suggests that the discharge would occur at low concentrations over a long period of time since the americium is expected to adsorb to soil and other particulate materials in the ground or in the well. Under this condition, no acute water quality effects would be expected. However, because the Am-Be source would not be sealed in the lower part of the well, continued monitoring would be necessary to ensure that unexpected contaminant concentrations do not occur in water or pond sediment. If ^{241}Am were subsequently detected in the water, the well could be plugged with cement as described under the proposed action.

Under the no-action alternative it would be possible for the source containment to be inadvertently breached by future drilling. If someone should attempt to redevelop the well without realizing the presence of the source, they could drill into it, thereby releasing americium. The potential impacts of such a scenario would be similar to those discussed in Section 3.1.5.2 above.

3.2 ECOLOGY

The SBNWR was established in 1982 to protect a wetlands habitat for wildlife and several species of fish, including the federally endangered Yaqui chub (*Gila purpurea*), the endangered Yaqui topminnow (*Poeciliopsis occidentalis sonoriensis*), and the threatened beautiful shiner (*Cyprinella formosa*) (Longsworth 1991; Maes 1995). The refuge covers about 930 ha (2,300 acres) of the San Bernardino Valley in southeastern Arizona and encompasses a portion of the headwaters of the Yaqui River, a major river system which primarily drains western Chihuahua and eastern Sonora, Mexico. Marshes, ponds, springs, and flowing wells in the refuge sustain a unique ecosystem in southeastern Arizona. Habitat damage from cattle grazing and land clearing for farming before acquisition of the area by the FWS resulted in a decline in native fish and wildlife [personal communication from K. Cobble, USFWS Manager of San Bernardino National Wildlife Refuge, Douglas, Arizona, to H. D. Quarles, Oak Ridge National Laboratory (ORNL), Oak Ridge, Tennessee, October 14, 1997].

Terrestrial vegetation consists of grasses, desert shrubs, cacti, mesquite, and acacia. Cottonwood and willow trees grow near the wetlands. Restoration of previously drained wetlands using water from flowing wells and springs has promoted growth of vegetation and an increase in wildlife and endangered fish populations (Longsworth 1991). The majority of aquatic habitats that now exist on the refuge are the result of manmade ponds maintained by clear water springs and artesian wells. The ponds are maintained (e.g., by vegetation thinning) to offer refugia for Rio Yaqui fishes. The degree of artificiality of aquatic habitats on the refuge is of concern, but such refugia are necessary until more secure natural habitats are available (Maes 1995).

Artesian flow from well Number 10 feeds Twin Pond, which is approximately 0.10 ha (0.25 acre) in area with an average depth of about 1 m containing about 1,000,000 L of water ($1,000 \text{ m}^3 \times 1,000 \text{ L/m}^3$). Near the pond are a variety of trees including cottonwoods, willows, and acacias.

Dominant aquatic vegetation includes sedges, cattails, and pondweed. The pond water is clear. Fish species present include Yaqui chub (endangered), Yaqui topminnow (endangered), and beautiful shiner (threatened). Runoff from the pond flows to the south and feeds a small nearby wetland which contains the endangered plant species water umbel (*Lilaeposis schaffneriana* spp. *recurva*) (personal communication from K. Cobble, USFWS Manager of San Bernardino National Wildlife Refuge, Douglas, Arizona, to H. D. Quarles, ORNL, Oak Ridge, Tennessee, October 14, 1997).

3.2.1 Methodology for Evaluating Radiation Effects on Aquatic Biota

A methodology for evaluating the potential for aquatic biota to incur effects from chronic exposure to low-level radiation in the environment has been adapted from several existing methods by the U.S. Department of Energy (DOE) (Blaylock et al. 1993). A detailed description and application is provided in Appendix A. The methodology considers external exposure from radionuclides in water, sediment, and from other biota such as vegetation, as well as internal radiation from radionuclides ingested via food and water and, in some cases, from radionuclides absorbed through the skin and respiratory organs. The risk is evaluated by comparing the calculated radiation dose to biota with the DOE's recommended dose rate of 0.4 mGy/h (1 rad/d). A lower dose rate to the most sensitive organisms should ensure protection of populations of aquatic organisms, based on reviews summarized in the National Council on Radiation Protection and Measurements Report No. 109 (NCRP 1991).

In the event that any ^{241}Am reaches, or has reached, the biota in Twin Pond, its potential distribution, after reaching equilibrium, may be similar to that observed in a pond on the Hanford Reservation (Emery et al. 1975). At Hanford the highest concentrations were found in algal floc (decomposing algal material) averaging 64 pCi/g (wet). Levels in other biota were in all cases lower than concentrations in algal floc, or for organisms feeding on it, and were generally below that in sediment [53 pCi/g (wet)]. For instance, goldfish, which feed on algae and detritus (algal floc), concentrated relatively small amounts of americium, from 2–4 pCi/g (wet). Based on this, the authors concluded, "These low levels of americium concentration in goldfish tissue suggest that even years of active feeding on a substrate relatively high in americium content will not cause much transfer across the gut wall and into various body tissues" (Emery et al. 1975). The concentration in aquatic insects and submerged vegetation varied widely, but was generally about 10 pCi/g (wet); watercress, dragonfly larvae, and snails had ^{241}Am levels about twice as high, i.e., 20 pCi/g (wet). A single mallard duck collected while feeding on the Hanford pond (food preferences are organic debris and algae) had a whole body concentration of 0.008 pCi/g (wet) ^{241}Am , a concentration so low that it was considered by the authors not to constitute an environmental hazard or an important transport mechanism (Emery and Klopfer 1975). Based on these observations the authors concluded that the potential for concentration by food chain transfer does not appear to be great (Emery et al. 1975).

3.2.2 Assessment of Alternatives

The ecological impacts associated with the three alternatives described in Section 2 are addressed in the following sections. Using the methodology and calculations presented in Appendix A, the potential for effects from ^{241}Am to threatened and endangered fish and other species in Twin Pond is described.

3.2.2.1 Proposed Action: Abandonment in Place

Under this alternative, near-term ecological impacts would be minor and temporary, involving only minimal disturbance to the well site.

Using the DOE methodology (Appendix A) for evaluating radiation effects on aquatic biota for an ^{241}Am concentration of 10 pCi/L in water entering Twin Pond, no effects would be expected. The dose rate (0.0036 mGy/h) is more than three orders of magnitude less than the DOE recommended dose limit. Therefore, there is little potential for effects on any of the species of fish present in Twin Pond. As the ^{241}Am in solution sorbs to sediments, the concentration in water would become markedly less, and dose to fish would decrease even more. At such low levels, effects to other pond biota less sensitive than teleost fish would not be expected.

3.2.2.2 Source Retrieval Alternative

The activities required to remove the source from the borehole are discussed in Section 2.2, and are similar to, but more extensive than, those of the proposed action. There would be short-term site disturbances associated with a larger staging area. Preventive measures would be employed to protect the integrity of the pond from entry of drilling materials. To protect the pond from drilling activities, a water-tight and bermed drilling platform would be constructed from the bank, allowing the work crew to perform drilling without introducing fluids and materials into the pond. To keep turbid water and drilling fluid wastes from entering the pond, a closed system would deliver these materials from the well head to a large truck-mounted container through a large diameter flexible hose. The container materials would be disposed of off-site. With these protective measures, impacts to the pond biota, as from introduction of small amounts of uncontaminated sediment from the surrounding work area, would be minimal and of short duration. If the ^{241}Am source has been breached, it is possible that contaminated solids could be mobilized in the well water. If so, these materials should also be prevented from entering the pond. If not, the possibility exists for deleterious effects to pond biota due to significant sediment entry. Upon completion of source retrieval, ecological impacts to the site and access road would be mitigated by revegetating them as necessary.

If the source were recovered intact, there would be no impacts to pond biota from ^{241}Am . The possibility exists, however, that the source could be breached during the recovery attempt. As a highly conservative, worst case scenario for this assessment, we assumed that the entire contents of the source are lost directly into Twin Pond. Using the previously discussed methodology for evaluating radiation effects on fish (Appendix A), a dose rate of 0.610 mGy/h was calculated.

A dose rate of 0.610 mGy/h exceeds the DOE recommended dose rate limit of 0.4 mGy/h; therefore, adverse effects to the three fish species of concern in Twin Pond (Yaqui chub, Yaqui topminnow, and beautiful shiner), and possibly other organisms in the food web would be possible. Effects of exposure at similar levels to natural populations of fish include greater brood size and embryo mortality for mosquitofish (*Gambusia affinis*) (Blaylock 1969; Trabalka and Allen 1977; Blaylock and Frank 1980) and lower fecundity and delay in spawning for roach (*Rutilus rutilus*) (Voronina et al. 1974; Peshkov et al. 1978).

Potential effects to the endangered plant species water umbel (*Lilaeposis schaffneriana* spp. *recurva*), which is present in the nearby small wetland fed by the runoff from Twin Pond, are unlikely due to the higher radiation tolerance of plants than animals and the lower concentrations of ^{241}Am that would reach the wetland.

The potential for effects would lessen as the pond ecosystem approached steady-state. Through time ^{241}Am would be lost from the pond as a result of outflow, contaminated sediments would become covered with those which were not contaminated, and radioactive decay of ^{241}Am to less hazardous ^{237}Np would occur.

An accidental breach of the Am-Be source containment resulting from activities associated with this alternative would be at least partially contained by the procedures described in Section 2.2. However, the potential for an accidental release at or near the ground surface is a negative factor for this alternative.

3.2.2.3 No-Action Alternative

Under the no-action alternative, the potential would remain for discharge of americium contaminated water or particulate material from Well 10 into the adjacent ponds and wetlands. Estimation of the likely concentrations that would be expected to result from this discharge suggests that the discharge would occur at low concentration over a long period of time since the americium is expected to adsorb to soil and other particulate materials in the ground or in the well. Under this condition, no acute ecological effects would be expected. However, because the Am-Be source would not be sealed in the lower part of the well, continued monitoring would be necessary to ensure that unexpected contaminant concentrations do not occur in water or pond sediment. If ^{241}Am were subsequently detected in the water, the well would be plugged with cement as described under the proposed action.

Under the no-action alternative it would be possible for the source containment to be inadvertently breached by future drilling. If someone should attempt to redevelop the well without realizing the presence of the source, they could drill into it, thereby releasing americium. The potential impacts of such a scenario would be less than those discussed in Section 3.2.2.2, as most of the americium would be confined to the lower aquifer (also see Section 3.1.4.2).

3.3 HEALTH AND SAFETY

This section includes a discussion of potential impacts the Am-Be source could have on local users of the water from the aquifer, as well as those users in Mexico. The safety of the U.S. and Mexican drinking and agricultural water supplies is discussed. The health and safety impacts to workers who might be involved in removing the source are addressed, as are the potential short- and long-term impacts to human health and safety of the three alternatives.

3.3.1 Human Population

Well 10 is located in the SBNWR approximately 30–35 km (19–21 miles) from the nearest population centers, Douglas, Arizona, and Agua Prieta, Mexico, respectively. Thus, there is little potential for direct contact of significant populations with Well 10 water. Another route of

exposure to any Well 10 contamination would be through the use of water from wells drilled into the same aquifer for drinking or irrigation. For this assessment, a high capacity well pumping 15,200 Lpm (4,000 gpm) (Section 3.1.2) is considered to be 1,000 m (3,300 ft) distant from the well.

3.3.2 Assessment of Alternatives

The potential human health effects of the three alternatives described in Section 2 are addressed in the following sections. Scenarios involving breached and unbreached conditions of the stainless steel containers are included.

3.3.2.1 Proposed Action: Abandonment In Place

Under the proposed action scenario, the source would remain sealed in place with installation of a cement plug. At issue is whether or not the ^{241}Am would be retained for its effective lifetime (i.e., 5 to 7 half-lives). Several perspectives on human risk are presented to provide a picture of the risk potential. Because the geology and hydrology of the site and nearby region are complex and not thoroughly understood (Section 3.1), the approach that is taken is to identify conservative approaches to estimate risk to humans. These approaches vary according to the alternative under discussion. By conservative, it is meant that the estimates are purposely designed not to underestimate human risk.

Container not breached at present: The 432 year half-life of ^{241}Am means that the total quantity of ^{241}Am will decrease by a factor of 2 every 432 years. The longer the source remains below ground, undisturbed, the lower will be the potential for harm from the parent radionuclide. However, the primary progeny, neptunium (^{237}Np) will grow in as the parent americium decays. This progeny radionuclide has a half-life of about 2.14×10^6 y and its radiotoxicity or hazard level per curie is approximately the same as that of ^{241}Am . However, the ^{237}Np has a much slower decay rate than ^{241}Am so that the hazard is proportionally less. Since hazard depends on radioactive decay, the Np hazard per gram is less than that for Am by the same factor as the ratio of their half-lives (i.e., $2.14 \times 10^6 \text{ y} \div 432 \text{ y} = 4953 \approx 5000$), so the hazard or Curie quantity potential is reduced by that factor. Thus, given that the source material or, more likely, its progeny, is bound to enter the aquifer, it is instructive to examine the potential health impacts down gradient.

The sum of the inner wall and outer wall thicknesses of the source container is about 3.1 mm (0.123 in.) and the corrosion rate for the Type 304 stainless steel in dilute nitric acid is in the range of 2.5×10^{-4} mm/y (10 mils/y). At this rate, the walls would be breached in about 12,000 years. In groundwater, the corrosion rate would be substantially lower. But even if it takes a few million years to breach the container, there is still a hazard because of the ingrowth of the daughter ^{237}Np , but this hazard is about a factor of 5,000 less than that from the parent ^{241}Am .

Given the likelihood that the stainless steel container and the proposed cement plug would eventually be breached by corrosion/erosion, migration of the ^{241}Am and/or ^{237}Np off-site through the aquifer would occur at some time. In this estimate of human hazard potential, the potential sources of exposure to be considered are via a home well in Mexico or an agricultural well in Mexico, both of which would be located approximately 1,000 m (3,300 ft) from the

radioactive source. As discussed in Section 3.1.2, the aquifer is poorly characterized and, as a consequence, refined estimates of dilution and retardation between the source and any location down gradient are not possible. However, it is possible to make an upper limit estimate of radiation dose to people using k_d .

There is substantial uncertainty regarding the k_d of ^{241}Am , with many sources being available which provide varying k_d values for ^{241}Am . In Section 3.1.4.1 a source is cited for a k_d of 10^4 to 10^6 for americium. However, in order to be very conservative in the assessment of human health effects, a different source is used here. The k_d between water and sediment has been measured for plutonium to be in the range of 10,000 to 100,000 in a variety of settings (Allard and Rydberg 1983). In this article, experimental evidence demonstrates that at near neutral pH, the k_d of Pu is greater than that for Am by an order of magnitude. Thus for the calculation of effects on humans, the value of 1,000 is conservatively chosen for the k_d because of the unspecified environment of silt/sand/basalt at the depth of the source in the case of ^{241}Am .

When the container fails and exposes the source material, it will be dissolved at a maximum concentration of 8×10^6 pCi/L requiring about 290,000 L (75,400 gal) of water to dissolve the 2.5 Ci (Kowalzyk 1998). At this point the water containing the ^{241}Am would interact with the sediment/soil particles surrounding the well. Once the contaminated water interacts with the sediment and/or soil particles, the k_d of 1,000 means that the concentration of ^{241}Am in the water would be reduced by a factor of 1,000 to 8×10^3 pCi/L. Eventually, as fresh water moves into the contaminated sediment/soil, it would become contaminated with ^{241}Am , but slightly less than 8×10^3 pCi/L. As the water moves farther down gradient, it would also interact with additional sediment and/or soil and become more diluted. But, in this conservative estimate, we will not take advantage of further hold-up in the sediment/soil. After many years, the plume of water at the concentration of 8×10^3 pCi/L would reach a hypothetical agricultural well about 1,000 m (3,300 ft) from the original contaminated source. If this well were to be used for irrigating 40 ha (100 acres), using 30 acre in. of irrigation per year, it would need to pump about 3×10^8 L (78×10^6 gal) during the growing season. This pumping rate would be seen by the deeper stagnant contaminated water as a type of "pressure relief" and there would be a slow migration of this contaminated water toward the agricultural well. If 1 percent annually of the 290,000-L (75,400-gal) contaminated plume from the deep, slowly migrating water (containing 8×10^3 pCi ^{241}Am), were mixed with the faster moving water in the aquifer supplying the bulk of the agricultural water, the average concentration in the irrigation water would be 0.077 pCi/L. If this concentration entered into the soil-to-plant pathway or into drinking water, the approximate annual dose would be less than 0.3 mrem/yr, well below any regulatory limit of concern.

A home well is shallow by comparison with an agricultural well because it is also only as deep as needed for supply rates of a few hundred gallons per day and the provisions of potable water. Home use pumping rates would not provide the "pressure relief" considered with the agricultural well, and essentially no water from the deep, slowly moving water would be taken up in the home well. Therefore, essentially no radiation dose would be received for the case of a home well in Mexico.

Container breached at present: Under the assumption that the container is breached, we must consider (1) the possibility of contaminated water coming to the surface and (2) contaminated water migrating off-site and down gradient into Mexico and used as (a) irrigation water or (b) small home well.

A series of measurements was made after the source was lost in the well. These data indicated roughly that ^{241}Am may have been present at a maximum level of 1.36 pCi/L early after the accident. Since June 1990, the presence of ^{241}Am has not been unambiguously indicated in water samples. The maximum value of 1.36 pCi/L was taken from the lower part of the well, probably in the stagnant zone. One would expect some dilution before the radionuclide could reach the surface. However, to make a bounding calculation of potential radiation dose it is assumed that a person could use Well 10 for drinking water and that the water was always at the maximum recorded concentration of 1.36 pCi/L. With the consumption of 2 L/d, on an annual basis, this would result in a dose of 3.6 mrem. This is to be compared with the 4 mrem/y dose limit promulgated by the U.S. Environmental Protection Agency (EPA), and the NRC standard for unrestricted use of decommissioned contaminated sites of 25 mrem/y (10 CFR Part 20).

(a) Migration of the ^{241}Am and its ^{237}Np daughter off-site through the aquifer is a possibility. Based on the discussion above, use of water from an agricultural well might result in a dose of less than 0.3 mrem/y.

(b) As discussed in Section 3.3.1.1, essentially no radiation dose would be received for the case of a home well in Mexico.

3.3.2.2 Source Retrieval Alternative

Retrieval of the source would present the potential for occupational doses and for the San Bernardino Wildlife Refuge to be restricted from public access.

Container breached at present: If the container is breached, it is possible that a substantial amount of the ^{241}Am is very close to the breached container. This would mean that, during the course of overdrilling and coring to retrieve the source, some volume of Am-contaminated soil would be encountered at the surface. Unless stringent and expensive precautions are maintained, contaminated material would spread to the ponds, possibly restricting their use. In the upper limit, all of the nearly 2.5 Ci could be brought up. In the case of the contaminated material entering the pond, a large amount of contaminated soil would have to be collected and disposed of. If the drilling spoils were carefully collected, only a small amount of contaminated material would require disposal at an approved site. The maximum potential concentration of contaminated water would be 2.5 Ci divided by the volume of the pond, $10^6 \text{ L} = 2.5 \mu\text{Ci/L}$.

Health physics procedures and measurement techniques are sufficiently developed to minimize the adverse impacts to workers. For example, occupational exposures to contamination could be precluded by preventing the contaminated drilling residue from becoming airborne during any of the processes. Americium decays by emitting an alpha particle; consequently, the major concern is inhalation, since gloves or clothing would adequately shield the body from the alphas. The use of respirators would preclude inhalation exposures. Regardless of the precautions used, the drilling equipment would become contaminated; thus decontamination would be required before the rig could be moved to another location. The major trade-off to minimize occupational exposures to contamination in a situation like the current scenario is cost.

Container not breached: If the container is not breached, two possibilities exist. The first is that it can be retrieved without incident. The second is that it is breached in the retrieval attempt. In the latter case, the above discussion in Section 3.3.2.1 would apply, thus adverse effects on human health would not be anticipated.

3.3.2.3 No-Action Alternative

Under the no-action alternative, the potential would remain for discharge of americium contaminated water or particulate material from Well 10. Estimation of the likely concentrations that would be expected to result from this discharge suggests that the discharge would occur at low concentration over a long period of time since the americium is expected to adsorb to soil and other particulate materials in the ground or in the well. Under this condition, no human health effects would be expected. However, because the Am-Be source would not be sealed in the lower part of the well, continued monitoring would be necessary to ensure that unexpected contaminant concentrations do not occur in water. If ^{241}Am were subsequently detected in the water, the well would be plugged with cement as described under the proposed action.

There is a possibility, under the no-action alternative, that future inadvertent drilling could penetrate the source, thereby releasing americium. The potential impacts of such a scenario on human health would be less than those discussed in Section 3.3.2.2, as most of the americium would be confined to the lower aquifer. The potential environmental impacts of this scenario would be similar to those discussed in Section 3.3.2.1.

4. REGULATORY COMPLIANCE

All appropriate regulations that apply to this project will be identified. In the case of the source removal alternative, special permits may be required from the FWS and the state of Arizona to disturb areas in or close to the ponds.

Actions undertaken as part of the proposed abandonment of the well at the SBNWR would comply with a number of federal statutes and regulations including the following: the Atomic Energy Act; National Environmental Policy Act along with the Council on Environmental Quality's implementing regulations (40 CFR Parts 1500-1508), and NRC's implementing regulations (10 CFR Part 51); Clean Water Act; the Endangered Species Act; EPA drinking water standards; the Occupational Safety and Health Act and its implementing regulations (29 CFR 1910, Subparts G, *Occupational Health and Environmental Controls*; I, *Personal Protective Equipment*; and J, *General Environmental Controls*; and 29 CFR Part 1926, *Safety and Health Standards for Construction*); NRC's regulations in 10 CFR Part 20, *Standards for Protection against Radiation*; and NRC's regulations concerning abandonment and termination of the source license would comply with regulations in 10 Part 39.

The staff initiated consultation of the proposed action with the FWS to comply with Section 7 of the Endangered Species Act of 1973 on June 15, 1999. On June 30, 1999, the FWS provided a letter on the project. During a follow-up call, the FWS stated that the project was in compliance with Section 7 of the Endangered Species Act and the FWS would not require additional action (personal communication from Bruce Palmer, Ecological Services Field Office, U.S. Fish and Wildlife Service, Phoenix, Arizona, to Murray Wade, ORNL, Oak Ridge, Tennessee, August 2, 1999). Correspondence concerning the consultation can be found in Appendix B.

On June 15, 1999, the staff initiated consultation with the State Historic Preservation Officer (SHPO) for the State of Arizona to comply with Section 106 of the National Historic Preservation Act. In a July 23, 1999 letter, the SHPO concurred that the project as proposed would not have an effect on cultural resources. Correspondence concerning cultural resources is included in Appendix C.

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APPENDIX A

METHODOLOGY FOR EVALUATING RADIATION EFFECTS ON AQUATIC BIOTA

A.1 METHODOLOGY

The U.S. Department of Energy (DOE) methodology uses indicator species and combines and simplifies three approaches for calculation of radiation doses to aquatic organisms, taking into account the organism's size, mass, and geometry. For alpha radiation, the internal dose rate for small fish or a mollusk, D_a , is calculated as

$$D_a = 5.76 \times 10^{-4} E_a n_a C_o \quad \mu\text{Gy/h}$$

where

E_a is the energy of the alpha particle (MeV);
(for ^{241}Am $E_a = 5.57 \text{ E} + 00$),

n_a is the proportion of transitions producing an alpha particle of energy E_a (MeV)
(dimensionless); (for ^{241}Am $n_a = 1$), and

C_o is the concentration of the radionuclide in the organism (Bq/kg wet weight).

It is assumed that external alpha radiation from water and sediment is insignificant (due to the low penetrating power of alpha radiation) for aquatic organisms. Biological concentration factors for freshwater fish have been derived to estimate the concentration of a radioisotope in the fish to that in the surrounding water at steady-state conditions. For ^{241}Am , the biological concentration factor, as determined from the findings of Emery et al. (1975) (see Section 3.1.4.4), is approximately 3,000 (3 pCi/g fish/0.001 pCi/g water). This factor is used in the calculation of C_o (i.e., $C_o = \text{concentration in water} \times \text{biological concentration factor}$).

A.2 ASSESSMENT OF ALTERNATIVES

The ecological impacts associated with the three alternatives described in Section 2 are addressed in the following sections.

A.2.1 Proposed Action: Abandonment in Place

If the ^{241}Am source has been or becomes breached, then near-field processes, such as precipitate formation and sorption by sedimentary materials (see Section 3.1.4) would cause strong retention of ^{241}Am in the materials that form the lower basin fill surrounding the well. If the source were breached at the bottom of the well and released its contents suddenly, as could have happened during attempted recovery or sealing operations, then reduction of the

^{241}Am concentration because of the near-field processes would result in a dissolved concentration on the order of 1–10 pCi/L (the EPA drinking water standard is 15 pCi/L) in water entering Twin Pond (see Section 3.1.4). This represents a worst case scenario for the abandonment in place alternative. Any future breach of the source would likely result from corrosion of the stainless steel container and would probably release ^{241}Am more slowly with corresponding lower ^{241}Am concentrations in water reaching Twin Pond.

Using the previously discussed methodology for evaluating radiation effects on aquatic biota for a concentration of ^{241}Am of 10 pCi/L in water entering Twin Pond, no effects would be expected. The dose rate to a small fish living in the undiluted stream of well water would be

$$\begin{aligned} E_a &= 5.57 \\ n_a &= 1 \\ C_o &= (10 \text{ pCi/L})(.037 \text{ Bq/pCi})(1 \text{ kg/L})(3000) = 1,110 \text{ Bq/kg;} \end{aligned}$$

therefore,

$$\begin{aligned} D_a &= (5.76 \times 10^{-4})(5.57)(1)(1,110) = 3.6 \mu\text{Gy/h} \\ D_a &= 0.0036 \text{ mGy/h} < 0.4 \text{ mGy/h (DOE recommended dose rate limit)} \end{aligned}$$

The dose rate is more than 3 orders of magnitude less than the DOE recommended dose limit. Therefore, there is little potential for effects on any of the species of fish present in Twin Pond. As the ^{241}Am in solution sorbs to sediments the concentration in water would become markedly less, and dose to fish would decrease even more. At such low levels effects to other pond biota less sensitive than teleost fish would not be expected.

Placement of an additional cement plug, as discussed in Section 2.1, would further reduce the likelihood of contaminant migration up the well. There would be minor and temporary short-term ecological impacts associated with the process of cement plug emplacement, which would entail transporting equipment and personnel on existing roadways and trails into the refuge and preparing the site for the drill rig, support vehicles, and personnel vehicles.

A.2.2 Source Retrieval Alternative

The volume of Twin Pond is 1,000,000 L, and the entire 2.5 Ci of ^{241}Am is assumed to be lost in the pond and go into solution with the pond water. Since the pond ecosystem would not be at steady-state, all initial exposure would be due to an organism's water consumption and gill throughput (typically several times the body weight of the fish each hour), and not from initially uncontaminated sediments or detritus. Assuming the resultant concentration in an organism is only twice that of the concentration in water, the dose rate to a small fish would be as follows:

$$\begin{aligned} E_a &= 5.57 \\ n_a &= 1 \\ C_o &= (2.5 \text{ Ci}) (3.7 \times 10^{10} \text{ Bq/Ci}) (2) / (1 \times 10^6 \text{ L}) (1 \text{ kg/L}) \\ C_o &= 9.25 \times 10^4; \end{aligned}$$

therefore,

$$D_a = (5.76 \times 10^{-4}) (5.57) (2) (9.25 \times 10^4) \mu\text{Gy/h}$$
$$D_a = 610 \mu\text{Gy/h} \quad \text{or} \quad 0.610 \text{ mGy/h.}$$

A dose rate of 0.610 mGy/h exceeds the DOE recommended dose rate limit of 0.4 mGy/h; therefore, adverse effects to the three fish species of concern in Twin Pond [Yaqui chub (endangered), Yaqui topminnow (endangered), and beautiful shiner (threatened)], and possibly other organisms in the food web would be possible. Effects of exposure at similar levels to natural populations of fish are greater brood size and embryo mortality for mosquitofish (*Gambusia affinis*) (Blaylock 1969; Trabalka and Allen 1977; Blaylock and Frank 1980) and lower fecundity and delay in spawning for roach (*Rutilus rutilus*) (Voronina et al. 1974; Peshkov et al. 1978).

Potential effects to the endangered plant species water umbel (*Lilaeposis schaffneriana* spp. *recurva*), which is present in the nearby small wetland fed by the runoff from Twin Pond, are unlikely due to the higher radiation tolerance of plants than animals and the lower concentrations of ^{241}Am that would reach the wetland.

Immediately upon dissolution of the ^{241}Am in the pond, the ^{241}Am in solution would begin to sorb to particulates and the pond bottom substrate, thereby lowering the concentration in water and increasing the concentration in sediments. There would also be loss of americium from the pond as contaminated water flowed out and was replaced by clean water. ^{241}Am associated with surface sediment particles is tightly bound and less than about 1 percent could be available to the food web in soluble form (Emery et al. 1975). However, under this very conservative scenario, the resulting concentrations in pond surface substrate could initially be high enough to expose snails at dose rates exceeding the DOE recommended limit. Predators feeding on pond organisms, or other species dependent this water resource, would be at less risk due to low potential for food chain transfer (Emery et al. 1975).

APPENDIX B

SECTION 7 CONSULTATION LETTERS

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FOR THE U.S. DEPARTMENT OF ENERGY

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June 15, 1999

Mr. David Harlow, Field Supervisor
Fish and Wildlife Service
Ecological Services Field Office
2321 W. Royale Palm Road
Suite 103
Phoenix, Arizona 85021

Dear Mr. Harlow:

Re: Informal Section 7 consultation for the draft Environmental Assessment, San Bernardino National Wildlife Refuge, Well 10, Arizona

The U.S. Geological Service (USGS) currently holds a license for the use of a radioactive Am-Be source composed of americium (^{241}Am) and beryllium (Be) for well logging in the San Bernardino National Wildlife Refuge (SBNWR) in Arizona (see Figure 1). The Refuge is located in extreme southeastern Arizona and is managed by the U.S. Fish and Wildlife Service (FWS). The radioactive source has been lost at a depth of approximately 600 ft in an artesian water well adjacent to Twin Ponds within the SBNWR since 1986 (see Figure 2). The Nuclear Regulatory Commission (NRC), with the assistance of Oak Ridge National Laboratory (ORNL), is preparing an Environmental Assessment (EA) that evaluates the potential impacts for safely terminating activities at the well in accordance with the National Environmental Policy Act (NEPA) and the NRC's regulations implementing NEPA. The proposed action is to abandon the source in place subsequent to compliance with all NRC requirements for termination of USGS license for the source.

In order to coordinate NEPA implementation with that required by Section 7 of the Endangered Species Act (ESA), please provide me with any information and/or concerns you might have regarding the effects of this proposed action on listed, proposed, and candidate threatened and endangered species. If you have any questions concerning this project, please contact me at (423) 574-8632 or Mr. Tim Ensminger at (423) 574-5657. Thank you for your assistance.

Sincerely,


Murray Wade, ORNL Staff Member

MCW:mh

Enclosures

cc: Bruce Carrico, NRC
J. T. Ensminger, ORNL
Lance McCold, ORNL
H. Quarles, ORNL

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United States Department of the Interior

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In Reply Refer To:
AESO/SE
2-21-99-I-255

June 30, 1999

Mr. Murray Wade
Oak Ridge National Laboratory
P.O. Box 2008
Oak Ridge, Tennessee 37831-6206

RE: Draft EA, San Bernardino National Wildlife Refuge, Well 10, Arizona

Dear Mr. Wade:

This letter responds to your June 15, 1999, request for an inventory of threatened or endangered species, or those that are proposed to be listed as such under the Endangered Species Act of 1973, as amended (Act), which may potentially occur in your project area (Cochise County). The enclosed list may include candidate species as well. We hope the enclosed county list of species will be helpful. In future communications regarding this project, please refer to consultation number 2-21-99-I-255.

The enclosed list of the endangered, threatened, proposed, and candidate species includes all those potentially occurring anywhere in the county, or counties, where your project occurs. Please note that your project area may not necessarily include all or any of these species. The information provided includes general descriptions, habitat requirements, and other information for each species on the list. Also on the enclosed list is the Code of Federal Regulations (CFR) citation for each listed or proposed species. Additional information can be found in the CFR and is available at most public libraries. This information should assist you in determining which species may or may not occur within your project area. Site-specific surveys could also be helpful and may be needed to verify the presence or absence of a species or its habitat as required for the evaluation of proposed project-related impacts.

Endangered and threatened species are protected by Federal law and must be considered prior to project development. If the action agency determines that listed species or critical habitat may be adversely affected by a federally funded, permitted, or authorized activity, the action agency must request formal consultation with the Service. If the action agency determines that the planned action may jeopardize a proposed species or destroy or adversely modify proposed critical habitat, the action agency must enter into a section 7 conference with the Service. Candidate species are those which are being considered for addition to the list of threatened or endangered species. Candidate species are those for which there is sufficient information to support a proposal for listing. Although candidate species have no legal protection under the

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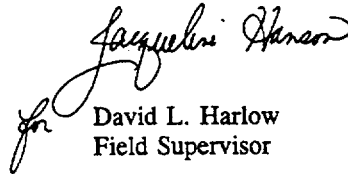
Act, we recommend that they be considered in the planning process in the event that they become listed or proposed for listing prior to project completion.

If any proposed action occurs in or near areas with trees and shrubs growing along watercourses, known as riparian habitat, the Service recommends the protection of these areas. Riparian areas are critical to biological community diversity and provide linear corridors important to migratory species. In addition, if the project will result in the deposition of dredged or fill materials into waterways or excavation in waterways, we recommend you contact the Army Corps of Engineers which regulates these activities under Section 404 of the Clean Water Act.

The State of Arizona protects some plant and animal species not protected by Federal law. We recommend you contact the Arizona Game and Fish Department and the Arizona Department of Agriculture for State-listed or sensitive species in your project area.

The Service appreciates your efforts to identify and avoid impacts to listed and sensitive species in your project area. If we may be of further assistance, please feel free to contact Tom Gatz (x240).

Sincerely,


David L. Harlow
Field Supervisor

Enclosure

LISTED, PROPOSED, AND CANDIDATE SPECIES FOR THE FOLLOWING COUNTY:
03/25/1999

COCHISE

1)LISTED

TOTAL= 21

NAME: CANELO HILLS LADIES' TRESSES

SPIRANTHES DELITESCENS

STATUS: ENDANGERED CRITICAL HAB No RECOVERY PLAN: No CFR: 62 FR 665, 01-06-97

DESCRIPTION: SLENDER ERECT MEMBER OF THE ORCHID FAMILY (ORCHIDACEAE).
FLOWER: STALK 50 CM TALL, MAY CONTAIN 40 WHITE FLOWERS
SPIRALLY ARRANGED ON THE FLOWERING STALK.

ELEVATION
RANGE: about 5000 FT.

COUNTIES: COCHISE, SANTA CRUZ

HABITAT: FINELY GRAINED, HIGHLY ORGANIC, SATURATED SOILS OF CIENEGAS

POTENTIAL HABITAT OCCURS IN SONORA, MEXICO, BUT NO POPULATIONS HAVE BEEN FOUND.

NAME: COCHISE PINCUSHION CACTUS

CORYPHANTHA ROBBINSORUM

STATUS: THREATENED CRITICAL HAB No RECOVERY PLAN: Yes CFR: 51 FR 952, 1-9-1986

DESCRIPTION: A SMALL UNBRANCHED CACTUS WITH NO CENTRAL SPINES AND 11-17
WHITE RADIAL SPINES. THE BELL-SHAPED FLOWERS ARE BORNE ON
THE ENDS OF TUBERCLES (Protrusions). FLOWERS: BELL SHAPED,
PALE YELLOW-GREEN. FRUITS: ORANGE-RED TO RED

ELEVATION
RANGE: >4200 FT.

COUNTIES: COCHISE AND SONORA, MEXICO

HABITAT: SEMIDESERT GRASSLAND WITH SMALL SHRUBS, AGAVE, OTHER CACTI, AND GRAMA GRASS.

GROWS ON GRAY LIMESTONE HILLS.

NAME: HUACHUCA WATER UMBEL

LILAEOPSIS SCHAFFNERIANA ssp RECURVA

STATUS: ENDANGERED CRITICAL HAB Yes RECOVERY PLAN: No CFR: 62 FR 665, 01-06-97

DESCRIPTION: HERBACEOUS, SEMI-AQUATIC PERENNIAL IN THE PARSLEY FAMILY
(UMBELLIFERAE) WITH SLENDER ERECT, HOLLOW, LEAVES THAT GROW
FROM THE NODES OF CREEPING RHIZOMES. FLOWER: 3 TO 10
FLOWERED UMBELS ARISE FROM ROOT NODES.

ELEVATION
RANGE: 3500-6500 FT.

COUNTIES: PIMA, SANTA CRUZ, COCHISE

HABITAT: CIENEGAS, PERENNIAL LOW GRADIENT STREAMS, WETLANDS

AND IN ADJACENT SONORA, MEXICO, WEST OF THE CONTINENTAL DIVIDE. POPULATIONS ALSO ON FORT
HUACHUCA MILITARY RESERVATION. PROPOSED CRITICAL HABITAT IN COCHISE AND SANTA CRUZ COUNTIES (63
FR 71838)

LISTED, PROPOSED, AND CANDIDATE SPECIES FOR THE FOLLOWING COUNTY: COCHISE
03/25/1999

NAME: NEW MEXICAN RIDGE-NOSED RATTLESNAKE *CROTALUS WILLARDI OBSCURUS*

STATUS: THREATENED CRITICAL HAB Yes RECOVERY PLAN: Yes CFR: 43 FR 34479, 04-04-1978

DESCRIPTION: SMALL 12-24 INCHES, SECRETIVE GRAYISH-BROWN WITH DISTINCT RIDGE ON THE END OF THE SNOUT. THE DORSAL SURFACE HAS OBSCURE, IRREGULARLY SPACED WHITE CROSSBARS EDGED WITH BROWN (NOT A BOLD PATTERN). ELEVATION RANGE: 5600-9000 FT.

COUNTIES: COCHISE

HABITAT: PRESUMABLY CANYON BOTTOMS IN PINE-OAK & PINE-FIR COMMUNITIES WITH ALDER, MAPLE, OAK, & BOX ELDER

THE SUBSPECIES HAS NOT BEEN DOCUMENTED IN ARIZONA. HOWEVER, IT HAS BEEN OBSERVED NEAR THE ARIZONA BORDER IN THE PELONCILLO MOUNTAINS AND LIKELY OCCURS IN THE ARIZONA PORTION OF THAT RANGE AS WELL. ANOTHER SUBSPECIES, (*CROTALUS WILLARDI WILLARDI*), IS AN ARIZONA STATE CANDIDATE.

NAME: JAGUAR, UNITED STATES POPULATION *PANTHERA ONCA*

STATUS: ENDANGERED CRITICAL HAB No RECOVERY PLAN: No CFR: 62 FR 39147, 7-22-97

DESCRIPTION: MUSCULAR CAT WITH RELATIVELY SHORT, MASSIVE LIMBS AND A DEEP-CHESTED BODY. CINNAMON-BUFF IN COLOR WITH BLACK SPOTS. ELEVATION RANGE: <8000 FT.

COUNTIES: COCHISE, PIMA

HABITAT: IN ARIZONA, RANGED WIDELY THROUGHOUT A VARIETY OF HABITATS FROM SONORAN DESERT TO CONIFER FORESTS

MOST RECORDS ARE FROM THE MADREAN EVERGREEN-WOODLAND, SHRUB-INVADDED SEMI-DESERT GRASSLAND, AND ALONG RIVERS. HISTORIC RANGE IS CONSIDERED TO HAVE EXTENDED BEYOND THE COUNTIES LISTED ABOVE. REPORTS OF INDIVIDUALS IN THE SOUTHERN PART OF THE STATE CONTINUE TO BE RECEIVED. THE MOST RECENT RECORDS OF A JAGUAR IN THE U.S. ARE FROM THE NEW MEXICO/ARIZONA BORDER AREA AND IN SOUTH-CENTRAL ARIZONA, BOTH IN 1996, AND CONFIRMED THROUGH PHOTOGRAPHS. UNCONFIRMED SIGHTINGS AND TRACKS CONTINUE TO BE REPORTED. THIS SPECIES HAS A SIGNED CONSERVATION AGREEMENT IN PLACE, BUT THE DEVELOPMENT OF THE AGREEMENT WAS NOT SUFFICIENT TO REMOVE THE NEED TO LIST THIS SPECIES

NAME: JAGUARUNDI *HERPAILURUS (=FELIS) YAGOUAROUNDI TOLTECA*

STATUS: ENDANGERED CRITICAL HAB No RECOVERY PLAN: No CFR: 41 FR 24064; 06-14-76

DESCRIPTION: SMALL CAT WITH SHORT LEGS; SLENDER, ELONGATE BODY; AND LONG TAIL. HEAD SMALL & FLATTENED WITH SHORT ROUNDED EARS. REDDISH-YELLOW OR BLACKISH TO BROWN-GRAY IN COLOR AND WITHOUT SPOTS. ELEVATION RANGE: 3500-6000 FT.

COUNTIES: SANTA CRUZ, PIMA, COCHISE

HABITAT: CAN BE FOUND IN A VARIETY OF HABITATS (SEE BELOW)

SEMI-ARID THORNY FORESTS, DECIDUOUS FORESTS, HUMID PRE-MONTANE FORESTS, UPLAND DRY SAVANNAHS, SWAMPY GRASSLANDS, RIPARIAN AREAS, AND DENSE BRUSH. UNCONFIRMED REPORTS OF INDIVIDUALS IN THE SOUTHERN PART OF THE STATE CONTINUE TO BE RECEIVED. NO SPECIMENS HAVE BEEN COLLECTED IN ARIZONA.

LISTED, PROPOSED, AND CANDIDATE SPECIES FOR THE FOLLOWING COUNTY: COCHISE
03/25/1999

NAME: LESSER LONG-NOSED BAT *LEPTONYCTERIS CURASOAE YERBABUENAE*
STATUS: ENDANGERED CRITICAL HAB No RECOVERY PLAN: Yes CFR: 53 FR 38456, 09-30-88
DESCRIPTION: ELONGATED MUZZLE, SMALL LEAF NOSE, AND LONG TONGUE.
YELLOWISH BROWN OR GRAY ABOVE AND CINNAMON BROWN BELOW.
TAIL MINUTE AND APPEARS TO BE LACKING. EASILY DISTURBED. ELEVATION
RANGE: <6000 FT.
COUNTIES: COCHISE, PIMA, SANTA CRUZ, GRAHAM, PINAL, MARICOPA
HABITAT: DESERT SCRUB HABITAT WITH AGAVE AND COLUMNAR CACTI PRESENT AS FOOD PLANTS
DAY ROOSTS IN CAVES AND ABANDONED TUNNELS. FORAGES AT NIGHT ON NECTAR, POLLEN, AND FRUIT OF
PANICULATE AGAVES AND COLUMNAR CACTI. THIS SPECIES IS MIGRATORY AND IS PRESENT IN ARIZONA,
USUALLY FROM APRIL TO SEPTMBER AND SOUTH OF THE BORDER THE REMAINDER OF THE YEAR.

NAME: MEXICAN GRAY WOLF *CANIS LUPUS BAILEYI*
STATUS: ENDANGERED CRITICAL HAB No RECOVERY PLAN: Yes CFR: 32 FR 4001, 03-11-67; 43
FR 1912, 03-09-78
DESCRIPTION: LARGE DOG-LIKE CARNIVORE WITH VARYING COLOR, BUT USUALLY A
SHADE OF GRAY. DISTINCT WHITE LIP LINE AROUND MOUTH. WEIGH 60-
90 POUNDS. ELEVATION
RANGE: 4,000-12,000FT.
COUNTIES: APACHE, COCHISE, GREENLEE, PIMA, SANTA CRUZ
HABITAT: CHAPPARAL, WOODLAND, AND FORESTED AREAS. MAY CROSS DESERT AREAS.
HISTORIC RANGE IS CONSIDERED TO BE LARGER THAN THE COUNTIES LISTED ABOVE. UNCONFIRMED REPORTS
OF INDIVIDUALS IN THE SOUTHERN PART OF THE STATE (COCHISE, PIMA, SANTA CRUZ) CONTINUE TO BE
RECEIVED. INDIVIDUALS MAY STILL PERSIST IN MEXICO. EXPERIMENTAL NONESSENTIAL POPULATION
INTRODUCED IN THE BLUE PRIMITIVE AREA OF GREENLEE AND APACHE COUNTIES.

NAME: OCELOT *LEOPARDUS (=FELIS) PARDALIS*
STATUS: ENDANGERED CRITICAL HAB No RECOVERY PLAN: Yes CFR: 47 FR 31670; 07-21-82
DESCRIPTION: MEDIUM-SIZED SPOTTED CAT WHOSE TAIL IS ABOUT 1/2 THE LENGTH
OF HEAD AND BODY. YELLOWISH WITH BLACK STREAKS AND STRIPES
RUNNING FROM FRONT TO BACK. TAIL IS SPOTTED AND FACE IS LESS
HEAVILY STREAKED THAN THE BACK AND SIDES. ELEVATION
RANGE: <8000 FT.
COUNTIES: SANTA CRUZ, PIMA, COCHISE
HABITAT: HUMID TROPICAL & SUB-TROPICAL FORESTS, SAVANNAHS, AND SEMI-ARID THORN SCRUB.
MAY PERSIST IN PARTLY-CLEARED FORESTS, SECOND-GROWTH WOODLAND, AND ABANDONED CULTIVATION
REVERTED TO BRUSH. UNIVERSAL COMPONENT IS PRESENCE OF DENSE COVER. UNCONFIRMED REPORTS OF
INDIVIDUALS IN THE SOUTHERN PART OF THE STATE CONTINUE TO BE RECEIVED.

LISTED, PROPOSED, AND CANDIDATE SPECIES FOR THE FOLLOWING COUNTY: COCHISE
03/25/1999

NAME: BEAUTIFUL SHINER *CYPRINELLA FORMOSA*

STATUS: THREATENED CRITICAL HAB Yes RECOVERY PLAN: Yes CFR: 49 FR 34490, 8-31-1984
DESCRIPTION: SMALL (2.5 INCHES) SHINY MINNOW AND VERY SIMILAR TO RED SHINER.
MALES COLORFUL DURING BREEDING (YELLOW-ORANGE OR ORANGE
ON CAUDAL AND LOWER FINS AND BLUISH BODY. ELEVATION
RANGE: <4500 FT.

COUNTIES: COCHISE

HABITAT: SMALL TO MEDIUM SIZED STREAMS AND PONDS WITH SAND, GRAVEL, AND ROCK BOTTOMS.

VIRTUALLY EXTIRPATED IN THE UNITED STATES, WITH THE EXCEPTION OF A FEW ISOLATED POPULATIONS ON NATIONAL WILDLIFE REFUGES AND IN MEXICO. SAME CRITICAL HABITAT AS YAQUI CHUB AND CATFISH (SEE 49 FR 34490, 08-31-1984).

NAME: YAQUI CATFISH *ICTALURUS PRICEI*

STATUS: THREATENED CRITICAL HAB Yes RECOVERY PLAN: Yes CFR: 49 FR 34490, 08-31-1984
DESCRIPTION: SIMILAR TO CHANNEL CATFISH (*Ictalurus punctatus*) EXCEPT ANAL FIN
BASE IS SHORTER AND THE DISTAL MARGIN OF THE ANAL FIN IS
BROADLY ROUNDED WITH 23-25 SOFT RAYS. BODY USUALLY ELEVATION
PROFUSELY SPECKLED. RANGE: 4000-5000 FT.

COUNTIES: COCHISE

HABITAT: MODERATE TO LARGE STREAMS WITH SLOW CURRENT OVER SAND AND ROCK BOTTOMS

CRITICAL HABITAT ALL AQUATIC HABITATS IN THE MAIN PORTION OF SAN BERNADINO NATIONAL WILDLIFE REFUGE

NAME: YAQUI CHUB *GILA PURPUREA*

STATUS: ENDANGERED CRITICAL HAB Yes RECOVERY PLAN: Yes CFR: 49 FR 34490, 08-31-1984
DESCRIPTION: MEDIUM SIZED MINNOW (<6 INCHES) DARK COLORED, LIGHTER BELOW.
DARK TRIANGULAR CAUDAL SPOT ELEVATION
RANGE: 4000-6000 FT.

COUNTIES: COCHISE (AZ), MEXICO

HABITAT: DEEP POOLS OF SMALL STREAMS, POOLS, OR PONDS NEAR UNDERCUT BANKS.

CRITICAL HABITAT INCLUDES ALL AQUATIC HABITATS OF THE MAIN PORTION SAN BERNADINO NATIONAL WILDLIFE REFUGE.

LISTED, PROPOSED, AND CANDIDATE SPECIES FOR THE FOLLOWING COUNTY: **COCHISE**
 03/25/1999

NAME: **YAQUI TOPMINNOW** *POECILIOPSIS OCCIDENTALIS SONORIENSIS*
 STATUS: ENDANGERED CRITICAL HAB No RECOVERY PLAN: Yes CFR: 32 FR 4001, 03-11-1967
 DESCRIPTION: SMALL (2 INCHES) TOPMINNOW GUPPY-LIKE, LIVE BEARING, LACKING DARK SPOTS. BREEDING MALES JET BLACK WITH YELLOW FINS.
 ELEVATION RANGE: <4500 FT.
 COUNTIES: COCHISE
 HABITAT: SMALL TO MODERATE SIZED STREAMS, SPRINGS, & CIENEGAS GENERALLY IN SHALLOWS

NAME: **AMERICAN PERÉGRINE FALCON** *FALCO PEREGRINUS ANATUM*
 STATUS: ENDANGERED CRITICAL HAB No RECOVERY PLAN: Yes CFR: 35 FR 16047, 10-13-70; 35 FR 8495, 06-02-70
 DESCRIPTION: A RECLUSIVE, CROW-SIZED FALCON SLATY BLUE ABOVE WHITISH BELOW WITH FINE DARK BARRING. THE HEAD IS BLACK AND APPEARS TO BE MASKED OR HELMETED. WINGS LONG AND POINTED. LOUD WAILING CALLS ARE GIVEN DURING BREEDING PERIOD.
 ELEVATION RANGE: 3500-9000 FT.
 COUNTIES: MOHAVE COCONINO NAVAJO APACHE SANTA CRUZ MARICOPA COCHISE YAVAPAI GILA PINAL PIMA GREENLEE GRAHAM YUMA
 HABITAT: CLIFFS AND STEEP TERRAIN USUALLY NEAR WATER OR WOODLANDS WITH ABUNDANT PREY
 THIS IS A WIDE-RANGING MIGRATORY BIRD THAT USES A VARIETY OF HABITATS. BREEDING BIRDS ARE YEAR-ROUND RESIDENTS. OTHER BIRDS WINTER AND MIGRATE THROUGH ARIZONA. SPECIES IS ENDANGERED FROM REPRODUCTIVE FAILURE FROM PESTICIDES. SPECIES HAS BEEN PROPOSED FOR DELISTING (63 FR 45446) BUT STILL RECEIVES FULL PROTECTION UNDER ESA

NAME: **BALD EAGLE** *HALIAEETUS LEUCOCEPHALUS*
 STATUS: THREATENED CRITICAL HAB No RECOVERY PLAN: Yes CFR: 60 FR 35999, 07-12-95
 DESCRIPTION: LARGE, ADULTS HAVE WHITE HEAD AND TAIL. HEIGHT 28 - 38"; WINGSPAN 66 - 96". 1-4 YRS DARK WITH VARYING DEGREES OF MOTTLED BROWN PLUMAGE. FEET BARE OF FEATHERS.
 ELEVATION RANGE: VARIES FT.
 COUNTIES: YUMA, LA PAZ, MOHAVE, YAVAPAI, MARICOPA, PINAL, COCONINO, NAVAJO, APACHE, SANTA CRUZ, PIMA, GILA, GRAHAM, COCHISE
 HABITAT: LARGE TREES OR CLIFFS NEAR WATER (RESERVOIRS, RIVERS AND STREAMS) WITH ABUNDANT PREY
 SOME BIRDS ARE NESTING RESIDENTS WHILE A LARGER NUMBER WINTERS ALONG RIVERS AND RESERVOIRS. AN ESTIMATED 200 TO 300 BIRDS WINTER IN ARIZONA. ONCE ENDANGERED (32 FR 4001, 03-11-1967; 43 FR 6233, 02-14-78) BECAUSE OF REPRODUCTIVE FAILURES FROM PESTICIDE POISONING AND LOSS OF HABITAT, THIS SPECIES WAS DOWN LISTED TO THREATENED ON AUGUST 11, 1995. ILLEGAL SHOOTING, DISTURBANCE, LOSS OF HABITAT CONTINUES TO BE A PROBLEM.

LISTED, PROPOSED, AND CANDIDATE SPECIES FOR THE FOLLOWING COUNTY: **COCHISE**
 03/25/1999

NAME: CACTUS FERRUGINOUS PYGMY-OWL *GLAUCIDIUM BRASILIANUM CACTORUM*
 STATUS: ENDANGERED CRITICAL HAB Yes RECOVERY PLAN: No CFR: 62 FR 10730, 3-10-97
 DESCRIPTION: SMALL (APPROX. 7"), DIURNAL OWL. REDDISH BROWN OVERALL WITH CREAM-COLORED BELLY STREAKED WITH REDDISH BROWN. SOME INDIVIDUALS ARE GRAYISH BROWN
 ELEVATION RANGE: <4000 FT.
 COUNTIES: MARICOPA, YUMA, SANTA CRUZ, GRAHAM, GREENLEE, PIMA, PINAL, GILA, COCHISE
 HABITAT: MATURE COTTONWOOD/WILLOW, MESQUITE BOSQUES, AND SONORAN DESERTSCRUB
 RANGE LIMIT IN ARIZONA IS FROM NEW RIVER (NORTH) TO GILA BOX (EAST) TO CABEZA PRIETA MOUNTAINS (WEST). ONLY A FEW DOCUMENTED SITES WHERE THIS SPECIES PERSISTS ARE KNOWN, ADDITIONAL SURVEYS ARE NEEDED. LISTING EFFECTIVE APRIL 9, 1997. PROPOSED CRITICAL HABITAT IN PIMA, COCHISE, PINAL, AND MARICOPA COUNTIES (64 FR 71821).

NAME: MEXICAN SPOTTED OWL *STRIX OCCIDENTALIS LUCIDA*
 STATUS: THREATENED CRITICAL HAB No RECOVERY PLAN: Yes CFR: 56 FR 14678, 04-11-91
 DESCRIPTION: MEDIUM SIZED WITH DARK EYES AND NO EAR TUFTS. BROWNISH AND HEAVILY SPOTTED WITH WHITE OR BEIGE.
 ELEVATION RANGE: 4100-9000 FT.
 COUNTIES: MOHAVE, COCONINO, NAVAJO, APACHE, YAVAPAI, GRAHAM, GREENLEE, COCHISE, SANTA CRUZ, PIMA, PINAL, GILA, MARICOPA
 HABITAT: NESTS IN CANYONS AND DENSE FORESTS WITH MULTI-LAYERED FOLIAGE STRUCTURE
 GENERALLY NESTS IN OLDER FORESTS OF MIXED CONIFER OR PONDERSA PINE/GAMBEL OAK TYPE, IN CANYONS, AND USE VARIETY OF HABITATS FOR FORAGING. SITES WITH COOL MICROCLIMATES APPEAR TO BE OF IMPORTANCE OR ARE PREFERRED.

NAME: NORTHERN APLOMADO FALCON *FALCO FEMORALIS SEPTENTRIONALIS*
 STATUS: ENDANGERED CRITICAL HAB No RECOVERY PLAN: Yes CFR: 51 FR 6686, 01-25-86
 DESCRIPTION: RUFIOUS UNDERPARTS, GRAY BACK, LONG BANDED TAIL, AND A DISTINCT BLACK AND WHITE FACIAL PATTERN. SMALLER THAN PEREGRINE LARGER THAN KESTREL. BREEDS BETWEEN MARCH- JUNE
 ELEVATION RANGE: 3500-9000 FT.
 COUNTIES: COCHISE, SANTA CRUZ
 HABITAT: GRASSLAND AND SAVANNAH
 SPECIES FORMERLY NESTED IN SOUTHWESTERN US. NOW OCCURS AS AN ACCIDENTAL. GOOD HABITAT HAS LOW GROUND COVER AND MESQUITE OR YUCCA FOR NESTING PLATFORMS. CONTINUED USE OF PESTICIDES IN MEXICO ENDANGERS THIS SPECIES. NO RECENT CONFIRMED REPORTS FOR ARIZONA.

LISTED, PROPOSED, AND CANDIDATE SPECIES FOR THE FOLLOWING COUNTY: COCHISE
03/25/1999

NAME: SOUTHWESTERN WILLOW FLYCATCHER *EMPIDONAX TRAILLII EXTIMUS*

STATUS: ENDANGERED CRITICAL HAB Yes RECOVERY PLAN: No CFR: 60 FR 10694, 02-27-95
DESCRIPTION: SMALL PASSERINE (ABOUT 6") GRAYISH-GREEN BACK AND WINGS,
WHITISH THROAT, LIGHT OLIVE-GRAY BREAST AND PALE YELLOWISH
BELLY. TWO WINGBARS VISIBLE. EYE-RING FAINT OR ABSENT.

ELEVATION
RANGE: <8500 FT.

COUNTIES: YAVAPAI, GILA, MARICOPA, MOHAVE, COCONINO, NAVAJO, APACHE, PINAL, LA PAZ, GREENLEE, GRAHAM,
YUMA, PIMA, COCHISE, SANTA CRUZ

HABITAT: COTTONWOOD/WILLOW & TAMARISK VEGETATION COMMUNITIES ALONG RIVERS & STREAMS

MIGRATORY RIPARIAN OBLIGATE SPECIES THAT OCCUPIES BREEDING HABITAT FROM LATE APRIL TO
SEPTEMBER. DISTRIBUTION WITHIN ITS RANGE IS RESTRICTED TO RIPARIAN CORRIDORS. DIFFICULT TO
DISTINGUISH FROM OTHER MEMBERS OF THE EMPIDONAX COMPLEX BY SIGHT ALONE. TRAINING SEMINAR
REQUIRED FOR THOSE CONDUCTING FLYCATCHER SURVEYS. CRITICAL HABITAT ON PORTIONS OF THE 100-YEAR
FLOODPLAIN ON SAN PEDRO AND VERDE RIVERS; WET BEAVER AND WEST CLEAR CREEKS, INCLUDING TAVASCI
MARSH AND ISTER FLAT; THE COLORADO RIVER, THE LITTLE COLORADO RIVER, AND THE WEST, EAST, AND
SOUTH FORKS OF THE LITTLE COLORADO RIVER, REFERENCE 60 CFR:62 FR 39129, 7/22/97.

NAME: WHOOPING CRANE *GRUS AMERICANA*

STATUS: ENDANGERED CRITICAL HAB Yes RECOVERY PLAN: Yes CFR: 32 FR 4001, 03-11-1967; 43
DESCRIPTION: TALLEST AMERICAN BIRD (UP TO 5 FEET) SNOWY WHITE, LONG NECK
AND LEGS, BLACK WING TIPS, RED CROWN, AND BLACK WEDGE
SHAPED PATCH OF FETHERS BEHIND ITS EYE.

ELEVATION
RANGE: 4500 FT.

COUNTIES: COCHISE

HABITAT: MARSHES, PRAIRIES, RIVER BOTTOMS

BIRDS IN THE ROCKY MOUNTAIN POPULATION ARE OCCASIONAL VISITORS IN ARIZONA DURING MIGRATION.
USUALLY NEAR WILCOX PLAYA.

NAME: SONORA TIGER SALAMANDER *AMBYSTOMA TIGRINUM STEBBINSI*

STATUS: ENDANGERED CRITICAL HAB No RECOVERY PLAN: No CFR: 62 FR 665, 01-06-97
DESCRIPTION: 2.6 TO 4.9" SNOUT-VENT LENGTH WITH LIGHT-COLORED BANDS ON A
DARK BACKGROUND. AQUATIC LARVAE ARE UNIFORM DARK COLOR
WITH PLUME-LIKE GILLS AND TAIN FINS.

ELEVATION
RANGE: 4000-6300 FT.

COUNTIES: SANTA CRUZ, COCHISE

HABITAT: STOCK TANKS AND IMPOUNDED CIENEGAS IN SAN RAFAEL VALLEY, HUACHUCA MOUNTAINS

ALSO OCCURS IN THE FOOTHILLS OF THE EAST SLOPE OF THE PATAGONIA AND HUACHUCA MOUNTAINS.
POPULATIONS ALSO ON FORT HUACHUCA.

LISTED, PROPOSED, AND CANDIDATE SPECIES FOR THE FOLLOWING COUNTY:
03/25/1999

COCHISE

2) PROPOSED

TOTAL= 2

NAME: BLUMER'S DOCK (CHIRICAHUA)

RUMEX ORTHONEURUS

STATUS: PROPOSED CRITICAL HAB No RECOVERY PLAN: No CFR:

DESCRIPTION: LARGE LONG-LIVED PERENNIAL PLANT IN THE BUCKWHEAT FAMILY
THAT CAN REACH 1.2-2.0 METERS. LARGE BROAD, OVAL SEMI-
SUCCULENT LEAVES ARE BRIGHT GREEN. CONSPICUOUS SECONDARY VEINS AT RIGHT ANGLES TO THE MIDVEIN ELEVATION
RANGE: 6500-9000 FT.

COUNTIES: APACHE, COCHISE, GILA, GRAHAM, NAVAJO

HABITAT: MID TO HIGH ELEVATION SPRINGS, STREAMS, & WETLANDS WITH MOIST ORGANIC SOILS OR SHADED CANYONS

SPECIES FOUND IN CHIRICAHUA, PINALENO, HUACHUCA, SIERRA ANCHA, AND WHITE MOUNTAINS. SPECIES FOUND ON CORONADO, A-S, TONTO, SOME ON AND COCONINO. SPECIES ALSO FOUND IN WESTERN AND NORTHERN NEW MEXICO (GILA, SANTA FE, AND CARSON NF).

NAME: MOUNTAIN PLOVER

CHARADRIUS MONTANUS

STATUS: PROPOSED THREATENED CRITICAL HAB No RECOVERY PLAN: No CFR: 64 FR 7587; 02-16-1999

DESCRIPTION: WADING BIRD; COMPACTLY BUILT; IN BREEDING SEASON WITH WHITE FOREHEAD AND LINE OVER THE EYE; CONTRASTING WITH DARK CROWN; NONDESCRIPT IN WINTER. VOICE IS LOW, VARIABLE WHISTLE. ELEVATION
RANGE: VARIABLE FT.

COUNTIES: YUMA, SANTA CRUZ, PIMA, COCHISE, PINAL, APACHE

HABITAT: OPEN ARID PLAINS, SHORT-GRASS PRAIRIES, AND SCATTERED CACTUS.

AZ PROVIDES WINTERING HABITAT ONLY. SPECIES PRIMARILY FOUND IN ROCKY MOUNTAIN STATES FROM CANADA TO MEXICO; SERVICE ACCEPTING COMMENTS ON PROPOSED RULE UNTIL APRIL 19, 1999; R6 HAS LEAD

LISTED, PROPOSED, AND CANDIDATE SPECIES FOR THE FOLLOWING COUNTY:
03/25/1999

COCHISE

3) CANDIDATE

TOTAL= 4

NAME: LEMMON FLEABANE

ERIGERON LEMMONII

STATUS: CANDIDATE CRITICAL HAB No RECOVERY PLAN: No CFR:

DESCRIPTION: A PROSTRATE PERENNIAL IN THE SUNFLOWER FAMILY. STEMS AND LEAVES ARE DENSELY HAIRY. FLOWERS LOOK LIKE SMALL DELICATE DAISIES, WITH WHITE TO LIGHT PURPLE OUTER PETALS AND YELLOW INNER PETALS.

ELEVATION RANGE: 1500-6000 FT.

COUNTIES: COCHISE

HABITAT: GROWS IN DENSE CLUMPS IN CREVICES, LEDGES, AND BOULDERS IN CANYON BOTTOMS IN PINE-OAK WOODLAND

ONE SITE ON FORT HUACHUCA MILITARY RESERVATION

NAME: GILA CHUB

GILA INTERMEDIA

STATUS: CANDIDATE CRITICAL HAB No RECOVERY PLAN: No CFR:

DESCRIPTION: DEEP COMPRESSED BODY, FLAT HEAD. DARK OLIVE-GRAY COLOR ABOVE, SILVER SIDES. ENDEMIC TO GILA RIVER BASIN.

ELEVATION RANGE: 2000 - 3500 FT.

COUNTIES: SANTA CRUZ, GILA, GREENLEE, PIMA, COCHISE, GRAHAM, YAVAPAI

HABITAT: POOLS, SPRINGS, CIENEGAS, AND STREAMS

MULTIPLE PRIVATE LANDOWNERS, INCLUDING THE NATURE CONSERVANCY, THE AUDUBON SOCIETY, AND OTHERS. ALSO FT. HUACHUCA. SPECIES ALSO FOUND IN SONORA, MEXICO.

NAME: HUACHUCA SPRINGSNAIL

PYRGULOPSIS THOMPSONI

STATUS: CANDIDATE CRITICAL HAB No RECOVERY PLAN: No CFR:

DESCRIPTION: VERY SMALL (1.7-3.2mm) CONICAL SHELL. IDENTIFICATION MUST BE VERIFIED BY CHARACTERISTICS OF REPRODUCTIVE ORGANS.

ELEVATION RANGE: 4500-6000 FT.

COUNTIES: COCHISE, SANTA CRUZ

HABITAT: AQUATIC AREAS, SMALL SPRINGS WITH VEGETATION SLOW TO MODERATE FLOW.

INDIVIDUALS FOUND ON FIRM SUBSTANCES (ROOTS, WOOD, AND ROCKS) OTHER POPULATIONS FOUND ON FORT HUACHUCA MILITARY PROPERTY

LISTED, PROPOSED, AND CANDIDATE SPECIES FOR THE FOLLOWING COUNTY:
03/25/1999

COCHISE

NAME: CHIRICAHUA LEOPARD FROG

RANA CHIRICAHUENSIS

STATUS: CANDIDATE CRITICAL HAB No RECOVERY PLAN: No CFR:

DESCRIPTION: CREAM COLORED TUBERCULES (spots) ON A DARK BACKGROUND ON
THE REAR OF THE THIGH, DORSOLATERAL FOLDS THAT ARE
INTERRUPTED AND DEFLECTED MEDIANLY, AND A CALL GIVEN OUT OF
WATER DISTINGUISH THIS SPOTTED FROG FROM OTHER LEOPRD ELEVATION
RANGE: 3000-8300 FT.

COUNTIES: SANTA CRUZ, APACHE, GILA, PIMA, COCHISE, GREENLEE, GRAHAM, YAVAPAI, COCONINO, NAVAJO

HABITAT: STREAMS, RIVERS, BACKWATERS, PONDS, AND STOCK TANKS THAT ARE FREE FROM INTRODUCED FISH
AND BULLFROGS

REQUIRE PERMANENT OR NEARLY PERMANENT WATER SOURCES. POPULATIONS NORTH OF THE GILA RIVER ARE
THOUGHT TO BE CLOSELY-RELATED, BUT DISTINCT, UNDESCRIBED SPECIES. SPECIES ALSO FOUND ON FORT
HUACHUCA

LISTED, PROPOSED, AND CANDIDATE SPECIES FOR THE FOLLOWING COUNTY: COCHISE
03/25/1999

CONSERVATION AGREEMENT **TOTAL= 1**

NAME: RAMSEY CANYON LEOPARD FROG *RANA SUBAQUAVOCALIS*

STATUS: NONE CRITICAL HAB No RECOVERY PLAN: No CFR:

DESCRIPTION: BROWN OR GREEN FROG, 2.5 TO 4 INCHES LONG; SPOTS ROUNDED
WITH LIGHT BORDERS; DORSOLATERAL FOLDS ARE INTERRUPTED
POSTERIORLY AND DEFLECTED MEDIALY; YELLOWISH PIGMENTATION ELEVATION
ON THE GROIN WHICH MAY EXTEND INTO THE POSTERIOR VENTER RANGE: 5,000 FT FT.

COUNTIES: COCHISE

HABITAT: STREAM AND PONDED AQUATIC HABITATS

CONSERVATION AGREEMENT BETWEEN THE SERVICE, ARIZONA GAME AND FISH DEPARTMENT, THE NATURE
CONSERVANCY, BUREAU OF LAND MANAGEMENT, CORONADO NATIONAL FOREST, THE US ARMY INTELLIGENCE
CENTER AND FORT HUACHUCA, AND A PRIVATE LANDOWNER WAS FINALIZED JULY 1996

APPENDIX C

SECTION 106 CONSULTATION LETTERS

OAK RIDGE NATIONAL LABORATORY
MANAGED BY LOCKHEED MARTIN ENERGY RESEARCH CORPORATION
FOR THE U.S. DEPARTMENT OF ENERGY

POST OFFICE BOX 2008
OAK RIDGE, TN 37831-6206

PHONE: (423) 574-8632
FAX: (423) 576-8661
INTERNET: wnw@ornl.gov

June 15, 1999

Ms. Jo Anne Miller
State Historic Preservation Office
Arizona State Parks
1300 W. Washington
Phoenix, Arizona 85007

Dear Ms. Miller:

The Nuclear Regulatory Commission (NRC) has requested the assistance of Oak Ridge National Laboratory (ORNL) in preparing an Environmental Assessment that evaluates the potential impacts for safely terminating activities at a well near Douglas, Arizona. This activity is in accordance with the National Environmental Policy Act (NEPA) and the NRC's regulations implementing NEPA.

The U.S. Geological Service (USGS) currently holds a license for the use of a radioactive Am-Be source composed of americium (²⁴¹Am) and beryllium (Be) for well logging in the San Bernardino National Wildlife Refuge (SBNWR) in Arizona (see Figure 1). The Refuge is located in extreme southeastern Arizona and is managed by the U.S. Fish and Wildlife Service (FWS). The radioactive source has been lost at a depth of approximately 600 ft in an artesian water well adjacent to Twin Ponds within the SBNWR since 1986 (see Figure 2). The proposed action is to abandon the source in place subsequent to compliance with all NRC requirements for termination of the USGS license for the source.

As part of the agency coordination and consultation responsibilities, in compliance with NEPA and Section 106 of the National Historic Preservation Act of 1966, as amended, federal agencies are required to consider the effects of their actions on historic properties. Based on the available information, the NRC has determined that no significant effect on historic properties will occur from the proposed well abandonment. We appreciate your written concurrence and/or comments on our determination. Should you require additional information, please call me at (423) 574-8632 or Tim Ensminger at (423) 574-5657. Thank you for your anticipated assistance.

Sincerely,


Murray Wade, ORNL Staff Member

MCW:mh

Enclosures

cc: B. Carrico, NRC
J. T. Ensminger, ORNL
L. McCoid, ORNL

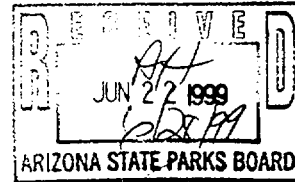
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OAK RIDGE NATIONAL LABORATORY
MANAGED BY LOCKHEED MARTIN ENERGY RESEARCH CORPORATION
FOR THE U.S. DEPARTMENT OF ENERGY

PHONE: (423) 574-8832
FAX: (423) 576-8661
INTERNET: wmv@ornl.gov

POST OFFICE BOX 2008
OAK RIDGE, TN 37831-6206

June 15, 1999



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Arizona State Parks
1300 W. Washington
Phoenix, Arizona 85007

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*10" diameter
existing
well;
non-historic*

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Sincerely,

Murray Wade
Murray Wade, ORNL Staff Member

MCW:rh

Enclosures

cc: B. Carrico, NRC
J. T. Ensminger, ORNL
L. McCold, ORNL

*

CONCUR
Ann Y. Howard 7/23/99
for ARIZONA STATE HISTORIC PRESERVATION OFFICER
ARIZONA STATE PARKS BOARD

** Contingent upon concurrence from USFWS. Thank you.
(FAXed to David Siegel, Regional Archaeologist/USFWS on same date.)*

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BIBLIOGRAPHIC DATA SHEET

(See instructions on the reverse)

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(Assigned by NRC, Add Vol., Supp., Rev.,
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San Bernardino National Wildlife Refuge Well 10

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4. FIN OR GRANT NUMBER
J5084

5. AUTHOR(S)

J.T. Ensminger, C.E. Easterly, R.H. Kettle, H. Quarles, M.C. Wade

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Oak Ridge National Laboratory
P.O. Box 2008
Oak Ridge, TN 37831-6370

9. SPONSORING ORGANIZATION - NAME AND ADDRESS *(If NRC, type "Same as above"; if contractor, provide NRC Division, Office or Region, U.S. Nuclear Regulatory Commission, and mailing address.)*

Division of Industrial and Medical Nuclear Safety
Office of Nuclear Material Safety and Safeguards
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

10. SUPPLEMENTARY NOTES

11. ABSTRACT *(200 words or less)*

The U.S. Geological Survey (USGS) currently holds a license issued by NRC for a radioactive (Am-241-Be) well logging source that has been lost in an artesian well (#10) in the San Bernardino National Wildlife Refuge, Arizona, since 1986. The USGS has requested that the Am-Be source license be terminated and has attempted to seal the source in place with cement as required by NRC license termination regulations. This environmental assessment addresses the potential water quality, ecological, and human health impacts of three alternatives for final disposition of source: (1) the proposed action, abandonment in place; (2) source retrieval; and (3) the no-action alternative.

The proposed action would require additional sealing of the Am-Be source and emplacement of a permanent plaque at the well head. No impacts to water quality, aquatic biota, or human-health would be expected. For the source retrieval alternative, the potential for an accidental release at or near the ground source is a negative factor for this alternative; and impacts to aquatic biota are possible for a worst-case scenario. Under the no-action alternative, no acute water quality, ecological, and human health effects would be expected. However, because the Am-Be source would not be sealed in the lower part of the well, continued monitoring would be necessary to ensure that unexpected contaminant concentrations do not occur.

12. KEY WORDS/DESCRIPTORS *(List words or phrases that will assist researchers in locating the report.)*

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environmental assessment
San Bernardino National Wildlife Refuge
well logging

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