November 8, 2020

Bureau of Land Management
Nevada State Office
1340 Financial Boulevard
Reno, Nevada 89502-7147

Re: Protest of BLM Nevada December 2020 Competitive Oil and Gas Lease Sale (DOI-BLM-NV-B000-2020-0012-EA)

Dear Responsible Official(s):

The Center for Biological Diversity (the Center) hereby files this Protest of the Bureau of Land Management's (BLM) proposed December 8, 2020 Competitive Oil and Gas Lease Sale (DOI-BLM-NV-B000-2020-0012-EA), Environmental Assessment (EA), and Finding of No Significant Impact (FONSI) for the following 17 parcels:

NVN 099962 NV-2020-12-1499, 1920.02 acres
NVN 099963 NV-2020-12-1503, 2536.13 acres
NVN 099964 NV-2020-12-1508, 1280 acres
NVN 099965 NV-2020-12-1502, 1920 acres
NVN 099966 NV-2020-12-6910, 120 acres
NVN 099967 NV-2020-12-6912, 200 acres
NVN 099968 NV-2020-12-1513, 320 acres
NVN 099969 NV-2020-12-1523, 2382.557 acres
NVN 099970 NV-2020-12-1526, 1759.25 acres
NVN 099971 NV-2020-12-1530, 2080 acres
NVN 099972 NV-2020-12-1534, 1446 acres
NVN 099973 NV-2020-12-1541, 1407 acres
NVN 099974 NV-2020-12-1537, 2264.8 acres
NVN 099975 NV-2020-12-1512, 920.44 acres
NVN 099976 NV-2020-12-6909, 560 acres
NVN 099977 NV-2020-12-1510, 640 acres
NVN 099978 NV-2020-12-1518, 1790.32 acres
NVN 099979 NV-2020-12-1528, 762.6 acres
NVN 099980 NV-2020-12-1506, 436.75 acres
NVN 099981 NV-2020-12-1516, 194.17 acres

Protesting Party Contact Information and Statement of Interests

This Protest is filed on behalf of the protesting party by its authorized representative:

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The Center is a non-profit environmental organization dedicated to the protection of native species and their habitats in the Western Hemisphere through science, policy, and environmental law. The

Center has over 1.7 million members and supporters throughout Nevada and the United States, including dozens of supporters who live in the Battle Mountain and Ely Districts, and who utilize public lands for recreation and other uses. The Center's Nevada program focuses on the protection of wildlife and endangered species, the preservation of public lands, and the sustainability of Nevada's groundwater resources.

The mailing addresses for individual protestors are as follows:

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Statement of Reasons Why the Proposed Lease Sale is Unlawful

A. BLM violated Section 7 of the Endangered Species Act (ESA) by failing to ensure that agency actions will not jeopardize the continued existence of species listed under the Endangered Species Act, including the Railroad Valley springfish.

B. BLM violated the Tonopah RMP and the Federal Land Policy and Management Act (FLPMA) by failing to consult with the U.S. Fish and Wildlife Service regarding the project's impacts to threatened and endangered species.

C. BLM violated the Tonopah RMP and the Federal Land Policy and Management Act (FLPMA) by failing to protect, restore, and enhance habitat for the threatened Railroad Valley springfish.

D. BLM violated the National Environmental Policy Act (NEPA) by failing to conduct the necessary analysis of site-specific impacts at the leasing stage; failing to provide a convincing statement of reasons as to why the project's impacts are insignificant; and failing to prepare an environmental impact statement (EIS).

E. BLM violated the National Environmental Policy Act (NEPA) by failing to adequately disclose or analyze the project's impacts on groundwater and surface water resources.

F. BLM violated the National Environmental Policy Act (NEPA) by failing to adequately disclose or analyze the project's impacts to threatened and endangered species.

G. BLM violated the National Environmental Policy Act (NEPA) by failing to adequately disclose or analyze the project's impacts to greater sage-grouse.

H. BLM violated the National Environmental Policy Act (NEPA) by failing to adequately disclose or analyze the project's impacts on global climate change.

A. BLM violated Section 7 of the Endangered Species Act (ESA) by failing to ensure that agency actions will not jeopardize the continued existence of species listed under the Endangered Species Act, including the Railroad Valley springfish.

BLM's failure to consult with the Fish and Wildlife Service regarding impacts to listed species, including the Railroad Valley springfish, is unsupported and violates Section 7 of the Endangered Species Act. BLM must not only evaluate the indirect and cumulative effects on special status species under NEPA, but it must also (a) consult with the Fish and Wildlife Service under Section 7 regarding the effects of oil and gas development and water use on listed species and critical habitat, and (b) evaluate the effects on sensitive species under its own sensitive species policy.

While BLM did complete "programmatic" consultation with FWS on the Tonopah RMP in 1994, the resulting biological opinion was, of necessity, a high-level document which was never intended to provide site-specific analysis or guidance on the potential impacts of oil and gas leasing and development on the Railroad Valley springfish. Nor is the document current. Subsequent developments—most notably BLM's failure to designate a Railroad Valley Area of Critical Environmental Concern (ACEC) and advances in oil and gas extraction technology—call into question the ongoing validity of the Tonopah RMP programmatic biological opinion.

Federal and state authorities have long recognized the high value of groundwater-dependent ecosystems in Railroad Valley for native wildlife, including migratory birds and endemic species such as the Railroad Valley springfish. A sweeping 1934 executive order set aside 133,396 acres as the Railroad Valley Migratory Bird Refuge, noting "swampy areas" that were used by migratory birds for "nesting, resting, and feeding." At the time, it was the third-largest federally designated wildlife sanctuary. Management of the refuge lands was subsequently transferred to BLM and the State of Nevada. Later, a series of executive actions in the 1960s changed the area's designation to the Railroad Valley "Wildlife Management Area," and significantly reduced its size. Nevertheless, 14,720 acres in Railroad Valley retain the special designation. A 1990 "Habitat Management Plan" for the Railroad Valley Wildlife Management Area (WMA) emphasizes the protection and recovery of imperiled wildlife species including the Railroad Valley springfish.

The 1997 Tonopah RMP acknowledges the special status of the Railroad Valley WMA and commits BLM to "protec[ing], restor[ing], enhance[ing]," and "expand[ing] habitat" for threatened and endangered species. Under the RMP, habitat for all federally listed threatened or endangered species must be "managed to maintain or increase populations of these species." Specific requirements include "protect[ing] the Railroad Valley springfish and its critical habitat" at springs in Railroad Valley. Importantly, the RMP expressly requires site-specific consultation for all projects that may affect threatened or endangered species.

The FWS biological opinion accompanying the RMP contemplates a number of specific actions, including the designation of a Railroad Valley ACEC. However, ACEC designation was ultimately deferred by the final RMP and Record of Decision (ROD) and has yet to occur. Further, the biological opinion for the RMP did not consider the regional or site-specific environmental impacts of present-day oil and gas extraction methods, including hydraulic fracturing or "fracking," in Railroad Valley or elsewhere.

BLM is now proposing to lease parcels in Railroad Valley in the September lease sale which lie within the same hydrographic basin as multiple springs within the Railroad Valley WMA and designated as critical habitat for the Railroad Valley springfish. The potential impacts of fracking to these springs, including impacts to groundwater quality, groundwater quantity, and resulting changes to surface waters, clearly warrant consultation with FWS about the specific lease parcels and how fracking at those parcels may affect the Railroad Valley springfish.

Congress enacted the Endangered Species Act (ESA) in 1973 to provide for the conservation of endangered and threatened fish, wildlife, plants and their natural habitats. 16 U.S.C §§ 1531-32. The ESA imposes substantive and procedural obligations on all federal agencies with regard to listed and proposed species and their critical habitats. *See id.* §§ 1536(a)(1)-(4) and 1538(a); 50 C.F.R. § 402. Under Section 7 of the ESA, federal agencies must "insure that any action authorized, funded, or carried out by such agency . . . is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat of such species which is determined . . . to be critical."16 U.S.C. § 1536(a)(2).

The definition of agency "action" is broad and includes "all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies," including programmatic actions. 50 C.F.R. § 402.02. Likewise, the "action area" includes "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action." *Id.*

The duties in ESA section 7 are only fulfilled by an agency's satisfaction of the consultation requirements that are set forth in the implementing regulations for section 7 of the ESA, and only after the agency lawfully complies with these requirements may an action that "may affect" a protected species go forward. *Pac. Rivers Council v. Thomas*, 30 F.3d 1050, 1055-57 (9th Cir. 1994). The action agency must initially prepare a biological assessment (BA) to "evaluate the potential effects of the proposed action" on listed species. 50 C.F.R. § 402.12. If the action agency concludes that the proposed action is "not likely to adversely affect" a listed species that occurs in the action area, the Service must concur in writing with this determination. *Id*. §§ 402.13(a) and 402.14(b). If the Service concurs in this determination, then formal consultation is not required. *Id*. § 402.13(a). If the Service's concurrence in a "not likely to adversely affect" finding is inconsistent with the best available data, however, any such concurrence must be set aside. *See id*. § 402.14(g)(8); 5 U.S.C. § 706(2).

If the action agency concludes that an action is "likely to adversely affect" listed species or critical habitat, it must enter into "formal consultation" with the Service. 50 C.F.R. §§ 402.12(k), 402.14(a). The threshold for triggering the formal consultation requirement is "very low"; indeed, "any possible effect . . . triggers formal consultation requirements."

Formal consultation commences with the action agency's written request for consultation and concludes with the Service's issuance of a "biological opinion." 50 C.F.R. § 402.02. The biological opinion states the Service's opinion as to whether the effects of the action are "likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of critical habitat." *Id.* § 402.14(g)(4). When conducting formal consultation, the Service and the action agency must evaluate the "effects of the action," including all direct and indirect effects of the proposed action, plus the effects of actions that are interrelated or interdependent, added to all existing environmental conditions—that is, the "environmental baseline." *Id.* §§ 402.14 and 402.02. The environmental baseline includes the past and present impacts of all Federal, state, and private actions and other human activities in the action area." *Id.* The effects of the action must be considered together with "cumulative effects." *Id.*

If the Service concludes in a biological opinion that jeopardy is likely to occur, it must prescribe "reasonable and prudent alternatives" to avoid jeopardy. *Id.* § 402.14(h)(3). If the Service concludes that a project is not likely to jeopardize listed species, it must nevertheless provide an incidental take statement (ITS) with the biological opinion, specifying the amount or extent of take that is incidental to the action (but which would otherwise be prohibited under Section 9 of the ESA), "reasonable and prudent measures" (RPMs) necessary or appropriate to minimize such take, and the "terms and conditions" that must be complied with by the action agency to implement any reasonable and prudent measures. 16 U.S.C. § 1536(b)(4); 50 C.F.R. § 402.14(i).

The ESA requires federal agencies to use the best scientific and commercial data available when consulting about whether federal actions will jeopardize listed species. *See* 16 U.S.C. § 1536(a)(2). Accordingly, an action agency must "provide the Service with the best scientific and commercial data available or which can be obtained during the consultation for an adequate review of the effects that an action may have upon listed species of critical habitat." 50 C.F.R. § 402.14(d). Likewise, "[i]n formulating its biological opinion . . . the Service will use the best scientific and commercial data available." *Id.* § 402.14(g)(8). However, if the action agency failed "to discuss information that would undercut the opinion's conclusions," the biological opinion is legally flawed, and the ITS will not insulate the agency from ESA Section 9 liability. *See Ctr. for Biological Diversity v. BLM*, 698 F.3d 1101, 1127-28 (9th Cir. 2012).

Section 7(d) of the ESA provides that once a federal agency initiates consultation on an action under the ESA, the agency, as well as any applicant for a federal permit, "shall not make any irreversible or irretrievable commitment of resources with respect to the agency action which has the effect of foreclosing the formulation or implementation of any reasonable and prudent alternative measures which would not violate subsection (a)(2) of this section." 16 U.S.C. § 1536(d). The purpose of section 7(d) is to maintain the environmental status quo pending the completion of consultation. Section 7(d) prohibitions remain in effect throughout the consultation period and until the federal agency has satisfied its obligations under section 7(a)(2) that the action will not result in jeopardy to listed species or adverse modification of critical habitat.

BLM must use the existing readily available data to identify which sensitive species that are of critical concern with regards to the lands included in, or in immediate proximity to, the proposed sale parcels.

In addition, BLM must consult with the Service regarding the impacts of the lease sale on affected listed species, in compliance with its section 7 obligations under the ESA. To the extent that BLM relies on its section 7 programmatic consultations for the Tonopah RMP, that reliance is not proper for any of the listed species affected by BLM's action. The Tonopah RMP and biological opinion expressly require site-specific consultation with FWS, and BLM has an independent legal duty under the ESA to formally consult over the lease sale's potential adverse effects on listed species and consider the full scope of fracking and other drilling activities that could affect these species.

The law is clear that, in the context of oil and gas leasing, "agency action" under the ESA includes not just the legal transaction of lease issuance, but also all resulting post-leasing activities from exploration, through production, to abandonment:

> [W]e hold that agency action in this case entails not only leasing but leasing and all post-leasing activities through production and abandonment. Thus, section 7 of the ESA on its face requires the FWS in this case to consider all phases of the agency action, which includes postleasing activities, in its biological opinion. Therefore the FWS was required to prepare, at the leasing stage, a comprehensive biological

> opinion assessing whether or not the agency action was likely to jeopardize the continued existence of protected species, based on "the best scientific and commercial data available.

Conner v. Burford, 848 F.2d 1441, 1453 (9th Cir. 1988). The BLM's refusal to consult at the lease stage, and proposal to defer consultation to the APD stage, is precisely the sort of incremental step consultation decisively rejected as inconsistent with the ESA in *Conner*. The refusal to consult at the lease stage further precludes reliance on the earlier Tonopah RMP and any related plan-level consultation, because that plan-level consultation does not include site-specific evaluations for individual activities. Under *Conner*, the individual activity in question is clearly the issuance of a lease, and consultation must occur prior to lease issuance if the resulting activities may affect listed species or critical habitat.

As discussed further below, a deep carbonate aquifer that underlies the majority of the Great Basin flows underneath the proposed lease parcels, generally trending from northeast to southwest. These groundwater reservoirs are the most vital resources in the Great Basin desert, supporting the vast majority of Nevada's robust biodiversity, and frequently harboring species protected or proposed for protection under the Endangered Species Act.

We have outlined in specific detail the ways that oil drilling and fracking may impact ground and surface water quantity and quality in our comment letter on the EA, which is incorporated here by reference. None of those concerns have been substantively addressed in the Final EA.

In light of the critical importance of groundwater and surface water resources, it is incumbent upon the BLM to include a rigorous analysis of potential impacts to these resources, and the cascading effects such impacts would have on the region's wildlife and biodiversity. Instead, what BLM offers in the EA is a minimization of potential impacts, and a delay on any actual analysis until the APD phase. As described above and below, this is an unlawful circumvention of the ESA's consultation requirements. Impacts to the quality and quantity of groundwater, and thus to the surface expression of those waters, are reasonably foreseeable and must be analyzed.

Based on the forgoing information and the proximity of the proposed lease parcels to the critical habitat for the Railroad Valley springfish, there is substantial basis to conclude that leasing and post-leasing activities may affect the threatened Railroad Valley springfish. Therefore, under ESA Section 7, BLM must have site-specific consultation with FWS prior to leasing.

B. BLM violated the Tonopah RMP and the Federal Land Policy and Management Act (FLPMA) by failing to consult with the U.S. Fish and Wildlife Service regarding the project's impacts to threatened and endangered species.

For the same reasons as discussed above, BLM has violated the Tonopah RMP and FLPMA. Under

FLPMA, all resource management decisions must "conform with the approved [land use] plan." 43 U.S.C. § 1712; 43 C.F.R. § 1610.5-3(a). *See also Norton v. S. Utah Wilderness Alliance*, 542 U.S. 55, 69 (2004); *Western Watersheds Project v. Bennett*, 392 F.Supp.2d 1217, 1227 (D. Id. 2005). If a proposed action is not consistent with the land use plan, BLM must rescind the proposed action or amend the plan. 43 C.F.R. §§ 1610.5-3, 1610.5-5.

Here, the Tonopah RMP requires Section 7 consultation on "all Federal actions involving threatened or endangered species." RMP/ROD at 28. As discussed above, courts have firmly established that oil and gas leasing is a federal action potentially affecting endangered or threatened species, and which therefore requires Section 7 consultation. BLM's failure to engage in such consultation at the leasing stage thus violates the ESA, the Tonopah RMP, and FLPMA.

C. BLM violated the Tonopah RMP and the Federal Land Policy and Management Act (FLPMA) by failing to protect, restore, and enhance habitat for the threatened Railroad Valley springfish.

In addition to requiring site-specific consultation for all federal actions affecting threatened and endangered species, the Tonopah RMP requires BLM to "protect, restore, enhance, and expand habitat of species identified as threatened, endangered, or Nevada BLM Sensitive Species under the Endangered Species Act." RMP/ROD at 9. "Habitat for all Federally listed threatened or endangered species or Nevada BLM Sensitive Species" must be "managed to maintain or increase current populations of these species." *Id.* Specifically, with respect to the Railroad Valley springfish, BLM must "[c]ontinue to protect the Railroad Valley springfish and its critical habitat" on BLM public lands. *Id.* BLM may not authorize any land uses "incompatible" with the Railroad Valley Wildlife Management Area's "values." *Id.*

The EA contains no specific information regarding the project's likely impacts to the Railroad Valley springfish or BLM sensitive species. Rather, the EA defers detailed, site-specific environmental analysis and ESA consultation to the APD stage. Not only does this approach violate the ESA, as discussed above, but it also violates the Tonopah RMP. Without detailed information on how the Railroad Valley springfish and other species of concern will be affected, BLM cannot ensure compliance with the RMP. Specifically, BLM cannot take appropriate action at the leasing stage to protect, restore, or enhance habitat for listed and sensitive species; it cannot ensure that habitat for these species is being managed to maintain or increase populations; and it cannot ensure consistency with the RMP's specific requirements that the Railroad Valley springfish continue to be protected, and that land uses incompatible with the Railroad Valley WMA's values not be authorized. Consequently, BLM has violated the Tonopah RMP and FLPMA.

D. BLM violated the National Environmental Policy Act (NEPA) by failing to conduct

the necessary analysis of site-specific impacts at the leasing stage; failing to provide a convincing statement of reasons as to why the project's impacts are insignificant; and failing to prepare an environmental impact statement (EIS).

NEPA requires agencies to undertake thorough, site-specific environmental analysis at the earliest possible time and prior to any "irretrievable commitment of resources" so that the action can be shaped to account for environmental values. *Pennaco Energy, Inc. v. United States DOI*, 377 F.3d 1147, 1160 (10th Cir. 2004). Oil and gas leasing is an irretrievable commitment of resources. *S. Utah Wilderness All. v. Norton*, 457 F. Supp. 2d 1253, 1256 (D. Utah 2006). Thus, NEPA establishes "action-forcing" procedures that require agencies to take a "hard look," at "all foreseeable impacts of leasing" before leasing can proceed. *Center for Biological Diversity v. United States DOI*, 623 F.3d 633, 642 (9th Cir. 2010); *N.M. ex rel. Richardson v. BLM*, 565 F.3d 683, 717 (10th Cir. 2009). Chief among these procedures is the preparation of an environmental impact statement ("EIS"). *Id.* BLM, however, did not prepare an EIS.

In order to determine whether a project's impacts may be "significant," an agency may first prepare an EA. 40 C.F.R. §§ 1501.4, 1508.9. If the EA reveals that "the agency's action may have a significant effect upon the . . . environment, an EIS must be prepared." *Nat'l Parks & Conservation Ass'n v. Babbitt*, 241 F.3d 722, 730 (9th Cir. 2001) (internal quotations omitted). If the agency determines that no significant impacts are possible, it must still adequately explain its decision by supplying a "convincing statement of reasons" why the action's effects are insignificant. *Blue Mountains Biodiversity Project v. Blackwood*, 161 F.3d 1208, 1212 (9th Cir. 1998) (emphasis added). However, BLM's EA did not outline any convincing statement of reasons as to whether the act of opening up over 16,598 acres of land to oil and gas activities such as fracking will have any significant impact, and furthermore failed to provide any clear or "convincing statement of reasons" for a finding of no significant impact.

BLM also failed to include any analyses of site-specific impacts. BLM claims, with regard to wildlife impacts:

> Offering, selling, and issuing federal oil and gas leases would not produce any direct impacts to wildlife resources. However, there may be indirect impacts from future ground disturbing activities on any leased parcels. It is not possible to know the specific acres and types of habitat that would be disrupted, and the BLM would not receive any applications for exploration or development until after the lease sale.

EA at 3.2.8, p. 27. BLM thus failed both of NEPA's "twin aims"—not only did BLM fail to ensure that the agency takes a "hard look" at the environmental consequences of its proposed action, but it also failed to make information on the environmental consequences available to the public, which may then offer its insight to assist the agency's decision-making through the comment process. *See Robertson v. Methow Valley Citizens Council*, 490 U.S. 332, 349 (1989). NEPA's procedural requirement is not merely a formality, but is there to allow the agencies and the public to understand the consequences of the proposed lease auction.

BLM's deferral of site-specific analysis until the APD stage is unlawful under NEPA, its implementing regulations, and legal precedents. Courts have repeatedly rejected BLM's claim that it is not required to conduct any site-specific environmental review until after the parcels are leased and a proposal is submitted by industry. *See Center for Biological Diversity & Sierra Club v. BLM*, 937 F. Supp. 2d 1140, 1158 (N.D. Cal. 2013) ("BLM asserts the now-familiar argument that there is no controversy because any degradation of the local environment from fracking should be discussed, if ever, when there is a site-specific proposal. But the Ninth Circuit has specifically disapproved of this as a reason for holding off on preparing an EIS.").

BLM is required under NEPA to perform and disclose an analysis of environmental impacts of the parcels offered for lease before there are any "irreversible and irretrievable commitments of resources." *Center for Biological Diversity*, 937 F. Supp. 2d at 1152 (citing *Conner v. Burford*, 848 F.2d 1441, 1446 (9th Cir. 1988) ("Our circuit has held that an EIS must be prepared before any irreversible and irretrievable commitment of resources.") (emphasis added). "[N]on-NSO leases, even if subject to substantial government regulation, do constitute an 'irretrievable commitment of resources.' As a result, unless the lease reserves to the agencies an 'absolute right to deny exploitation of those resources,' the sale of [] non-NSO leases . . . constitutes the go or no-go point where NEPA analysis becomes necessary." *Id.* at 1152. In other words, the specific environmental effects of oil and gas leasing in the project area must be analyzed and disclosed now, at the leasing stage.

Rather than perform the environmental review as required, BLM tiers to the environmental impact statements ("EIS") for the 1997 Tonopah RMP, and the 2015 Nevada and Northeastern California Greater Sage-Grouse Approved RMP Amendment ("ARMPA"), EA at 18-19, and defers the site-specific analysis until after the parcels are leased. *Id.* at 2.1, p. 4. This is unlawful.

For instance, BLM is required to analyze all foreseeable human health and safety risks, environmental risks and seismic risks posed by unconventional extraction techniques before leasing. BLM's analyses on these issues are outdated and/or cursory at best. In *Center for Biological Diversity & Sierra Club v. BLM*, 937 F. Supp. 2d 1140, 1152 (N.D. Cal. 2013), BLM also attempted to defer NEPA analysis of hydraulic fracturing on the parcels at issue until it received a site-specific proposal, because the exact scope and extent of drilling that would involve fracking was unknown. The district court held BLM's "unreasonable lack of consideration of how fracking could impact development of the disputed parcels went on to unreasonably distort BLM's assessment," and explained:

> "[T]he basic thrust" of NEPA is to require that agencies consider the range of possible environmental effects before resources are committed and the effects are fully known. "Reasonable forecasting and speculation is thus implicit in NEPA, and we must reject any attempt by agencies to shirk their responsibilities under NEPA by labeling any and all discussion of future environmental effects as 'crystal ball inquiry.'"

Center for Biological Diversity, 937 F. Supp. 2d at 1157 (citing *City of Davis v. Coleman*, 521 F.2d 661, 676 (9th Cir. 1975)). In sum, BLM must take a hard look at the specific parcels that it is offering for oil and gas leasing, and the foreseeable impacts to the resources on these parcels. BLM insists, however, on postponing any such analysis until it has already signed over drilling rights and is unable to preclude all surface disturbing activities to prevent critical environmental impacts that may arise after a proper NEPA analysis. This is a violation of NEPA.

Moreover, the EA at issue here does not provide any clear or convincing statement of reasons for a finding of no significant impact (FONSI). If a FONSI is to be issued, substantial changes would have to be made to the EA to provide legitimate disclosure and analysis of impacts, something lacking in the current document. The EA discusses generally and vaguely the amount of surface disturbance that may result from leasing, the number of wells that might be drilled, the types of pollutants that may be emitted during development and production; but it does not discuss the potential impacts of any of these on climate change or the human environment. BLM cannot simply jump to the conclusion that its stipulations and proposed mitigation measures will lessen the potential impacts to the level of insignificance.

In evaluating the significance of the impact of the proposed action, the agency must consider both the context of the action as well as the intensity. The several contexts in which the significance of an action must be analyzed includes "society as a whole (human, national), the affected region, the affected interests, and the locality." 40 C.F.R. § 1508.27. For site-specific actions, significance usually depends on the impact of the action on the locale, *id.*, but it also depends on the impact on the world as a whole. Thus, to determine the significance of the action, BLM needed to look at not only the environmental impacts on the area to be leased, but also the analysis of the cumulative effects of oil and gas leasing on climate change.

Furthermore, BLM's estimates regarding surface disturbance is based on historic information from a decades old RMP which apparently does not take into account the recent sharp increase in leasing nominations and initial instances of fracking use in Nevada. BLM should have considered in its EA the increased industry interest in Nevada oil and gas, and the potential for drilling levels to increase, should oil prices rise or well stimulation techniques change the production potential of Nevada hydrocarbon-bearing formations.

E. BLM violated the National Environmental Policy Act (NEPA) by failing to adequately disclose or analyze the project's impacts on groundwater and surface water resources.

The more than 16,598 acres of proposed lease parcels are situated within a vast and complex hydrographic region. A deep carbonate aquifer that underlies the majority of the Great Basin flows underneath the proposed lease parcels, generally trending from northeast to southwest. This aquifer is largely comprised of "fossil water," which accumulated underground during the Pleistocene and continues to flow and discharge to this day. Above the carbonate aquifer are basin-fill or alluvial aquifers, which move precipitation from the region's numerous mountain ranges to the valley floors. As groundwater flow meets resistant layers of rock, both systems give rise to surface expressions of groundwater, generally in the form of springs and wetlands. These surface water expressions are the most vital resources in the desert, supporting the vast majority of Nevada's robust biodiversity, and frequently harboring species protected or proposed for protection under the Endangered Species Act.

Nevada's most precious resource is its groundwater. Abundant relative to the aridity of the climate, Nevada's groundwater supports hundreds of thousands of Nevadans for domestic use, the majority of Nevada's agricultural output and almost the entirety of Nevada's biodiversity. As a result of the critical importance of this resource, any federal action which may cause impacts to groundwater quantity must include a rigorous analysis of the possibility of those impacts, and the potential effects should impacts to groundwater quantity occur.

Here, the EA literally makes no mention of the potential or mechanism for the consumption of water resources. However, there are numerous reasonably foreseeable impacts to water quantity from fracking, and BLM is legally obligated to analyze such impacts.

As detailed in the Center's August 19, 2020 comments, the volumes of water needed to successfully fracture rock to open up oil and gas resources vary widely: statewide median quantities utilized fall between 76,818 gallons (0.23 acre-feet) per well to 5,259,965 gallons (15.9 acre-feet) per well. Without citations, the EA's own fracking "white paper" puts forward ranges of 25,000 to 500,000 gallons for shallow vertical wells, and 800,000 to 10 million (2.4 to 30.3 acre-feet) for deep tight sand gas horizontal or directionally drilled wells.

Given the variability in both estimates of water consumption per well and in the number of anticipated wells, there is great uncertainty in attempting to evaluate the impacts of the proposed lease sale on quantities of water. However, this does not relieve BLM from their legal obligation to evaluate such impacts. 40 C.F.R. § 1502.22 is known as the "uncertainty rule," and indicates that agencies must include information on uncertain impacts if such information "is essential to a reasoned choice among alternatives, and the overall costs of obtaining it are not exorbitant." And indeed, these requirements are important for "impacts which have catastrophic consequences, even if their probability of occurrence is low."

The potential impacts to water quantity clearly meet this threshold. If hundreds or thousands of wells were developed—something that is not outside the realm of possibility should oil prices go back above $100 per barrel—and if those wells each required the high-end estimate of 10,000,000 gallons (30.3 acre-feet) to fracture, total water withdrawals for fractured wells from this lease sale could reach into the billions of gallons (tens of thousands of acre-feet).

Withdrawals on the level of tens of thousands of acre-feet have the potential to radically alter the hydrologic regime in the areas where such withdrawals are made. If the withdrawals are made from shallow alluvial aquifers, adjacent springs, wetlands, and other water features may dry up. If the withdrawals are made from the deeper regional aquifer, effects may be far reaching and drying could occur tens of miles away. Additionally, due to connections between local and regional aquifers, intensive pumping of alluvial aquifers may eventually impact regional aquifers. A February 4, 2020 report by Dr. Tom Myers provides a data-based analysis of the relevant hydrogeologic mechanisms, and the likely impacts of groundwater withdrawals pollution from fracking. Dr. Myers' report is hereby incorporated by reference into this protest.

A robust analysis of impacts to groundwater is important because BLM cannot rely on the state of Nevada to safeguard groundwater resources. First, the state's concept of "perennial yield" allows for the unmitigated destruction of all unallocated surface water resources. Perennial yield is notably not defined in statute, but a working definition is "the maximum amount of groundwater that can be salvaged each year over the long term without depleting the groundwater reservoir. The perennial yield cannot be more than the natural recharge of the groundwater reservoir and is usually limited to the maximum amount of natural discharge." What this functionally means is that the state of Nevada makes available for appropriation an amount of water equivalent to that which is discharged within a basin through surface discharge and evapotranspiration through phreatophytic vegetation. As such, if a basin is fully appropriated and all of those water rights are being exercised, the long-term effect will be to cease all surface discharge and eliminate all phreatophytes. This will have catastrophic and existential consequences to a variety of species.

Nevada state water law therefore does nothing to protect wildlife and other natural values present on public land—indeed, the law is structured to encourage full development of water resources, so it can be argued that Nevada state water law is actively detrimental to public land water-dependent resources. As such, BLM cannot rely on Nevada's water law as an indicator of the potential for groundwater impacts and overappropriation. An independent analysis must be made by BLM of any groundwater withdrawals associated with development of these leases, to examine the impacts of such withdrawals and how they may affect the environment.

As has been outlined here, there is the distinct possibility of impacts to quantity of groundwater, and therefore amount of surface discharge, due to pumping for fracking either via overappropriation or localized drawdown. BLM has neglected its duty under NEPA to analyze the impacts of withdrawals for fracking on water resources and their dependent ecosystems. Further, an adequate "hard look" at such impacts would include a very broad area of analysis based on a detailed hydrologic characterization of the regional aquifers potentially affected. As discussed elsewhere in this protest and in Dr. Myers' report, dozens of endemic, endangered, or threatened species rely on water features potentially affected by pumping. Thus there are significant ramifications from neglecting to analyze impacts to water quantity or offering any protections whatsoever to water features.

BLM must also consider impacts to groundwater quality from oil and gas development. Studies have reported many instances around the country of groundwater contamination due to surface spills of oil and gas wastewater, including fracking flowback. As Dr. Myers states, fracking and other unconventional techniques pose inherent risks to groundwater due to releases below the surface, and these risks must be properly evaluated. Once groundwater is contaminated, it is very difficult, if not impossible, to restore the original quality of the water.

Groundwater contamination can occur in a number of ways, and the contamination may persist for many years. Poorly constructed or abandoned wells are recognized as one of the most likely ways by which contaminants may reach groundwater. Faulty well construction, cementing, or casing, as well as the injection of fracking waste underground, can all lead to leaks. Older wells that may not have been designed to withstand the stresses of hydraulic fracturing but which are reused for this purpose are especially vulnerable. As the Center noted in its August 2020 comments, improper well construction and surface spills are cited as a confirmed or potential cause of groundwater contamination in numerous incidents at locations across the U.S. including but not limited to Colorado, Wyoming, Pennsylvania, Ohio, West Virginia, and Texas.

Neither current federal nor state of Nevada rules do not ensure well integrity. The well casing can potentially fail over time and potentially create pathways for contaminants to reach groundwater. Well casing failure can occur due to improper or negligent construction. The EA should have studied the rates of well casing failures over time and evaluate the likelihood that well casing failures can lead to groundwater contamination.

Dr. Myers additionally notes that fluids and hydrocarbons may contaminate groundwater by migrating through newly created or natural fractures. Many unconventional techniques intentionally fracture the formation to increase the flow of gas or oil. New cracks and fissures can allow the additives or naturally occurring elements such as natural gas to migrate to groundwater. Fluids can also migrate through pre-existing and natural faults and fractures that may become pathways once the fracking or other method has been used.

BLM must consider long-term studies on the potential for fluid migration through newly created subsurface pathways. Fluid migration is of particular concern when oil and gas operations are close to drinking water supplies or waters that support special-status species such as the Railroad Valley springs.

Surface waters can also be contaminated in many ways from unconventional well stimulation. In addition to storm water runoff, surface water contamination may also occur from chemical and waste transport, chemical storage leaks, and breaches in pit liners. The spilling or leaking of fracking fluids, flowback, or produced water is a serious problem. Harmful chemicals present in these fluids can include volatile organic compounds (VOCs), such as benzene, toluene, xylenes, and acetone. As much as 25 percent of fracking chemicals are carcinogens, and flowback can even be radioactive. Contaminated surface water can thus result in many adverse effects to wildlife, agriculture, and human health and safety. It may make waters unsafe for drinking, fishing, swimming and other activities, and may be infeasible to restore the original water quality once surface water is contaminated. Based on the hydrogeology of the Railroad Valley region, springs in the Duckwater Valley and near Lockes Ranch are at particular risk of contamination. BLM should have considered this analysis in the EA.

Rather than deferring the tens of thousands of acres of proposed leases which have substantial conflict with water resources, BLM has instead elected to implement a water resources stipulation. Although we commend BLM's acknowledgment of its authority to consider and add lease stipulations at the leasing stage, the particular stipulation relied upon here would do little to protect water resources and the wildlife which depend on them. Contamination of an aquifer due to fracking would affect the entire aquifer, causing impacts to water sources as far as miles away. CSU or NSO "buffers" do little to actually protect groundwater resources. This stipulation also offers extensive discretion to BLM to accommodate developers in the form of exceptions, modifications, and waivers.

F. BLM violated the National Environmental Policy Act (NEPA) by failing to adequately disclose or analyze the project's impacts to threatened and endangered species.

The lack of any substantive analysis of impacts of the proposed action to threatened and endangered species in Section 3.2.7 of the EA is an unlawful violation of NEPA as well as the ESA. Due to its proximity to and presence in the same hydrographic basin as some of the lease parcels, BLM is legally obligated to analyze potential impacts of the proposed action to the Railroad Valley springfish.

As was outlined above, there is the distinct possibility of substantial impacts to groundwater and surface water from the proposed action. Impacts to such waters have the potential to jeopardize the continued existence of these species, and adversely modify the critical habitat of those species for which it has been so designated.

The Railroad Valley springfish is known from only two locations in the Railroad Valley—the Lockes Ranch spring complex, and the spring complex located on the Duckwater Reservation. Both locations contain designated critical habitat, and while the basin they lie within (173B) is not designated, there are significant groundwater withdrawals currently taking place. As outlined above, the fact that a basin is not overappropriated does not mean that groundwater withdrawals are not affecting surface water features. Additionally, localized effects of pumping need to be examined with close scrutiny for impacts to critical habitat adjacent to Parcel Group D, because the parcels are located extremely close to the Duckwater spring complex. Even the slightest perturbation in the aquifers that give rise to the Lockes Ranch and Duckwater spring complexes poses an existential threat to the fish, and will result in adverse modification of its critical habitat.

BLM has violated both NEPA and the ESA by unlawfully deferring its analysis of these impacts to the APD stage.

G. BLM violated the National Environmental Policy Act (NEPA) by failing to adequately disclose or analyze the project's impacts to greater sage-grouse.

The greater sage-grouse (GRSG) is a BLM sensitive species. In September 2015, all BLM resource management plans for Nevada and Northeastern California, including Tonopah, were amended as part of an effort to secure adequate regulatory mechanisms to prevent the listing of the greater sage-grouse under the Endangered Species Act. Because oil and gas development and associated infrastructure has numerous well-documented adverse effects on GRSG survival, breeding, and behavior, these plan amendments prescribe management measures for BLM-permitted activities, including oil and gas leasing, within sage-grouse habitat, and prescribed stipulations for all new fluid mineral leases within those designated habitats.

Given the significance of the potential impacts that oil and gas development could have on the species, proper investigation here is crucial. BLM is required under NEPA to collect data particular to the region affected by the leases. Despite the acknowledged presence of greater sage-grouse habitat (i.e., sagebrush) within the areas proposed for leasing, the draft EA provides absolutely no discussion of the location, nature, or significance of impacts to sage-grouse populations within the project area. This approach clearly does not provide the "hard look" that NEPA requires. The December 2020 Battle Mountain EA not only includes no site-specific analysis, but it also includes no analysis whatsoever of what sage-grouse populations and habitats will be affected, to what degree, and how those impacts may or may not be mitigated.

As the Center noted in its August 2020 comment letter, sage-grouse populations in the southern Great Basin are declining at an alarming rate, and oil and gas development has been shown to have significant impacts on both sage-grouse populations and sagebrush habitat. The failure to consider the acreage of habitat lost due to abandonment of otherwise suitable habitats adjacent to roads and well sites, and the failure to even quantify the amount of habitats critical to the life cycles of sage-grouse that occur on individual leases (much less evaluate the site-specific topography and how that might mitigate or exacerbate impacts of oil and gas development), constitute failures of NEPA's hard look requirements.

H. BLM violated the National Environmental Policy Act (NEPA) by failing to adequately disclose or analyze the project's impacts on global climate change.

Meaningful consideration of greenhouse gas emissions (GHGs) is clearly within the scope of required NEPA review. As the Ninth Circuit has held, in the context of fuel economy standard rules:

The impact of greenhouse gas emissions on climate change is precisely the kind of cumulative impacts analysis that NEPA requires agencies to conduct. Any given rule setting a CAFE standard might have an "individually minor" effect on the environment, but these rules are "collectively significant actions taking place over a period of time."

Center for Biological Diversity v. Nat'l Highway Traffic Safety Admin., 538 F.3d 1172, 1216 (9th Cir. 2008)(quoting 40 C.F.R. § 1508.7). The courts have ruled that federal agencies consider indirect GHG emissions resulting from agency policy, regulatory, and leasing decisions. For example, agencies cannot ignore or dismiss as speculative the indirect air quality and climate change impact of decisions that would open up access to coal reserves. *See Mid States Coal. for Progress v. Surface Transp. Bd.*, 345 F.3d 520, 532, 550 (8th Cir. 2003); *High Country Conservation Advocates v. U.S. Forest Serv.*, 52 F.Supp. 3d 1174, 1197-98 (D. Colo. 2014). Moreover, the U.S. Court of Appeals for the Tenth Circuit reaffirmed in strikingly clear language that the National Environmental Policy Act does not allow the BLM to dismiss downstream combustion effects of fossil fuel leasing decisions based on the unsupported assumption that leasing actions will have no net effect on greenhouse gas emissions. In *Wildearth Guardians v. U.S. Bureau of Land Management*, the Court of Appeals ruled unanimously that BLM "failed to comply with the National Environmental Policy Act (NEPA) when it concluded that issuing the leases would not result in higher national carbon dioxide emissions than would declining to issue them." No. 15-8109 (10th Cir. Sept. 15, 2017), slip op. at 2-3. The BLM cannot ignore basic economic principles and assume that there will be no net effect on oil and gas production, markets, price, and ultimate consumption when it opens new federal minerals to oil and gas exploration and development.

The EA's analysis of the direct and indirect greenhouse gas emissions that would result from this lease sale is grossly inadequate. A robust body of scientific research, discussed in detail in the Center's August 2020 comments, has established that most fossil fuels must be kept in the ground to avoid the worst dangers of climate change. Human-caused climate change is already causing widespread damage from intensifying global food and water insecurity, the increasing frequency of heat waves and other extreme weather events, flooding of coastal regions by sea level rise and increasing storm surge, the rapid loss of Arctic sea ice and Antarctic ice shelves, increasing species extinction risk, and the worldwide collapse of coral reefs. BLMs failure to consider the climate change impacts of this lease sale thus not only violates NEPA, but also turns a blind eye to the existential threats posed by fossil fuel development.

Conclusion

The expansion of fossil fuel leasing into vast areas of previously-unleased Nevada public lands serves no legitimate public purpose, but threatens both the waters and native wildlife of the area and the climate at large. Unconventional oil and gas development not only fuels the climate crisis but entails significant public health risks and harms to the environment. BLM has violated the ESA, NEPA, and FLPMA by forgoing any substantive environmental analysis of the proposed lease sale. Accordingly, BLM should cancel the lease auction, or else stay the action while it conducts formal ESA consultation and prepares an EIS that thoroughly analyzes the effects of the proposed lease sale, as compared to the alternative of no new fossil fuel leasing and no fracking or other unconventional well stimulation methods within the Battle Mountain and Ely districts.

As authorized representative on behalf of the Protestor:

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Attachments:

Dr. Tom Myers, Risks Posed by Hydraulic Fracturing on Warm Springs in Railroad Valley North, Draft Technical Memorandum Prepared for the Center For Biological Diversity (Feb. 4, 2020).

The Center for Biological Diversity, Comment Letter Regarding BLM Battle Mountain District December 2020 Competitive Oil and Gas Lease Sale Draft Environmental Assessment and its

Information Supplement (DOI-BLM-NV-B000-2020-0012-EA) (August 19, 2020).

USDOI BLM, Habitat Management Plan for the Railroad Valley Wildlife Management Area (1990).

Attachment A

Dr. Tom Myers, Risks Posed by Hydraulic Fracturing on Warm Springs in Railroad Valley North, Draft Technical Memorandum Prepared for the Center For Biological Diversity (Feb. 4, 2020)

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February 4, 2020

Technical Memoradum

Prepared for: Center for Biological Diversity

Re: **DRAFT**: Risks Posed by Hydraulic Fracturing on Warm Springs in Railroad Valley North

Railroad Valley North (RRVN) is a major topographic basin in east central Nevada (Figure 1) that has three systems of warm springs that support threatened endemic fish species. The three systems are Duckwater, Lockes and Blue Eagle Springs (Figure 1).

The US Fish and Wildlife Service describes the Railroad Valley Springfish as follows:

> Railroad Valley springfish were isolated in six thermal springs distributed in two areas of Railroad Valley as ancient Lake Railroad dried. They are native to Big Warm and Little Warm Springs and Duckwater Creek on the Duckwater Shoshone Indian Reservation and Big, Reynolds, Hay Corral, and North Springs near Lockes Ranch, Nevada . Additionally, they have been introduced outside of their historical range in private ponds at Sodaville, a spring in hot Creek Canyon , Chimney Spring near Lockes, and Warm Spring in Nye County. Railroad Valley springfish have been extirpated at Big Warm Spring. They remain common in Little Warm Spring. However, Duckwater Creek no longer has resident springfish. They remain fairly numerous in Big, North, Hay Corral, and Reynolds Springs. Introduced populations are believed to remain at all but the Warm Spring and Sodaville sites.
> https://www.fws.gov/nevada/protected_species/fish/species/rrv_springfish.html

The Bureau of Land Management has proposed leasing parcels within RRVN for natural gas development which would likely include hydraulic fracturing (fracking). For example, BLM offered a Competitive Oil and Gas Lease Sale in December 2017 for areas in northern RRVN. Specifically, Parcel Group D includes BLM lands just south and east of Duckwater. The shale formations targeted for development are the Pilot and Chainman Shale, which are part of the siliclastic formation that lies between the Upper and Lower Carbonate aquifers that supply the water to Big and Little Warm Springs. The fundamental question considered herein are the potential impacts of fracking on surface waters at Lockes Ranch, Railroad Valley Wildlife Management Area, other central Railroad Valley springs, and Duckwater.

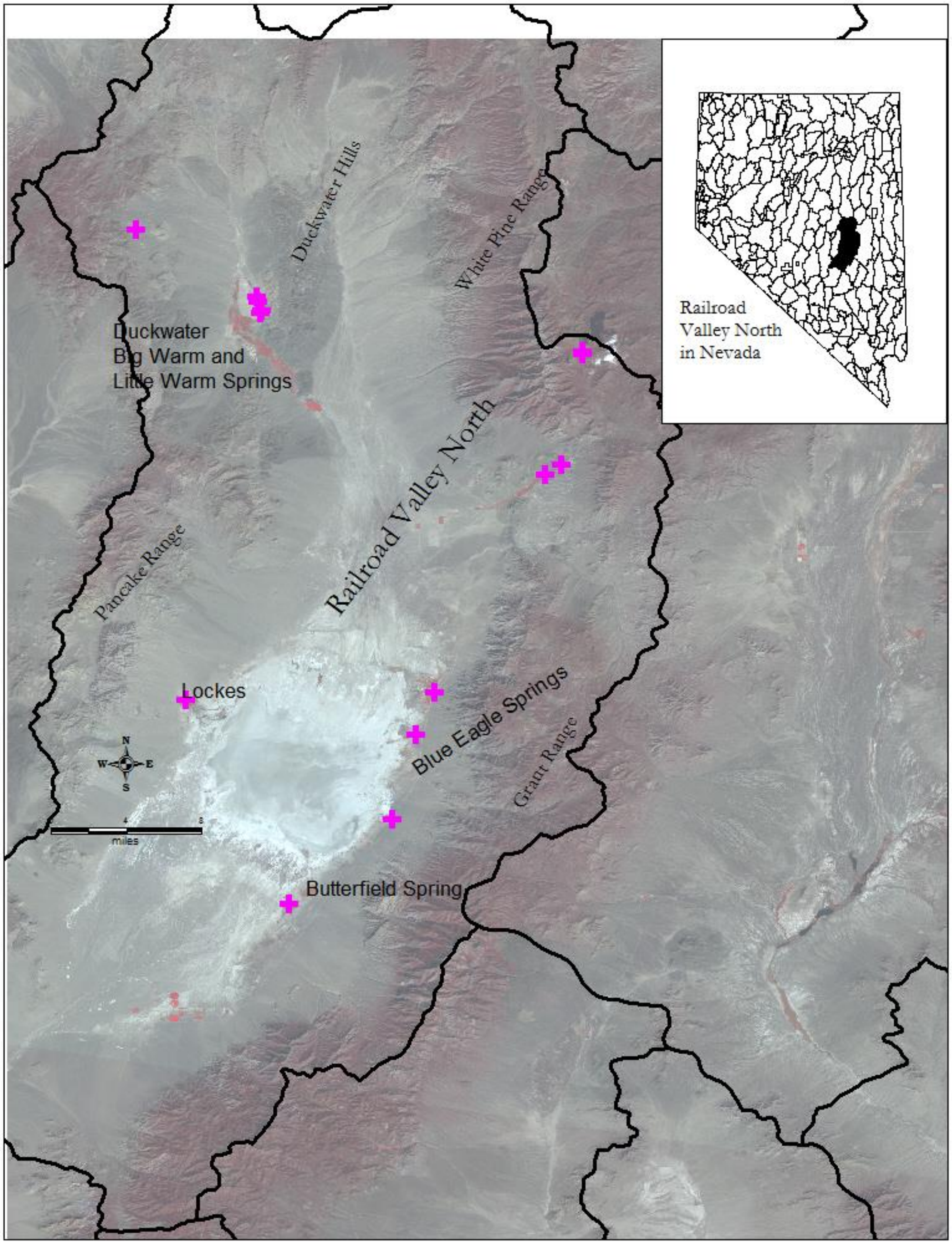

Figure 1: Railroad Valley North (RRVN) showing general location of springs and surround mountains. Unlabeled springs are not warm springs.

Conceptual Flow Model of RR Valley and the Geothermal Springs

A CFM describes the flow sources, sinks, and pathways in a hydrologic system. For a groundwater system, a CFM describes the sources of recharge to the system, such as distributed, mountain front, and stream, groundwater discharge such as evapotranspiration (ET), ET from groundwater, and interbasin flow. Recharge is meteoric water (precipitation and melting snowwater) that infiltrates the ground surface to reach a groundwater aquifer. Recharge occurs in the mountains and at the mountain front, and groundwater flows either to discharge points within the same basin or a downstream basin. Discharge points are streams, springs, and wetlands, with the warm springs being primary discharge points for RRVN. Interbasin flow includes groundwater flow to or from basins surrounding RRVN. Evapotranspiration is evaporation from the ground or plant surfaces and transpiration is evaporation from within the plant through the leaves. Groundwater ET (GWET) is ET that comes from groundwater.

Figure 2 presents a general CFM applicable to an individual basin without interbasin flow and a flow system with interbasin flow. In an unconfined aquifer, the water table is the point at which the pressure equals atmospheric pressure, the level to which groundwater would rise in a well completed in the aquifer. In a confined aquifer, groundwater levels rise above the top of the confining layer and a map of that level is a potentiometric surface. Interbasin flow in the Great Basin generally occurs through carbonate rock connecting basins. Carbonate rock is much more transmissive than other bedrock.

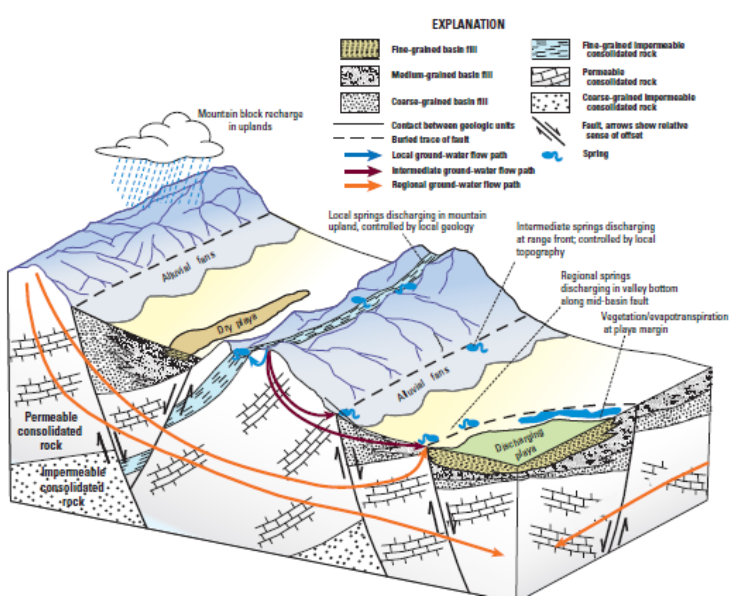

Figure 2: Figure 16 from Welch et al (2008) showing conceptual flow systems for the Great Basin.

RRVN lies within an overall flow system roughly defined by the extent of carbonate rocks overlain by alluvial or basin fill material (Figure 3). The mountain range and valleys trend broadly north to south. Carbonate rock dominates the mountain ranges east and volcanics west of RRVN (Figure 3). Carbonate rock likely provides a north-south passage for groundwater flow. Warm springs generally occur on the basin boundaries coincident with faults among the carbonate rock indicating the springs are discharge points for carbonate aquifers.

A closer focus on RRVN shows mountain ranges north and east consisting of carbonate rock (Figure 4). Springs occur on both sides of the south portion of RRVN. A small extension of RRVN to the northwest is Duckwater Valley (Figures 4 and 5). Duckwater Big and Little Warm Springs occur at the base of an escarpment in the carbonate Duckwater Hills on the east side of Duckwater Valley (Figure 4).

The overall flow system is Great Basin Carbonate and Alluvial Aquifer System (GBCAAS) (Heilweil and Brooks 2011) (Figure 6). Harrill and Prudic (1998) describe the carbonate-rock province as a 100,000-square-mile area dominated by carbonate rocks as part of a clastic rock sequence of Paleozoic age ranging from about 5000 to 30,000 feet thick (Harrill and Prudic 1998). Fault-block mountains and basins of Cenozoic age, formed from extension faulting, dominate the structural features (Id.). There is little surface water in the carbonate province, except for streams on alluvium below regional carbonate springs, because of the high infiltration and recharge capacity of the rock.

RRVN is part of a larger flow system known as the Railroad Valley flow system (RVFS) (Harrill and Prudic 1998, Prudic et al 1995, Harrill et al 1988)., which includes, in addition to RRVN, Little Smokey Valley South (155c), Little Fish Lake Valley (150), and Hot Creek Valley (156) (Figure 6). The Newark Valley/Diamond Valley flow systems bound RVFS on the north; the White River flow system on the east, the Death Valley flow system on the south, and the South-Central Marshes on the west. Generally, little groundwater flow occurs among flow systems, a factor which helps define their boundaries. Within a flow system, there may be extensive flow among individual basins. However, there is considerable uncertainty regarding whether flow exits RRV to the south. If so, it may enter the Death Valley Flow System (Rose et al 2003, Davisson et al 1999) or the White River Flow System (Thomas and Mihevc 2011) with the deep basin fill trough running north-south through RRVN dividing groundwater flow east to west.

Basin fill thickness, or depth to bedrock, varies throughout Great Basin valleys, including RRVN which has an asymmetric shape, with depth to bedrock being less than 1000 feet on the west side and more than 7000 feet in the east (Figure 7). Faults bound both sides and provide vertical pathways for groundwater to flow from depth, in the carbonate aquifer, to the surface warm springs.

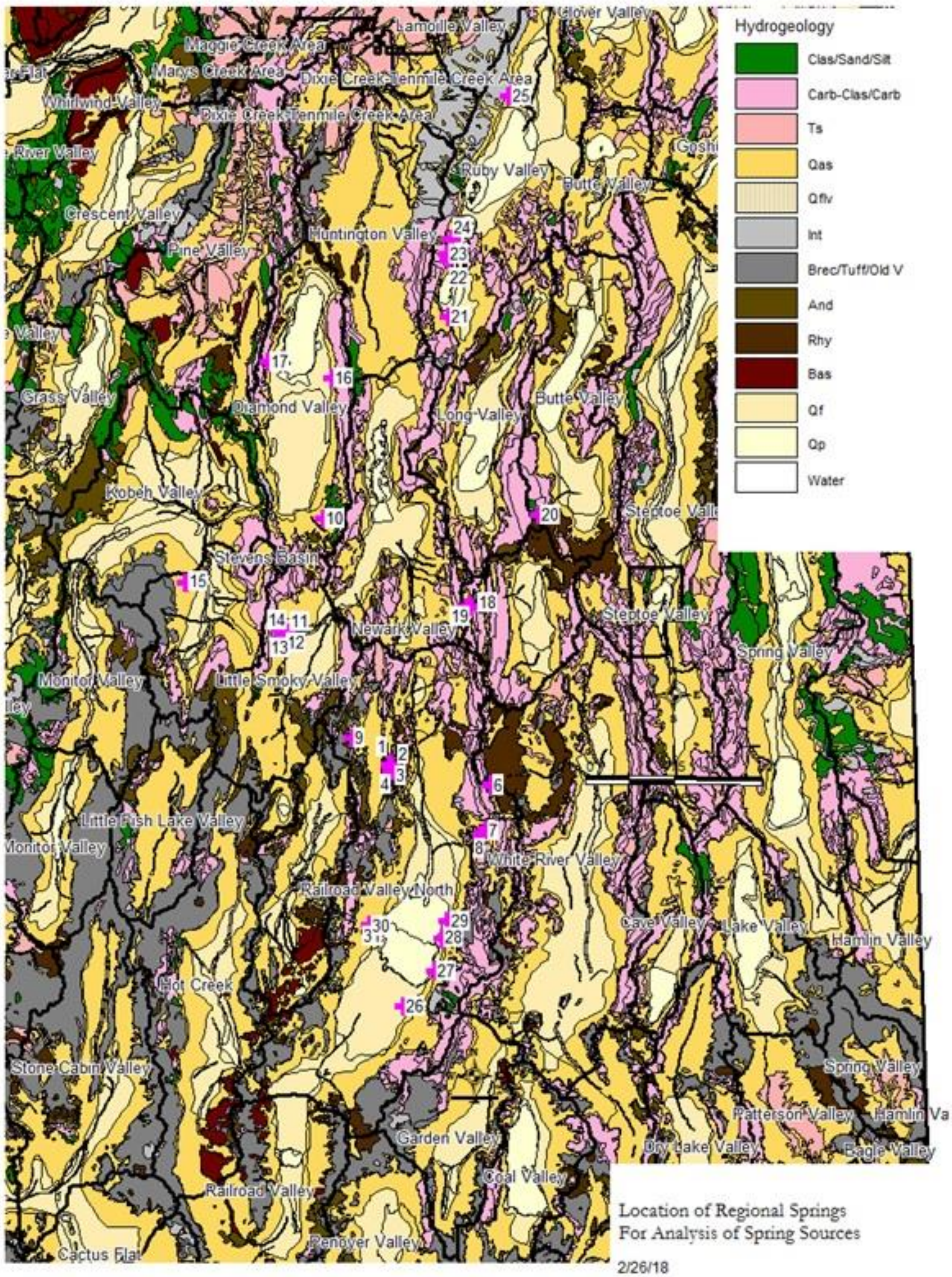

Figure 3: Location map for select regional springs analyzed for flow paths, with spring numbers, names and data in Appendix D.

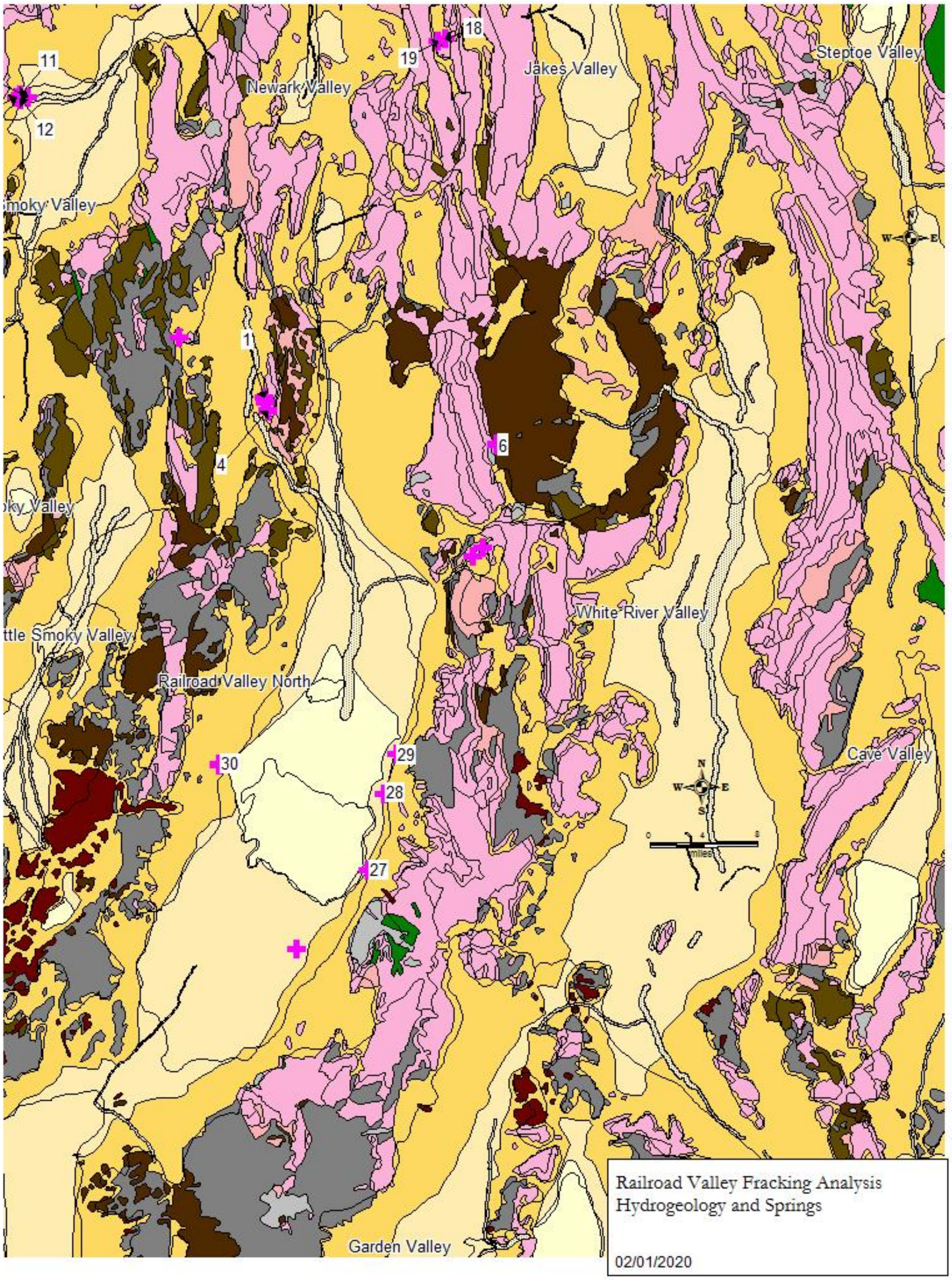

Figure 4: Hydrogeology of Railroad Valley North. See Figure 2 for definitions of the hydrogeology and Appendix A for the names of the springs.

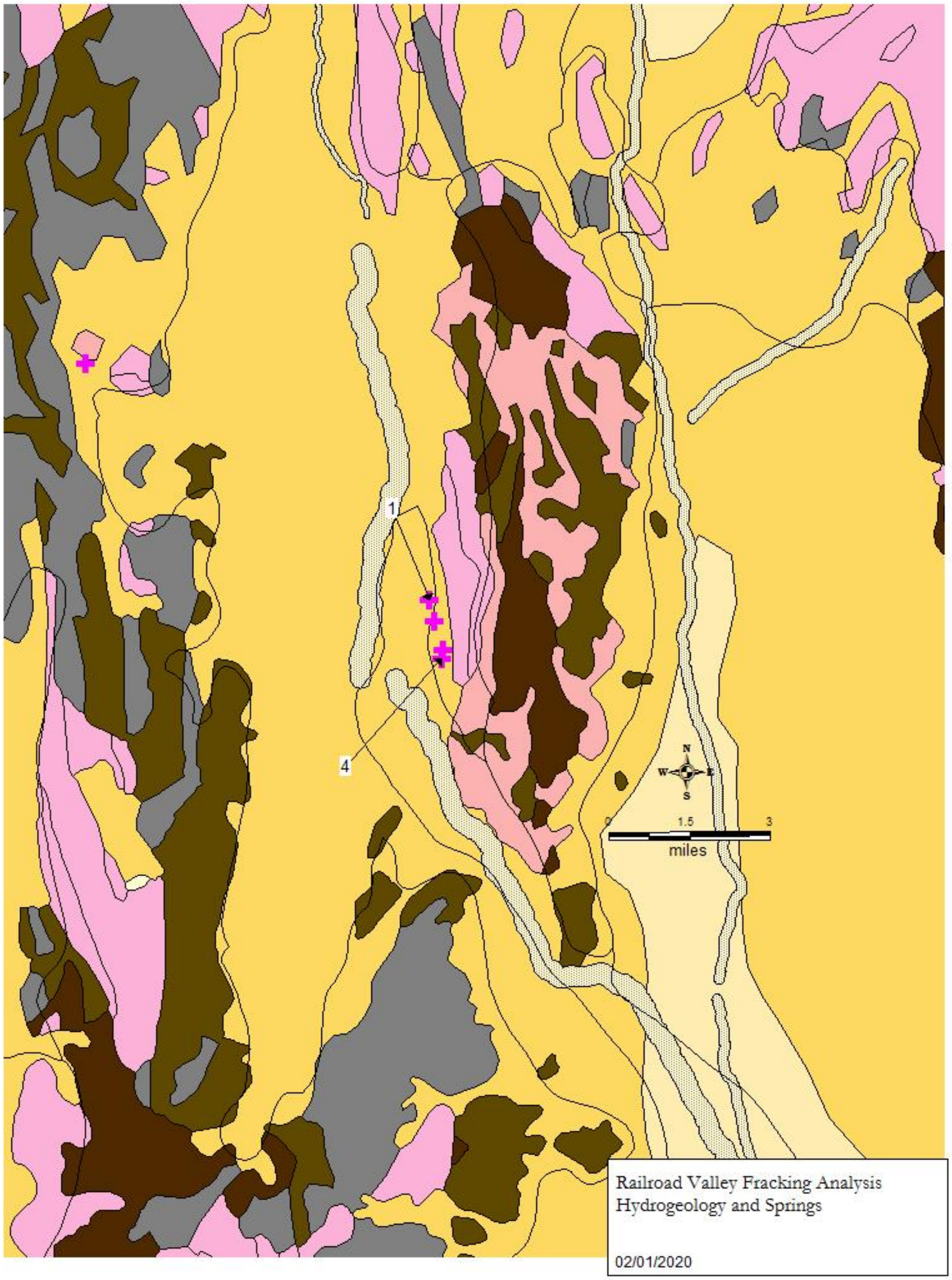

Figure 5: Hydrogeology of Duckwater Valley, which lies west of the carbonate outcrop shown in the middle of the map. See Figure 2 for definitions of the hydrogeology and Appendix A for the names of the springs.

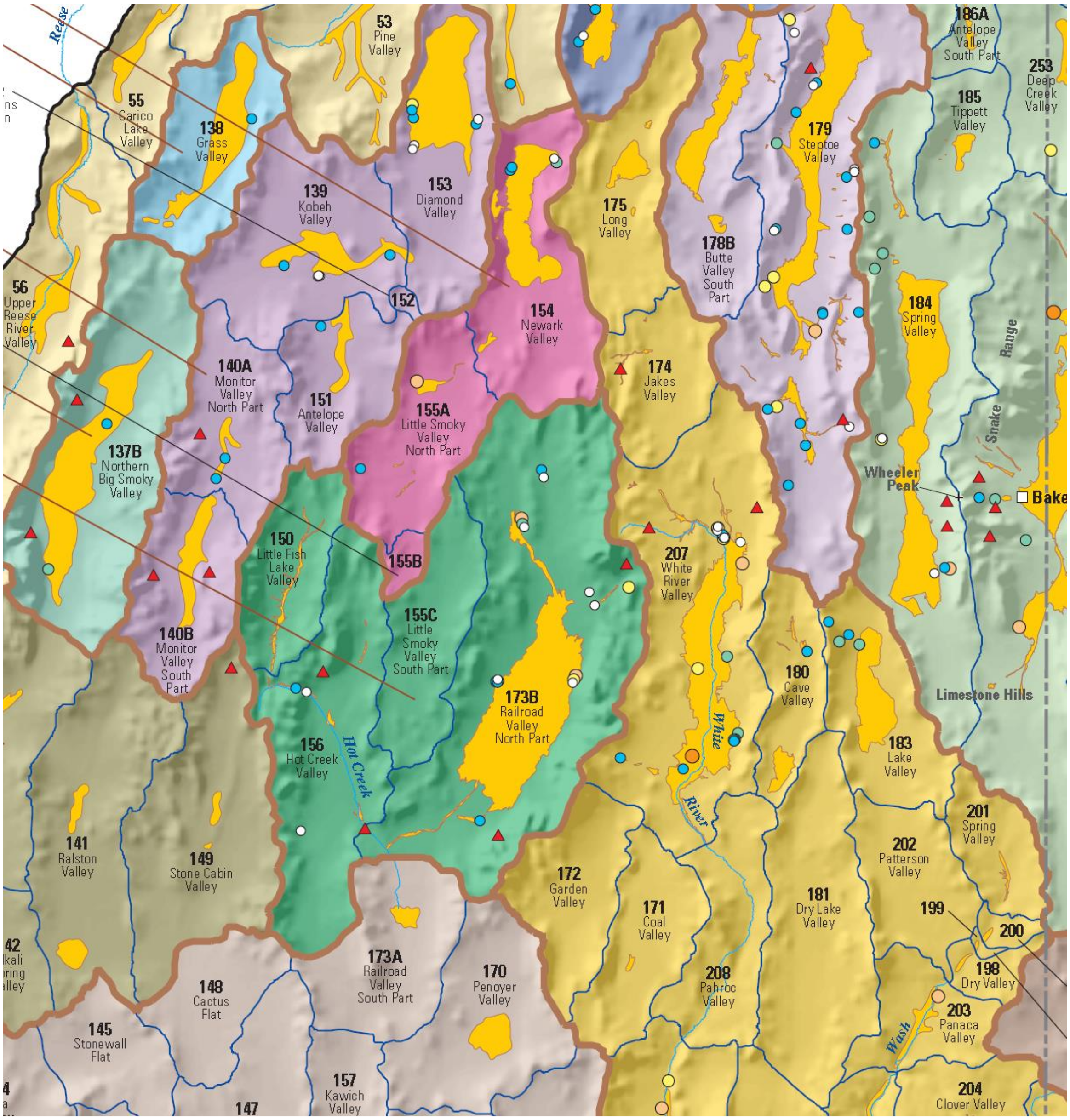

Figure 6: Snapshot of portion of Plate 1 from Heilweil and Brooks (2011) showing the Railroad Valley flow system (in green) and surrounding flow systems and basins.

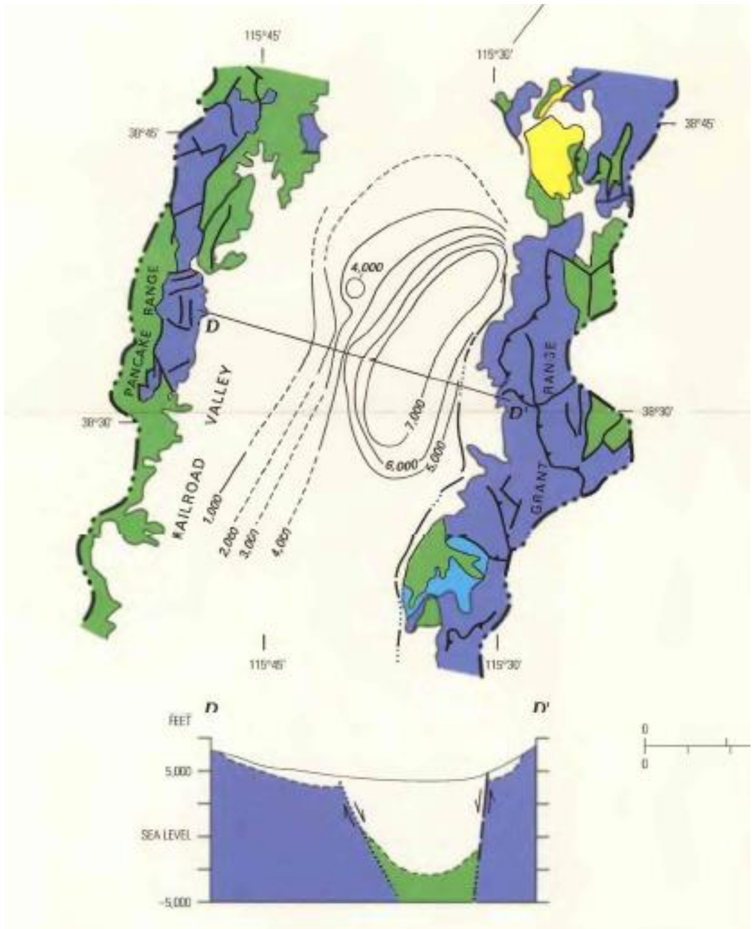

Figure 7: Snapshot of portion of Plate 3 (Plume 1996) showing plan and cross-section through Railroad Valley North about ten miles south of Duckwater.

Precipitation recharges in the mountains where the geology is conducive, such as fractured carbonate or volcanic rock, or runs off to potentially recharge at the mountain front. Carbonate rock forms most of the eastern and northern boundaries of much of RRVN, especially the boundary with White River Valley (Figure 4). Carbonate rock also forms the northern boundary with Newark Valley and extends into RRVN through the Duckwater Hills (Figures 4 and 5). Volcanics occur on the boundaries around most of the rest of the valley; their recharge properties depend on site-specific factors. In locations where the volcanics are not conducive to in-place recharge, the resulting runoff could become mountain-front recharge into surrounding basins. The mountains that form the eastern boundary are high and have substantial precipitation, especially in the north (the White Pine Range) and south (the Grant Range) (Figure 8). The high precipitation corresponds with carbonate rock so most becomes recharge (Figure 3).

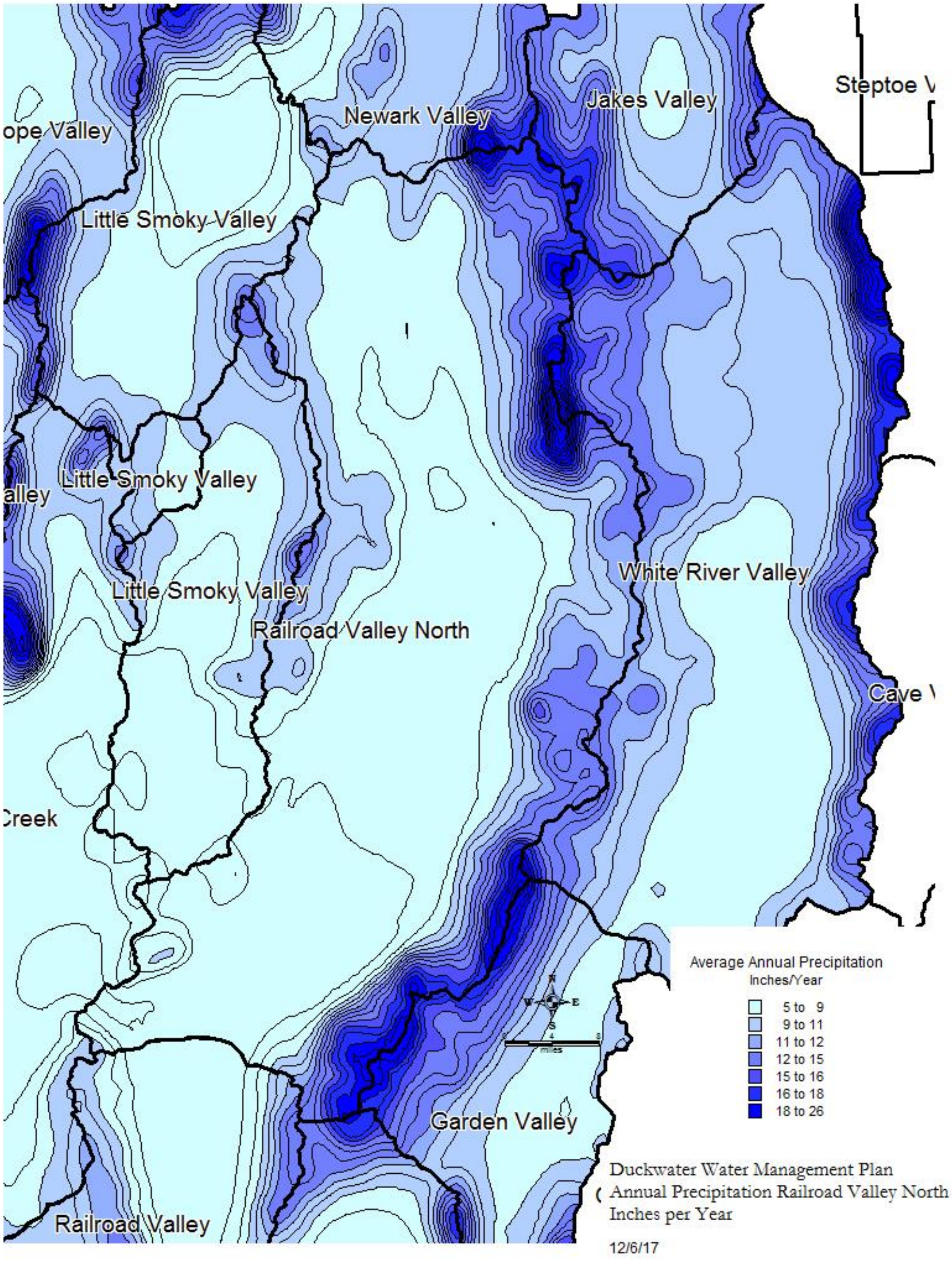

Figure 8: Average annual precipitation (in/y) for Railroad Valley North. Estimated using PRISM (***). Average based on 1981 through 2010.

Duckwater Valley lies at the northwest end of RRVN surrounded by relatively low mountains including the carbonate Duckwater Hills on the east (Figure 5). It is a distinct hydrogeologic subunit of RRVN. The watershed boundaries are 32 miles from north to south and 12 miles from east to west, for an area of 266 square miles or 170,000 acres. Elevations range from 5320 feet above mean sea level near the point Duckwater Creek leaves the Reservation to 8142 feet above mean sea level (amsl) in the Pancake Range to the southwest. Precipitation in these mountains is relatively low (Figure 8).

Potentiometric surface contours of the nearby area show upgradient regions, especially in the carbonate aquifer, that could potentially be a source that flow to the springs in Duckwater Valley. The general slope is north to south (Heilweil and Brooks 2011, Welch et al 2008), but near Duckwater Valley the slope is mostly northwest to southeast toward a trough in RRVN east of the Duckwater Hills (Figure 9). The location and depth of the trough in the water table east of the Duckwater Hills is uncertain due to the paucity of wells. The trough in the RRVN east of the Duckwater Hills probably prevents groundwater flowing from the high ridges of the White Pine Range near Currant Peak to the Duckwater area. Potentiometric contours indicate the potentiometric surface just north of RRVN and through the south end of Newark Valley and Little Smokey and Antelope Valleys is very flat. Closed contours further north in the Diamond Range and south end of the Ruby Mountains are potential high points that provide a gradient for flow to the south. Due to carbonate rock across the north end of RRVN (Figures 4 and 5), interbasin flow from adjoining basins to the north is likely a significant source of groundwater for Duckwater Valley. The Duckwater Hills, forming the east side of the Duckwater Valley, have a carbonate base (Figures 5 and 10). Big and Little Warm Springs emerge from this carbonate, probably at a fault contact (Welch et al 2008).

Just southeast of the Duckwater Reservation, the bedrock pinches the valley into a narrow section (Figure 5). The bedrock is volcanic in the southwest and carbonate in the northeast. This narrowing would cause groundwater to surface. The combination of carbonate rock draining basins north of Duckwater converging with volcanics in the Pancake Range indicates that the springs on Duckwater discharge much of the deep groundwater flowing south from north of the valley.

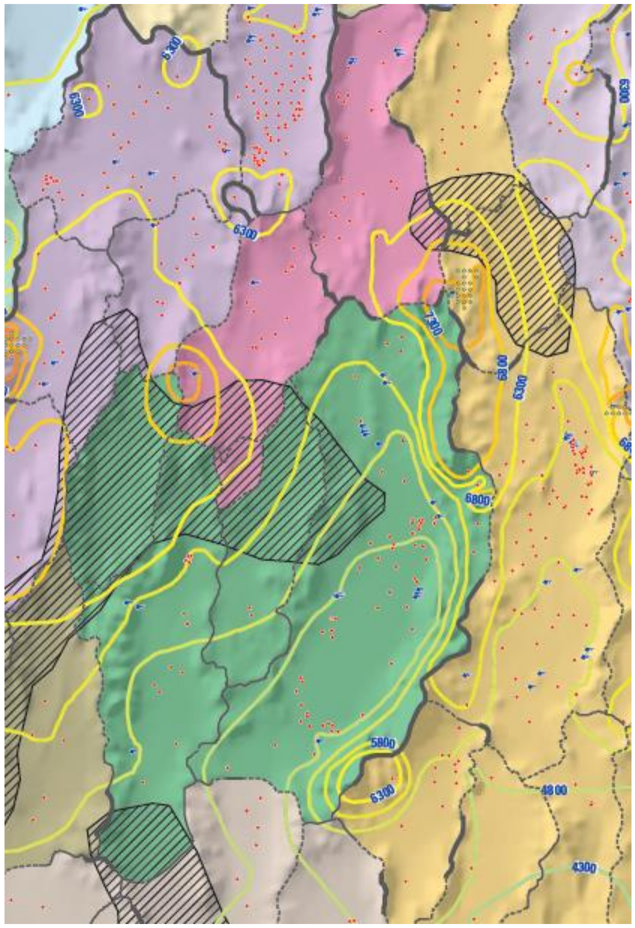

Figure 9: Snapshot of a portion of Plate 2 from Heilweil and Brooks (2011) showing groundwater contours for the Railroad Valley flow system and surrounding areas. The hatching signifies an area with poor water level control. The green is the RVFS. See Figure 6 to identify other flow systems.

Figure 10: Google Earth image of the northern portion of Duckwater Valley, showing Big and Little Warm Springs, the upper portion of Duckwater Creek, and the diversion channel from Big Warm Springs to the north and then west side of Duckwater Valley.

Geochemistry

Isotopes and geochemistry of an area provide evidence to assess the source areas of recharge and the flow pathways due to the evolution of various parameters. In the carbonate aquifers of eastern Nevada, from which the springs within the RRFS are discharge points, the dominant geochemical processes are dissolution of minerals and carbon dioxide in the soils, precipitation of minerals when the solubility is exceeded, mixing of chemically or isotopically different waters, ion exchange, and geothermal heating (Thomas et al. 1996). Calcium, magnesium, and bicarbonate ions dominates the water chemistry in recharge areas of carbonate rocks, meaning recharge occurs in carbonate outcrops on the mountain ranges. Flow paths through carbonate rocks cause few changes in composition, but once discharge reaches the basin fill, it may dissolve salts, and specific conductivity, TDS, or chloride (Cl) increases. Stable isotopes $\delta 18O$ and δD (oxygen 18 and deuterium) are governed by the temperature at which evaporation and condensation occur leading to differences that manifest by differences in latitude and altitude (Rose et al 2003, Davisson et al 1999). The isotope signature in the water discharging from a spring would equal that of the recharge points. Of course, the pathway is a mixture of groundwater from different sources, so the isotopes would be a blend.

The geochemistry data in Appendix A provides sufficient data to form some hypotheses regarding groundwater flow through the Railroad and Duckwater Valley area.

Figure 3 shows selected springs from the NWIS data base from Railroad Valley and points north to the Ruby Marshes east of the Ruby Mountains along with the area hydrogeology; many discharge from the carbonate rock. The intent is to distinguish springs in the flow system north of RRV that may discharge to springs in RRV. Springs 1 through 4 are springs on the Duckwater Reservation. Springs near the Fish Springs complex, numbers 11 through 14, just east of a carbonate outcrop, discharge from the basin fill aquifer. Flow from Fish Springs averaged 7.4 cfs with a range from 3.6 to 11.7 cfs in 16 observations taken between 1965 and 2012. Flows during spring are almost twice as much as during the fall, after the dry summer and irrigation season, indicating a combined regional and local source; a local source is subject to seasonal variation due to recharge.

Specific conductivity and Cl concentrations generally increase from north to south (Figures 11 and 12). Several low SC values occur in springs at the base of the Ruby Mountains, a likely recharge source, in the Ruby Marshes. Low SC reflects a short flow path. Values at Duckwater and at Fish Springs are in the 500 to 600 µs/cm ranges. Further south in Railroad Valley, SC values exceed 600 µs/cm. Exceptions include spring 25 in the far north (Figure 3), Sulpher Hot Springs, where SC equals 601 µs/cm, which is probably not representative of the carbonate flow path. Geothermal wells have significantly different geochemical signatures (Davisson et al 1999).

Chloride is a good tracer because it is conservative, meaning once dissolved into the flow it does not precipitate. Concentrations decrease only through dilution with cleaner water. The north-south trends of Cl concentration (Figure 12) are similar to those of SC (Figure 11). There are no apparent differences between the Fish Springs and Duckwater springs. Springs further south in Railroad Valley have higher values which indicates a pathway through basin fill.

Deuterium is lighter (more negative) at the northern end of the area near the Ruby Mountains and northern Diamond Valley than further south (Figure 13). Hershey et al (2007) found similar values in northern Spring Valley and Steptoe Valley, but there is no feasible pathway from those areas to Duckwater Valley. Deuterium at Fish Springs and Duckwater are also very similar, excepting one unexplainable value at Fish Springs (Figure 13). Values further south in Railroad Valley, including those from Blue Eagle Springs (with likely recharge in the Blue Eagle Mountain area) are less negative, meaning heavier. The data does not indicate there is a difference in source between Fish Springs and Duckwater Springs; each could be from recharge further north that has mixed slightly with heavier water further south. The regional potentiometric surface described above would support this concept. Water from springs on Currant Mountain east of Duckwater (#s 6 and 7) and from a snowmelt observation below Duckwater Peak (Appendix A) is substantially heavier than at the Reservation, which indicates it could not be on the same flow path. δ18O trends confirm the δD findings, although the changes within Railroad Valley are not as substantial (Figure 14).

Five of the springs had carbon 14 data which the USGS used to estimate an age of the water. The northernmost was Shipley Hot Spring and Spring 395415115524301 at 21,100 and 11,800 years, respectively. The value at Fish Springs Culvert was 27,800. These values suggest that groundwater is older approaching Duckwater. Two values in Railroad Valley, at Blue Eagle Springs and Spring 383321115461501, are 18,800 and 28,200 years. Both are likely different pathways.

The trends in conservative tracers and isotopes support a hypothesis that water at Big and Little Warm Springs begins as recharge in the Diamond Range and south end of the Ruby Mountains. The flow path could include Fish Springs to the northwest of the Duckwater Reservation. Unfortunately, there is no age estimate for the Duckwater springs. The isotopic and potentiometric surface evidence suggest the north end of the White Pine Range, including Mt Hamilton, is not the source. The ages reported for several of the springs also supports a very long flow path, which could commence in the Ruby Mountains. Because of the constriction in Duckwater Valley that causes most groundwater flow to discharge to the surface, it is possible that Big and Little Warm Springs in Duckwater Valley is a terminus of a flow system. The significantly heavier water seen further south in Railroad Valley also supports the hypothesis that they are on a separate flow path.

Results of other studies are also consistent with the hypothesis just presented. Groundwater flows from northern White River Valley southward towards Coyote Springs and Muddy River Springs (Thomas and Mihevc 2011, Davisson et al 1999, Thomas et al 1996). Water in the north half of Spring Valley flows toward the Great Salt Lake (Hershey et al 2007). Water in the Sheep Range and Spring Mountains flows toward Ash Meadows and Las Vegas Wash (Thomas et al 1996). Based on the size of the springs, the hypothesis of a flow path from the Ruby Mountains and Diamond Mountains to the Duckwater Reservation is reasonable.

Temperatures at the Duckwater Springs and the springs near Lockes are substantially higher than the temperatures near Blue Eagle Mountain (Figure 15). This reflects a more direct flow path from depth to the surface, with less mixing with shallow waters. Deep groundwater may be less important along Blue Eagle Mountain than in the other springs.

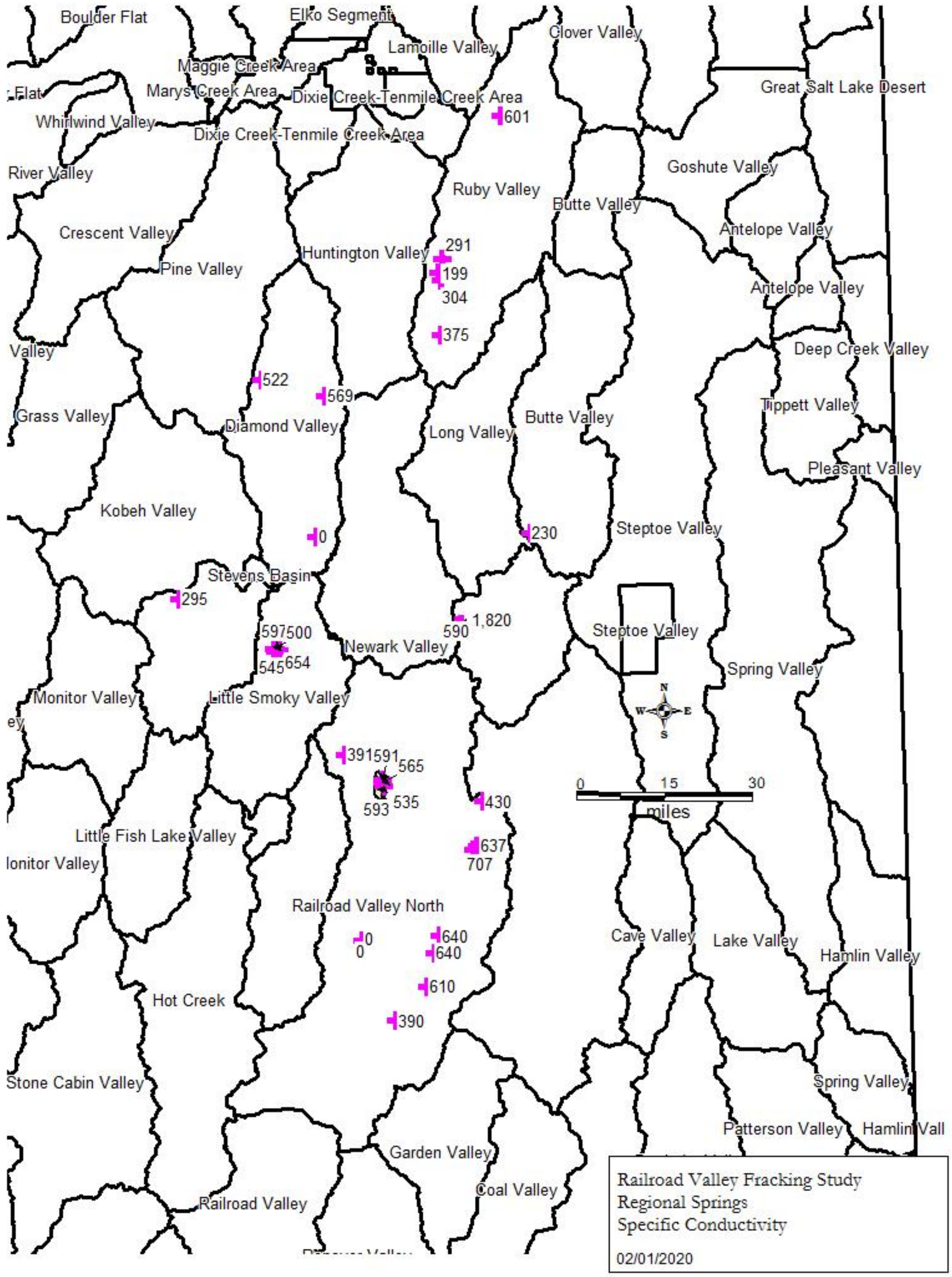

Figure 11: Specific conductivity (µs/cm 25C) for select regional springs near Railroad Valley

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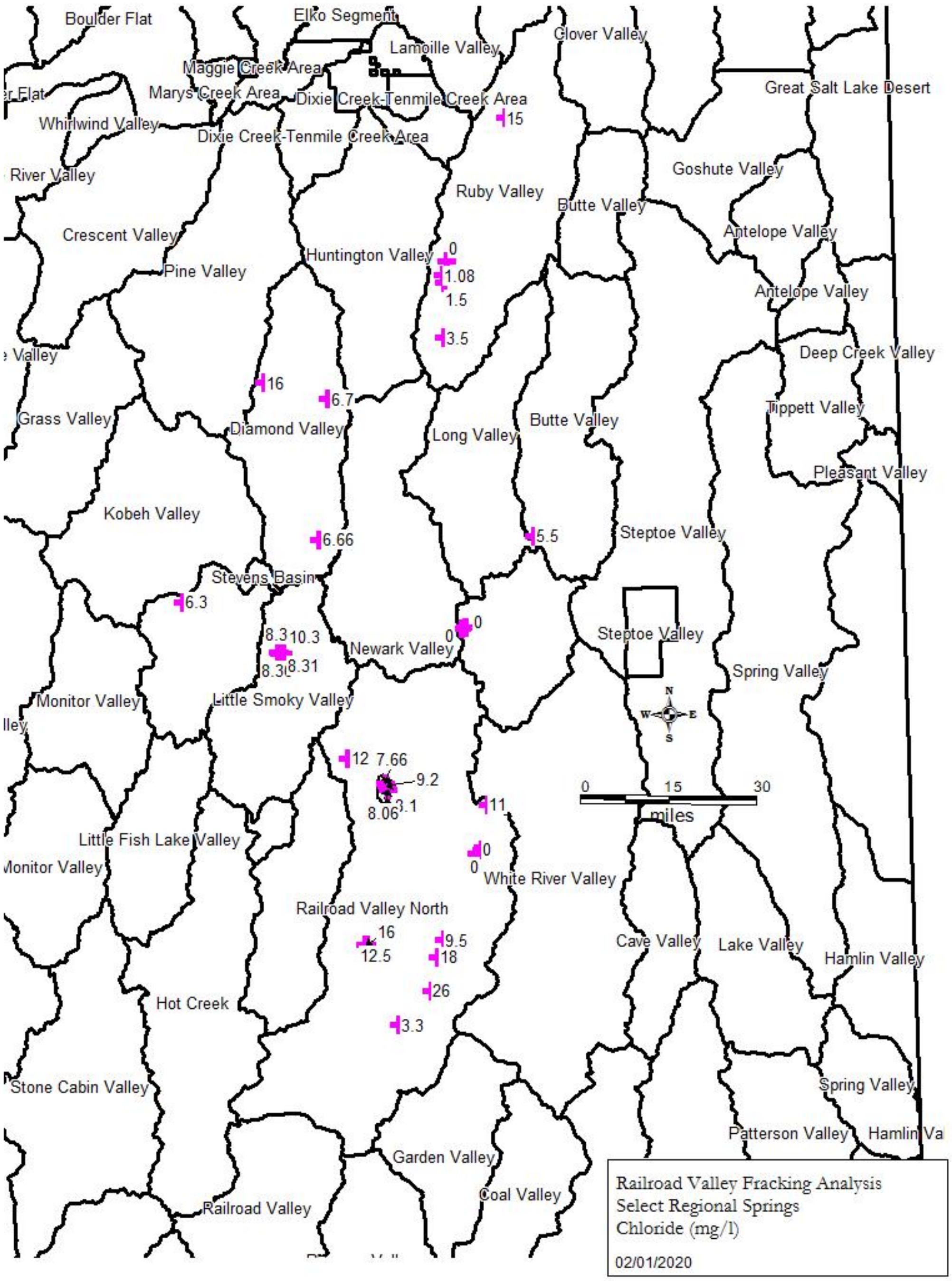

Figure 12: Chloride (mg/l) for select regional springs near Railroad Valley.

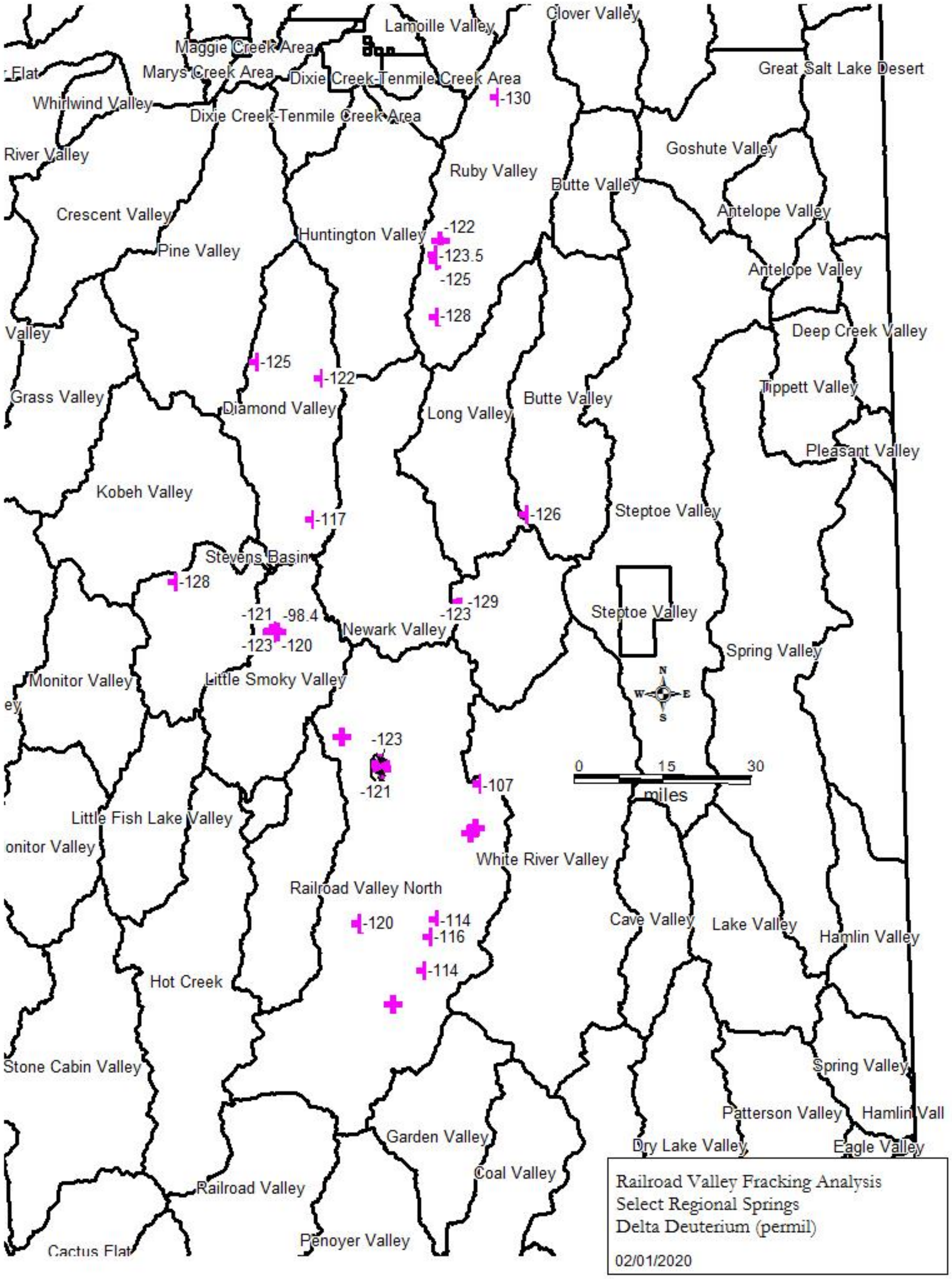

Figure 13: Delta deuterium (permil) for select regional springs near Railroad Valley.

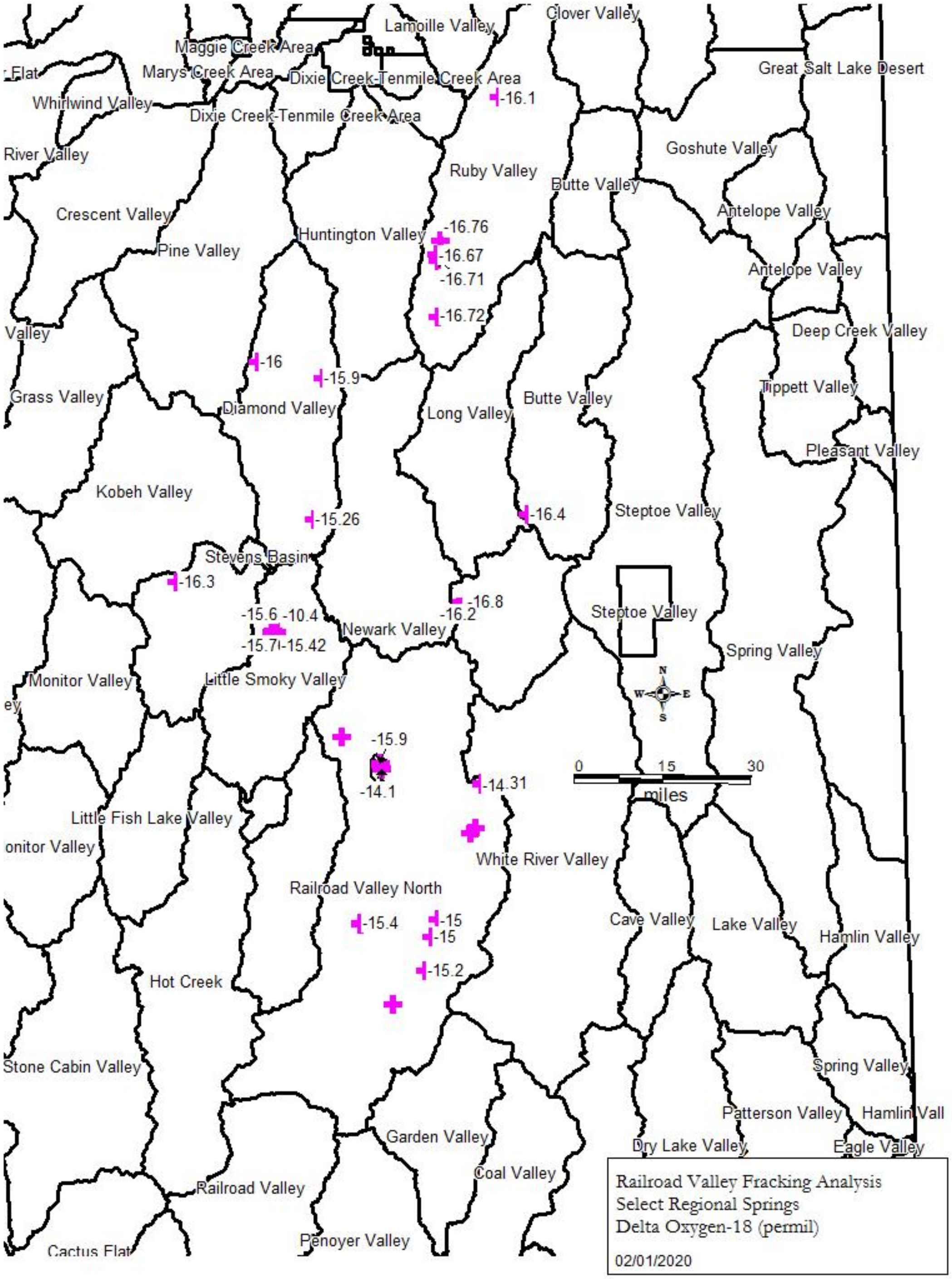

Figure 14: Delta oxygen-18 (permil) for select regional springs near Railroad Valley.

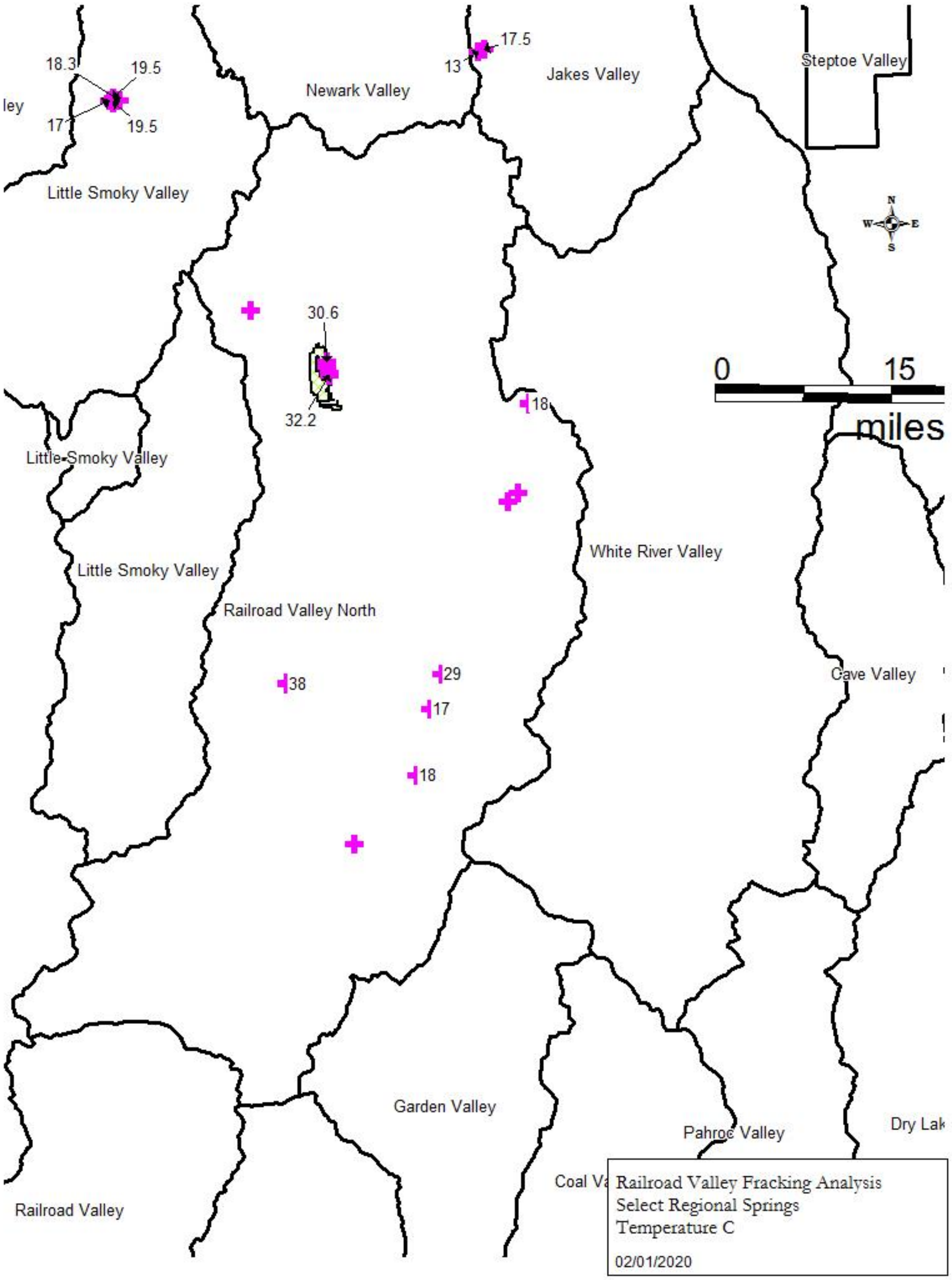

Figure 15: Temperature data (°C) for select regional springs near Railroad Valley

Summary

Springs in Duckwater Valley, at Lockes and along the west face of Blue Eagle Mountain, discharge substantial amounts of old, geothermal water. The groundwater flow follows fault pathways from depth to the surface. Differing amounts of local recharge mixes in, as is reflected in the SC, chloride and temperature data. Anything that affects the flow along the faults could also affect the springs and resources dependent on the springs.

Springflow

There are few measurements of flow at springs other than in Duckwater Valley. Table 1 reports some early spring flow measurements (Pupacko et al 1989). Excepting the Hay Corral Spring (near Lockes) the maximum flows are more than twice the minimum flows. These proportions are based on no more than 5 measurements. The flow rate is highly variable suggesting there is much shallow groundwater mixed with deeper, geothermal water. As will be discussed the Duckwater springs have much less variable flow rates.

Table 1: Spring flow observations from Pupacko et al (1989)

	Measurement Date		Flow (gpm)		Flow (cfs)		
Spring	Earliest	Most recent	Max	Min	Max	Min	Number
Butterfield	1/24/1935	1/15/1982	440	200	0.980	0.445	2
Hay Corral	11/1/1966	1/15/1982	450	390	1.002	0.868	4
Lockes: Reynolds	11/1/1966	1/18/1982	590	220	1.314	0.490	2
Lockes Big	3/5/1966	1/17/1982	640	360	1.425	0.802	2
Lockes North	6/1/1957	1/18/1982	250	76	0.557	0.169	3
Blue Eagle	2/7/1934	1/14/1982	2300	900	5.124	2.005	5

There are numerous estimates of spring flow at Duckwater Big and Little Warm Springs. Nichols (2000) estimated springflow at Duckwater to be 13,500 afa (18.6 cfs) based on two observations, one in January 1995 and in February 1986. Nichols (2000) also estimated that GWET due to spring discharge was 11,500 afa (15.9 cfs) and suggested that measurement uncertainty essentially made the springflow measurements equal the GWET estimates. Van Denburgh and Rush (1973) estimated flow at Big Warm Springs to equal 13.0 cfs, or about 9400 afa. Prudic et al (1995) calibrated their numerical groundwater model of the carbonate flow system so that Duckwater springs, not differentiated into separate discharge points due to the scale of the model, would equal 11,000 afa.

The USGS has estimated the average discharge to equal 14.55 cfs or 10,533 afa (Figure 12) based on continuous flows at Big Warm Springs since 2007. From 1982 to 2007, the average of various spot measurements was 14.6 cfs, with significant variability (Figure 13).

Little Warm Spring flow averaged 2.57 cfs from 1985 through 1994 (Figure 14), if the earliest two observations, from 1972 and 1982, which are much less than half the flow rates observed since 1985, are not considered. The measurement during a synoptic survey event on August 22, 2017 (Myers 2017) was 3.62 cfs, which is close to the higher recorded flow rates. The 2.57 cfs (1860 afa) average is a good estimate of flow for Little Warm Spring.

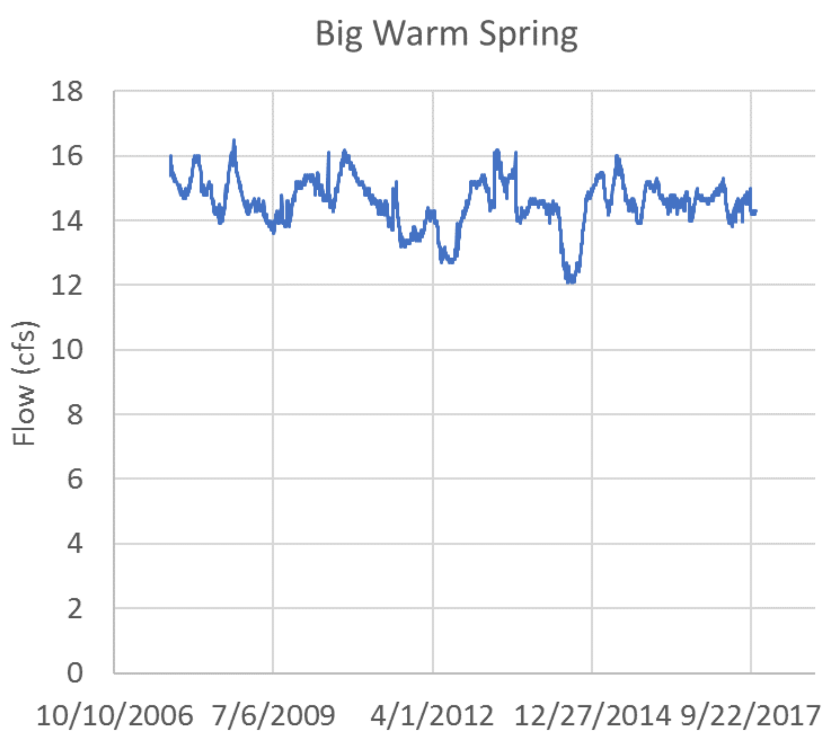

Figure 16: Discharge at Big Warm Spring since 2007 as recorded as USGS gage 10246835.

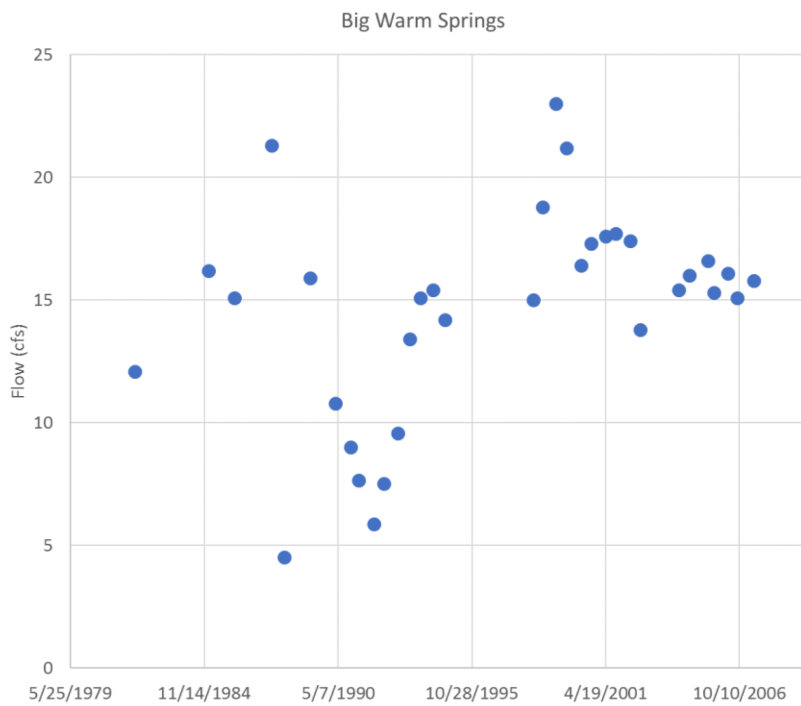

Figure 17: Flow measurement at Big Warm Spring, gage USGS 385650115421301 173B N13D56 32BACD1

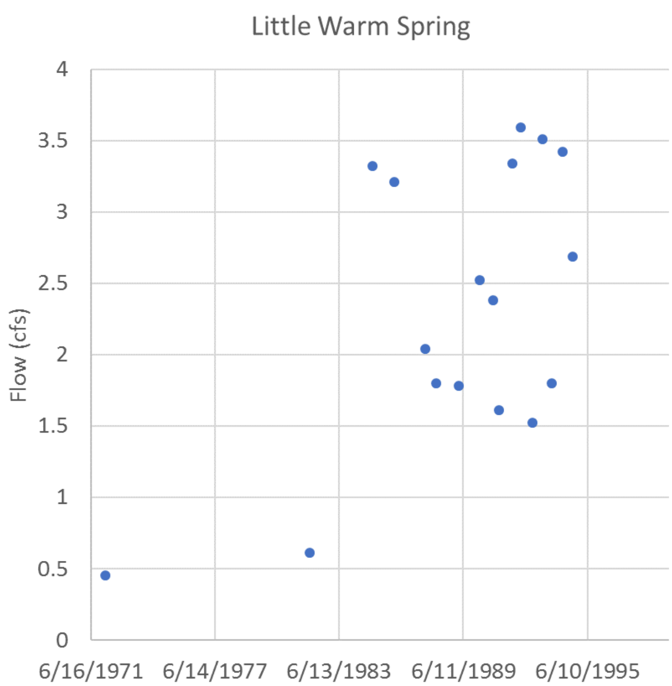

Figure 18: Spot flow measurements at Little Warm Spring, USGS gage 385552115421001 173B N12 E56 05ABCB1

Description of Fracking

Pathways for Contaminants to Reach the Surface

Hydraulic fracturing (fracking) is the process of injecting slickwater, or water and hydraulic fracturing fluids, at high pressure into low permeability formations to fracture them sufficiently to release oil or natural gas. Fracking releases both fracking fluid injected into the formation and brine which can follow natural or artificial pathways to shallow groundwater. It also can release natural gas whether it or oil was the target. The high pressure required for fracking can provide sufficient pressure to cause fracking fluid and natural fluids, brine or natural gas, to leak from the well bores into surrounding formations. From those sources, the fluid can follow natural pathways to shallow groundwater, streams and springs. The natural pathways include faults and fractures, which as discussed above can discharge to warm springs.

Fracking mobilizes gas from deep shale or from shallow formations containing conventional gas. Simply drilling through formations with natural gas can provide a pathway for the gas in that formation to move vertically toward the surface; the pathway can be along the annulus between the casing and the hole wall; the formation can be sandstone or other conventional type gas formation that may not extensive enough to be developed conventionally. The well does not have to provide the entire pathway to the shallow groundwater but could simply connect the source with a shallow fault or fracture which could link the well to shallow groundwater.

The permeability of the target formation also changes due to fracking. Pre-fracking, the rate of flow through the shale can be measured in inches per millenia due to the shale's extremely low permeability. Hydraulic fracturing increases the permeability of the formation. This allows the oil/gas to flow with the natural groundwater (brine which becomes produced water) to the well more easily. If the fractures contact the edge of the shale, the increased permeability allows the fluids to contact more naturally permeable formations above or below the formation more easily. In this sale, these formations are carbonate aquifers.

In Nevada, siliclastic formations which contain shale are often the target for natural gas development including fracking. This includes the siliclastics that bound the carbonate aquifer. All deep bedrock formations are extensively folded and faulted, which provides natural fractures throughout the formations. If fracking pressures or fractures contact these natural fractures, the natural fractures provide a pathway for fluids to flow upward out of the shale (Caine et al 1996). If a target formation is close to a natural pathway, fracking fluids or natural brine could flow to the near surface. Fracking pressure could reactivate old faults that have been sealed, so faults that previously did not transmit fluid could begin to if the fracking pressures reactivated the fractures.

Based on observed experience in the Marcellus shale, fractures often leave the target formation. Much fracking fluid leaves the shale during fracking through out-of-formation fractures which extend as much as 1500 feet above the Marcellus shale (Hammock et al. 2014; Fisher and Warpinski 2011). These fractures did not extend to shallow groundwater, but they provided a pathway from the shale to much more permeable formations closer to shallow groundwater. In the Great Basin, the adjoining formations could be the carbonate aquifer. New fractures also potentially connect with natural fractures and faults. The pressure forces fracking fluid to flow outside of the shale, whether through out-of-formation fractures or through just making a contact with more permeable formations above the shale and start the movement of fluid to shallow groundwater through natural pathways. Travel time for contaminants to reach the surface could vary from tens to thousands of years, depending on the conductivity of the connections (Myers 2012).

The coincidence of fracking between two carbonate aquifers magnifies the potential for contaminants from the fracking to reach aquifers, and pathways to shallow aquifers and warm springs.

An additional risk to springs and shallow aquifer is spills of flowback and produced water. Flowback is the fluid that flows back up the well from the formation after the pressure induced to cause fracturing is released. It results naturally from most fracking operations. Flowback can be either fracking fluid or natural fluids occurring in the targeted formation. Spills near the springs in RRVN would devastate those springs.

Risks of Fracking to the Geothermal Springs

Warm groundwater that discharges from Warm Springs in RRVN likely follows pathways from the north through carbonate aquifer. Recharge into the aquifers occurs in the mountains and along mountain fronts. Various structural features impinge the flow and concentrate it along pathways to the surface. In other words, upgradient from the springs, the groundwater is dispersed through the carbonate aquifer but near the springs it likely is concentrated within substantial fractures leading to the spring.

Fracking can cause fluids to enter the flow pathway at any point between recharge in the mountains and the discharge points. Because flow concentrates along faults, that is the point risk would be highest. Fracking along the faults that bound the basins on either side would likely cause fluid to enter the pathway and contaminate the warm springs. Springs in Duckwater Valley and near Lockes are more at risk because the deep geothermal water is less mixed with shallow water. Fracking along the faults north of Duckwater and Lockes would maximize the risk because the majority of flow originates from that direction. However, fracking south of the springs could also affect them because the high pressure due to fracking could change the flow within the faults and affect the springs.

References

Caine JS, Evans JP, Forster CB (1996) Fault zone architecture and permeability structure. Geology 24(11):1025-1028.

Davisson ML, Smith DK, Kenneally J, Rose TP (1999) Isotope hydrology of southern Nevada groundwater: Stable isotopes and radiocarbon. Wat Resourc Res 35(1):279-294.

Heilweil, V.M., and Brooks, L.E., eds., 2011, Conceptual model of the Great Basin carbonate and alluvial aquifer system: U.S. Geological Survey Scientific Investigations Report 2010-5193, 191 p.

Harrill JR, Gates JS, Thomas JM (1988) Major ground-water flow systems in the Great Basin region of Nevada, Utah, adjacent States: US Geological Survey Hydrologic Investigations Atlas HA-694-C, 2 sheets.

Harrill JR, Prudic DE (1998) Aquifer systems in the Great Basin Region of Nevada, Utah, and adjacent states – Summary report, US Geological Survey Professional Paper 1409-A.

Hershey RL, Lyles BF, Earman S, Thomas JM, Lundmark KW (2007) Ground-water chemistry interpretations supporting the Basin and Range Regional Carbonate-rock Aquifer System (BARCAS) Study, Eastern Nevada and western Utah. DHS Publication No. 41230. Desert Research Institute, Reno.

Myers T (2017) Water Management Plan, Duckwater Shoshone Indian Reservation. Prepared for Duckwater Shoshone Tribe. Reno NV

Myers T (2012) Potential contaminant pathways from hydraulically fractured shale to aquifers. Ground Water 50(6): 872-882 doi: 10.1111/j.1745-6584.2012.00933.x

Nichols WD (2000) Regional ground-water evapotranspiration and ground-water budgets, Great Basin, Nevada, US Geological Survey Professional Paper 1628.

Plume RW (1996) Hydrogeologic framework of the Great Basin region of Nevada, Utah, and adjacent states. US Geological Survey Professional Paper 1409-B.

Pupacko A, Wood DB, Williams RP (1989) Geohydrologic data for selected springs in eastern Nevada through 1982, with emphasis o White Pine County, US Geological Survey Open-File 88-712. Carson City, NV

Rose TP, Davisson (2003) Isotopic and geochemical evidence for Holocene-age groundwater in regional flow systems of south-central Nevada. P 143-164 in Enzel Y, Wells SG, Lancaster N (ed) Paleoenvironments and paleohydrology of the Mojave and southern Great Basin Deserts, Special Paper 368. Geological Society of America, Boulder CO.

Thomas JM, Mihevc TM (2011) Evaluation of groundwater origins, flow paths, and ages in East-Central and Southeastern Nevada, Publication No. 41253. Desert Research Institute, Reno

Thomas JM, Welch AH, Dettinger MD (1996) Geochemistry and isotope hydrology of representative aquifers in the Great Basin region of Nevada, Utah, and adjacent states. US Geological Survey Professional Paper 1409C.

Van Denburgh AS, Rush FE (1973) Water-resources appraisal of Railroad and Penoyer Valleys, east-central Nevada. Water Resources-Reconnaissance Series Report 60. US Geological Survey.

Welch AH, Bright DJ, Knochenmus, Eds. (2008) Water resources of the basin and range carbonate-rock aquifer system, White Pine county, Nevada, and adjacent areas in Nevada and Utah, A report to Congress. US Geological Survey Scientific Investigations Report 2007-5261.

Appendix A: Table of Chemistry Data from Select Regional Springs

Data from https://nwis.waterdata.usgs.gov/nv/nwis/qwdata

Number	Name	Elevation (ft amsl)	Temp (° C)	Spec_cond	Cl (mg/l)	delta_H2_H1 (per mil)	delta_O18_O16 (per mil)
1	Duckwater Big spg	5604	30.6	591	7.66	-123	-15.9
2	Duckwater spg 2	5617	33	565	9.2	0	0
3	Duckwater spg 3	5604	32	535	8.1	0	0
4	Little Warm Spg	5500	32.2	593	8.06	-121	-14.1
5	Currant Spring	7700	0	0	0	-114	-15.31
6	spring below Currant Mtn	7723	18	430	11	-107	-14
7	Well 384706115241301	5770	16.1	637	0	0	0
8	Well 384631115250701	5675	13.8	707	0	0	0
9	spring 390055115491001	6263	16.5	391	12	0	0
10	Four-eye Nicks Spring	6816	11	0	6.66	-117	-15.26
11	Fish Springs Cpl N	6053	19.5	500	10.3	-98.4	-10.4
12	Fish Spring Cpl S	6051	19.5	654	8.31	-120	-15.42
13	Fish Springs W Orifice	6054	17	545	8.36	-123	-15.76
14	Fish Crk Spgs Culvert	6047	18.3	597	8.3	-121	-15.6
15	Spring 392410116202401	0	54	295	6.3	-128	-16.3
16	Spring 395415115524301	5840	21	569	6.7	-122	-15.9
17	Shipley Hot Springs	5800	39	522	16	-125	-16
18	Wildhorse Spring	7185	17.5	1820	0	-129	-16.8
19	Sand Spring	7598	13	590	0	-123	-16.2
20	Thirty-Mile Spring	7100	8.5	230	5.5	-126	-16.4

21	Station Spg at orifice	6020	10.9	375	3.5	-128	-16.72
22	Nino Spg at Fish Hatchery	5970	10.6	304	1.5	-125	-16.71
23	Cave Creek Spg	6042	7	199	1.08	-123.5	-16.67
24	spg .89 mi nw bressman	0	13	291	0	-122	-16.76
25	Sulpher Hot Springs	0	0	601	15	-130	-16.1
26	Spring 382120115401001	4744	13.8	390	3.3	0	0
27	Bullwhacker Spg	4760	18	610	26	-114	-15.2
28	Bitter field Spg	4749	17	640	18	-116	-15
29	Blue Eagle Spgs	4765	29	640	9.5	-114	-15
30	Spring 383321115461501	4860	38	0	16	-120	-15.4
31	Spring 383318115461701	4810	35	0	12.5	0	0

Attachment B

The Center for Biological Diversity, Comment Letter Regarding BLM Battle Mountain District December 2020 Competitive Oil and Gas Lease Sale Draft Environmental Assessment and its Information Supplement (DOI-BLM-NV-B000-2020-0012-EA) (August 19, 2020)

August 19, 2020

BLM Battle Mountain District Office
50 Bastian Road
Battle Mountain, NV 89820
BLM_NV_BMDO_TFO_NonRenewable@blm.gov

VIA BLM EPLANNING & ELECTRONIC MAIL

Re: Center for Biological Diversity comments on BLM Battle Mountain District December 2020 Competitive Oil and Gas Lease Sale Draft Environmental Assessment and its Information Supplement (DOI-BLM-NV-B000-2020-0012-EA)

The Center for Biological Diversity ("Center") and Western Watersheds Project are pleased to submit these comments on the Battle Mountain District Office December 2020 Competitive Oil and Gas Lease and Environmental Assessment ("EA") and its Information Supplement.

The Center is a non-profit environmental organization dedicated to the protection of native species and their habitats in the Western Hemisphere through science, policy, and environmental law. The Center has over 1.7 million members and supporters throughout Nevada and the United States, including dozens of supporters who live in the Battle Mountain District, and who utilize public lands for recreation and other uses. The Center's Nevada program focuses on the protection of wildlife and endangered species, the preservation of public lands, and the sustainability of Nevada's groundwater resources.

Western Watersheds Project is a non-profit organization with more than 12,000 members and supporters. Our mission is to protect and restore western watersheds and wildlife through education, public policy initiatives and legal advocacy. Western Watersheds Project and its staff and members use and enjoy the public lands and their wildlife, cultural and natural resources for health, recreational, scientific, spiritual, educational, aesthetic, and other purposes, including in Nevada. Western Watersheds Project also has a direct interest in mineral development that occurs in areas with sensitive wildlife populations and important wildlife habitat, such as greater sage-grouse and designated sage-grouse habitat management areas.The Bureau of Land Management ("BLM") is proposing to lease 14 parcels across the Battle Mountain District, totaling approximately 16,599 acres of public land. The EA for this project is unlawfully deficient in numerous regards, suggesting numerous violations of the National Environmental Policy Act ("NEPA") and the Endangered Species Act ("ESA") if adopted in its current form. Due to the substantial and unmitigable impacts to resources on most parcels, and the broader unmitigable impacts of fossil fuel extraction on all parcels, we recommend that BLM adopt the No Action Alternative.

I. BLM's Environmental Assessment ("EA") Violates the National Environmental Policy Act ("NEPA").

NEPA requires agencies to undertake thorough, site-specific environmental analysis at the earliest possible time and prior to any "irretrievable commitment of resources" so that the action can be shaped to account for environmental values.[1] Oil and gas leasing is an irretrievable commitment of resources.[2] Thus, NEPA establishes "action-forcing" procedures that require agencies to take a "hard look," at "all foreseeable impacts of leasing" before leasing can proceed.[3] Chief among these procedures is the preparation of an environmental impact statement ("EIS").[4] BLM, however, did not prepare an EIS.

In order to determine whether a project's impacts may be "significant," an agency may first prepare an EA.[5] If the EA reveals that "the agency's action may have a significant effect upon the . . . environment, an EIS must be prepared."[6] If the agency determines that no significant impacts are possible, it must still *adequately* explain its decision by supplying a "convincing statement of reasons" why the action's effects are insignificant.[7] However, BLM's EA did not outline any convincing statement of reasons as to whether the act of opening up over 16,598 acres of land to oil and gas activities such as fracking will have any significant impact, and furthermore failed to provide any clear or "convincing statement of reasons" for a finding of no significant impact. BLM moreover failed to include any analyses for site-specific impacts. BLM claims, with regard to wildlife impacts:

> Offering, selling, and issuing federal oil and gas leases would not produce any direct impacts to wildlife resources. However, there may be indirect impacts from future ground disturbing activities on any leased parcels. It is not possible to know the specific acres and types of habitat that would be disrupted, and the BLM would not receive any applications for exploration or development until after the lease sale.[8]

BLM failed both of NEPA's "twin aims"—not only did BLM fail to ensure that the agency takes a "hard look" at the environmental consequences of its proposed action, it also failed to make information on the environmental consequences available to the public, which may then offer its insight to assist the agency's decision-making through the comment process.[9] NEPA's procedural

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[1] *Pennaco Energy, Inc. v. United States DOI*, 377 F.3d 1147, 1160 (10th Cir. 2004).

[2] *S. Utah Wilderness All. v. Norton*, 457 F. Supp. 2d 1253, 1256 (D. Utah 2006).

[3] *Center for Biological Diversity v. United States DOI*, 623 F.3d 633, 642 (9th Cir. 2010); *N.M. ex rel. Richardson v. BLM*, 565 F.3d 683, 717 (10th Cir. 2009).

[4] *Id*.

[5] 40 C.F.R. §§ 1501.4, 1508.9.

[6] *Nat'l Parks & Conservation Ass'n v. Babbitt*, 241 F.3d 722, 730 (9th Cir. 2001) (internal quotations omitted).

[7] *Blue Mountains Biodiversity Project v. Blackwood*, 161 F.3d 1208, 1212 (9th Cir. 1998) (emphasis added).

[8] EA at 3.2.8, p. 27.

[9] *See Robertson v. Methow Valley Citizens Council*, 490 U.S. 332, 349 (1989).

requirement is not merely a formality, but is there to allow the agencies and the public to understand the consequences of the proposed lease auction. Not only did BLM fail to provide an adequate environmental analysis of the foreseeable impacts of the proposed lease sale, but furthermore failed to provide the public adequate notice. Given the enormous amount of land being considered, the substantial resource conflicts present on the parcels, and the fact that BLM's complete lack of substantive analysis meant that the onus was on commenters to make up for BLM's deficiencies, an extension of the comment period was warranted. BLM refused to grant such an extension.

A. NEPA Requires Site-Specific Environmental Analysis at the Leasing Stage.

BLM's deferral of site-specific analysis until the APD stage is unlawful under NEPA, its implementing regulations, and legal precedents. Courts have repeatedly rejected BLM's claim that it is not required to conduct any site-specific environmental review until after the parcels are leased and a proposal is submitted by industry.[10]

BLM is required under NEPA to perform and disclose an analysis of environmental impacts of the 14 parcels offered for lease *before* there are any "irreversible and irretrievable commitments of resources."[11] "[N]on-NSO leases, even if subject to substantial government regulation, do constitute an 'irretrievable commitment of resources.' As a result, unless the lease reserves to the agencies an '*absolute right* to deny exploitation of those resources,' the sale of [] non-NSO leases . . . constitutes the go or no-go point where NEPA analysis becomes necessary."[12] In other words, the specific environmental effects of oil and gas leasing in the project area must be analyzed and disclosed now, at the leasing stage.

Rather than perform the environmental review as required, BLM tiers to the environmental impact statements ("EIS") for the 1997 Tonopah Resource Management Plan ("TRMP"), and the 2015 Nevada and Northeastern California Greater Sage-Grouse Approved RMP Amendment ("GRSG RMPA")[13] and defers the site-specific analysis until after the parcels are leased.[14] This is unlawful. For instance, BLM is required to analyze all foreseeable human health and safety risks, environmental risks and seismic risks posed by unconventional extraction techniques before leasing. BLM's analyses on these issues are outdated and/or cursory at best. In *Center for*

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[10] *See Center for Biological Diversity & Sierra Club v. BLM*, 937 F. Supp. 2d 1140, 1158 (N.D. Cal. 2013) ("BLM asserts the now-familiar argument that there is no controversy because any degradation of the local environment from fracking should be discussed, if ever, when there is a site-specific proposal. But the Ninth Circuit has specifically disapproved of this as a reason for holding off on preparing an EIS."); *Conner v. Burford*, 848 F.2d 1441, 1450 (9th Cir. 1988) ("The government's inability to fully ascertain the precise extent of the effects of mineral leasing . . . is not, however, a justification for failing to estimate what those effects might be before irrevocably committing to the activity.").

[11] *Center for Biological Diversity*, 937 F. Supp. 2d at 1152 (citing *Conner v. Burford*, 848 F.2d 1441, 1446 (9th Cir. 1988) ("Our circuit has held that an EIS must be prepared *before* any irreversible and irretrievable commitment of resources.") (emphasis added).

[12] *Id*. at 1152.

[13] EA at 18-19.

[14] *Id*. at 2.1, p. 4.

Biological Diversity & Sierra Club v. BLM, 937 F. Supp. 2d 1140, 1152 (N.D. Cal. 2013), BLM also attempted to defer NEPA analysis of hydraulic fracturing (hereinafter referred to as "fracking") on the parcels at issue until it received a site-specific proposal, because the exact scope and extent of drilling that would involve fracking was unknown. The district court held BLM's "unreasonable lack of consideration of how fracking could impact development of the disputed parcels went on to unreasonably distort BLM's assessment," and explained:

> "[T]he basic thrust" of NEPA is to require that agencies consider the range of possible environmental effects *before resources are committed and the effects are fully known*. "Reasonable forecasting and speculation is thus implicit in NEPA, and we must reject any attempt by agencies to shirk their responsibilities under NEPA by labeling any and all discussion of future environmental effects as 'crystal ball inquiry.'"[15]

As we have pointed out, and as the courts have made clear time and again, NEPA requires that "assessment of all 'reasonably foreseeable' impacts must occur at the earliest practicable point, and must take place before an 'irretrievable commitment of resources' is made."[16] In *Richardson*, BLM again argued that it was not required to conduct any site-specific environmental reviews until the issuance of an APD. The court looked to the Ninth and D.C. Circuits in concluding that "NEPA requires BLM to conduct site-specific analysis before the leasing stage."[17] The Richardson court then offered a two-part test to determine whether NEPA has been satisfied. First, the agency must ask whether the lease constitutes an "irretrievable commitment of resources." The Tenth Circuit, again citing to the Ninth and D.C. Circuits, concluded that issuing an oil and gas lease without an NSO stipulation constitutes such a commitment. Second, the agency must ask whether all "foreseeable impacts of leasing" have been taken into account before leasing can proceed.[18] Given the utter lack of any site-specific review of the present surface-occupancy-permitting parcels, for this lease sale, such impacts have not been taken into account.

BLM must take a hard look at the specific parcels that it is offering for oil and gas leasing, and the foreseeable impacts to the resources on these parcels. BLM insists, however, on postponing any such analysis until it has already signed over drilling rights and is unable to preclude all surface disturbing activities to prevent critical environmental impacts that may arise after a proper NEPA analysis. This is a violation of NEPA.

B. BLM Failed to Provide any Convincing Statement of Reasons as to why the Project's Impacts are Insignificant.

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[15] *Center for Biological Diversity*, 937 F. Supp. 2d at 1157 (citing *City of Davis v. Coleman*, 521 F.2d 661, 676 (9th Cir. 1975)).

[16] *N.M. ex rel. Richardson v. BLM*, 565 F.3d 683, 717-18 (10th Cir. 2009) (citing 42 U.S.C. § 4332(2)(C)(v)); compare with *Center for Biological Diversity*, 937 F. Supp. 2d at 1152 (N.D. Cal. 2013) ("Agencies are required to conduct this review at the 'earliest possible time' to allow for proper consideration of environmental values . . . . A review should be prepared at a time when the decisionmakers 'retain a maximum range of options.'").

[17] *Richardson*, 565 F.3d at 688.

[18] *Id*.

As the time for NEPA analysis was triggered by the proposal for the sale of the lease, BLM had to analyze whether its decision to open up over 16,598 acres of land to development activities such as fracking might have significant environmental impact.[19] If BLM finds based on the EA that the proposed actions will not significantly affect the environment, BLM can issue a finding of No Significant Impact ("FONSI") in lieu of the EIS.[20] However, BLM's EA did not make any finding that the environmental effects of its major action are insignificant. Nor did BLM provide any explanation to the public as to why BLM chose not to prepare an EIS.

BLM did not even clearly state in any part of the EA that the action does not presents any significant impacts. In *Center for Biological Diversity v. National Highway Traffic Safety Admin.*, 538 F.3d 1172 (9th Cir. 2008), the court took similar issues with the BLM's failure to explain why it chose not to prepare an EIS:

> Nowhere does the EA provide a 'statement of reasons' for a finding of no significant impact, much less a 'convincing statement of reasons.' For example, the EA discusses the amount of CO[2] emissions expected from the Rule, but does not discuss the potential impact of such emissions on climate change. In the "Affected Environment" section of the EA, NHTSA states that "[i]ncreasing concentrations of greenhouse gases are likely to accelerate the rate of climate change." The agency notes that "[t]he transportation sector is a significant source of greenhouse gas (GHG) emissions, accounting for approximately 28 percent of all greenhouse gas emissions in the United States." From this, NHTSA jumps to the conclusion that "[c]oupled with the effects resulting from the 2003 light truck rule, the effects resulting from the agency's current action are expected to lessen the GHG impacts discussed above."[21]

Similar to the *National Highway Traffic Safety Admin* case, the EA at issue here does not provide any clear or convincing statement of reasons for a FONSI. If a FONSI is to be issued, substantial changes would have to be made to the EA to provide legitimate disclosure and analysis of impacts, something lacking in the current document. The EA discusses generally and vaguely the amount of surface disturbance that may result from leasing, the number of wells that might be drilled, the types of pollutants that may be emitted during development and production; but it does not discuss the potential impacts of any of these on climate change or the human environment. BLM cannot simply jump to the conclusion that its stipulations and proposed mitigation measures will lessen the potential impacts to the level of insignificance.

In evaluating the significance of the impact of the proposed action, the agency must consider both the context of the action as well as the intensity. The several contexts in which the significance of an action must be analyzed includes "society as a whole (human, national), the affected region, the

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[19] *Center for Biological Diversity & Sierra Club v. BLM*, 937 F. Supp. 2d 1140, 1153 (N.D. Cal. 2013).

[20] *Id.*

[21] *Center for Biological Diversity v. National Highway Traffic Safety Admin.*, 538 F.3d 1172, 1223 (9th Cir. 2008) (internal citations omitted).

affected interests, and the locality."[22] For site-specific actions, significance usually depends on the impact of the action on the locale,[23] but it also depends on the impact on the world as a whole. Thus, to determine the significance of the action, BLM needed to look at not only the environmental impacts on the area to be leased, but also the analysis of the cumulative effects of oil and gas leasing on climate change.

Furthermore, BLM's estimates regarding surface disturbance is based on historic information from a decades old RMP which apparently does not take into account the recent sharp increase in leasing nominations and initial instances of fracking use in Nevada.[24] BLM should have considered in its EA the increased industry interest in Nevada oil and gas, and the potential for drilling levels to increase, should oil prices rise or well stimulation techniques change the production potential of Nevada hydrocarbon-bearing formations.

C. BLM Must Prepare an Environmental Impact Statement ("EIS") under NEPA.

"[T]o prevail on a claim that the agency violated its statutory duty to prepare an EIS, a plaintiff need not show that significant effects will in fact occur. It is enough for the plaintiff to raise substantial questions whether a project may have a significant effect on the environment."[25] The significance of the impact of the proposed action depends on both the context of the action as well as the intensity. Numerous environmental harms may result from unconventional methods used by the industry to extract oil and gas, including hydraulic fracturing and horizontal drilling, as well as concerns relating to climate change. BLM has declined to look at these issues until it received an APD proposal from the industry. As we have already explained above, this is unlawful. The impact of fracking alone raises substantial questions on whether the proposed project may have significant effects on the environment. Additionally, we raised several highly controversial issues below. BLM therefore has a duty to prepare an EIS on the issues required by NEPA.

II. The EA Fails to Adequately Disclose or Analyze the Leasing Decision's Impacts to Groundwater and Surface Water Resources.

The more than 16,598 acres of proposed lease parcels are situated within a vast and complex hydrographic region. A deep carbonate aquifer that underlies the majority of the Great Basin flows underneath the proposed lease parcels, generally trending from northeast to southwest. This aquifer is largely comprised of "fossil water," which accumulated underground during the Pleistocene and continues to flow and discharge to this day. Above the carbonate aquifer are basin-fill or alluvial aquifers, which move precipitation from the region's numerous mountain ranges to the valley floors. As groundwater flow meets resistant layers of rock, both systems give rise to surface expressions of groundwater, generally in the form of springs and wetlands. These surface water

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[22] 40 C.F.R. § 1508.27.

[23] *Id*.

[24] *See* U.S. BLM, Nevada, 2016 Industry Expressions of Interest for Possible Oil and Gas Leasing; U.S. BLM, Nevada, 2015 Industry Expressions of Interest for Possible Oil and Gas Leasing; *See also* DeLong, Jeff, "Fracking Hits Home in Nevada," Reno Gazette-Journal, April 15, 2014.

[25] *Center for Biological Diversity & Sierra Club v. BLM*, 937 F. Supp. 2d 1140, 1154 (N.D. Cal. 2013).

expressions are the most vital resources in the desert, supporting the vast majority of Nevada's robust biodiversity, and frequently harboring species protected or proposed for protection under the Endangered Species Act.

In light of the critical importance of groundwater and surface water resources, it is incumbent upon the BLM to include a rigorous analysis of potential impacts to these resources, and the cascading effects such impacts would have on the region's wildlife and biodiversity. Instead, what BLM offers in the EA is a minimization of potential impacts, and a delay on any actual analysis until the APD phase. As described above and below, this is an unlawful circumvention of NEPA's hard look requirement. Impacts to the quality and quantity of groundwater, and thus to the surface expression of those waters, are reasonably foreseeable and must be analyzed.

A. Impacts to Groundwater Quantity

Nevada's most precious resource is its groundwater. Abundant relative to the aridity of the climate, Nevada's groundwater supports hundreds of thousands of Nevadans for domestic use, the majority of Nevada's agricultural output and almost the entirety of Nevada's biodiversity. As a result of the critical importance of this resource, any federal action which may cause impacts to groundwater quantity must include a rigorous analysis of the possibility of those impacts, and the potential effects should impacts to groundwater quantity occur. Instead, the EA literally makes no mention of the potential or mechanism for the consumption of water resources. There are numerous reasonably foreseeable impacts to water quantity from fracking, and BLM is legally obligated to analyze such impacts.

An EPA study found that the volumes of water needed to successfully fracture rock to open up oil and gas resources vary widely: statewide median quantities utilized fell between 76,818 gallons (0.23 acre-feet) per well to 5,259,965 gallons (15.9 acre-feet) per well.[26] Without citations, the EA's own fracking "white paper" puts forward ranges of 25,000 to 500,000 gallons for shallow vertical wells, and 800,000 to 10 million (2.4 to 30.3 acre-feet) for deep tight sand gas horizontal or directionally drilled wells.[27]

In addition to information about the quantities of water, an important piece of information in determining the impacts to water quantity is the number of anticipated wells. In this, the EA falls woefully short. The Reasonably Foreseeable Development (RFD) scenario is based exclusively on past development in Nevada, which has been miniscule compared to other Western States. It does not account for current or anticipated market trends, including the volatile price of oil. The EA does not give a precise estimate for the number of wells that will result from the lease sale, instead using general numbers from RMPs which cover the entire BLM Field Offices. It is therefore impossible to rationally examine the impacts to quantity of groundwater, without even an estimate given of the number of wells expected. At any rate, the RFD assumes stable prices of oil, not accounting for the high levels of geopolitical instability around the world, which have significant

[26] U.S. EPA, Hydraulic Fracturing for Oil and Gas: Impacts from the Hydraulic Fracturing Water Cycle on Drinking Water Resources in the United States (Final Report). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-16/236F (2016).

[27] EA Supplemental Information at 25.

effects on the price of oil. Should the price of oil spike, the number of wells resulting from this lease sale could dramatically increase, potentially numbering in the thousands of wells being developed across Nevada.

Given the variability in both estimates of water consumption per well and in the number of anticipated wells, there is great uncertainty in attempting to evaluate the impacts of the proposed lease sale on quantities of water. However, this does not relieve BLM from their legal obligation to evaluate such impacts. 40 CFR §1502.22 is known as the "uncertainty rule," and indicates that agencies must include information on uncertain impacts if such information "is essential to a reasoned choice among alternatives, and the overall costs of obtaining it are not exorbitant." And indeed, these requirements are important for "impacts which have catastrophic consequences, even if their probability of occurrence is low."

The potential impacts to water quantity clearly meet this threshold. If hundreds or thousands of wells were developed, something that is not outside the realm of possibility should oil prices go back above $100 per barrel, and if those wells each required the high-end estimate of 10,000,000 gallons (30.3 acre-feet) to fracture, total water withdrawals for fractured wells from this lease sale could reach into the billions of gallons (tens of thousands of acre-feet).

Withdrawals on the level of tens of thousands of acre-feet have the potential to radically alter the hydrologic regime in the areas where such withdrawals are made. If the withdrawals are made from shallow alluvial aquifers, adjacent springs, wetlands, and other water features may dry up.[28] If the withdrawals are made from the deeper regional aquifer, effects may be far reaching and drying could occur tens of miles away. Additionally, due to connections between local and regional aquifers, intensive pumping of alluvial aquifers may eventually impact regional aquifers.[29]

Further, this analysis is important because the BLM cannot rely on the state of Nevada to safeguard groundwater resources. First, the state's concept of "perennial yield" allows for the unmitigated destruction of all unallocated surface water resources. Perennial yield is notably not defined in statute, but a working definition is "[T]he maximum amount of groundwater that can be salvaged each year over the long term without depleting the groundwater reservoir. The perennial yield cannot be more than the natural recharge of the groundwater reservoir and is usually limited to the maximum amount of natural discharge."[30] What this functionally means is that the state of Nevada makes available for appropriation an amount of water equivalent to that which is discharged within a basin through surface discharge and evapotranspiration through phreatophytic vegetation. As such, if a basin is fully appropriated and all of those water rights are being exercised, the long-term effect will be to cease all surface discharge and eliminate all phreatophytes. As will be discussed below, this will have catastrophic and existential consequences to a variety of species.

Nevada state water law does nothing to protect wildlife and other natural values present on public land—indeed, the law is structured to encourage full development of water resources, so it can be

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[28] Deacon, J.E. et al., Fueling population growth in Las Vegas: How large-scale groundwater withdrawal could bum regional biodiversity, 57 Bioscience (8): 688-698 (2007).

[29] U.S. Geological Survey Circular 1139, Ground Water and Surface Water: A Single Resource (1998).

[30] Nevada Department of Conservation and Natural Resources, Nevada Water Law 101.

argued that Nevada state water law is actively detrimental to public land water-dependent resources. As such, BLM cannot rely on Nevada's water law as an indicator of the potential for groundwater impacts and overappropriation. An independent analysis must be made by BLM of any groundwater withdrawals associated with development of these leases, to examine the impacts of such withdrawals and how they may affect the environment.

Even if one accepts the basic premise that perennial yield is a concept which results in sustainable water management, there are other avenues for impacts from pumping. Groundwater can behave in paradoxical ways, and localized drawdown of aquifers can occur even if a basin is not overallocated. Groundwater pumping forms a wide "cone of depression" surrounding the point of diversion, reducing aquifer levels across the "area of influence," meaning the areal extent of the cone.[31] Thus while a basin may not be overallocated, any given pumping project can cause localized impacts across the area of influence. Given the direct proximity of many of the lease parcels to surface water features, and the lack of any water resources stipulations, it is highly likely that localized drawdown secondary to pumping for fracking will cause impacts to surface water features.

As has been outlined here, there is the distinct possibility of impacts to quantity of groundwater, and therefore amount of surface discharge, due to pumping for fracking either via overappropriation or localized drawdown. Therefore, BLM has neglected its duty under NEPA to analyze the impacts of withdrawals for fracking on water resources and their dependent ecosystems. Further, an adequate "hard look" at such impacts would include a very broad area of analysis based on a detailed hydrologic characterization of the regional aquifers potentially affected. As will be detailed below, dozens of endemic, endangered, or threatened species rely on water features potentially affected by pumping. Thus there are significant ramifications from neglecting to analyze impacts to water quantity or offering any protections whatsoever to water features.

B. Impacts to Groundwater Quality

Studies have reported many instances around the country of groundwater contamination due to surface spills of oil and gas wastewater, including fracking flowback.[32] Fracking and other unconventional techniques likewise pose inherent risks to groundwater due to releases below the surface, and these risks must be properly evaluated. Once groundwater is contaminated, it is very difficult, if not impossible, to restore the original quality of the water. As a result, in communities that rely on groundwater drinking water supplies, groundwater contamination can deprive communities of usable drinking water. Such long-term contamination necessitates the costly importation of drinking water supplies.

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[31] Heath, Ralph C., Basic Ground-Water Hydrology, U.S. Geological Survey Water-Supply Paper 2220 (2004).

[32] Vengosh, Avner, et al., A Critical Review of the Risks to Water Resources from Unconventional Shale Gas Development and Hydraulic Fracturing in the United States, Environ. Sci. Technol. dx.doi.org/10.1021/es405118y (2014).

Groundwater contamination can occur in a number of ways, and the contamination may persist for many years.[33] Poorly constructed or abandoned wells are recognized as one of the most likely ways by which contaminants may reach groundwater. Faulty well construction, cementing, or casing,[34] as well as the injection of fracking waste underground, can all lead to leaks.[35] Older wells that may not have been designed to withstand the stresses of hydraulic fracturing but which are reused for this purpose are especially vulnerable.[36] Improper well construction and surface spills are cited as a confirmed or potential cause of groundwater contamination in numerous incidents at locations across the U.S. including but not limited to Colorado,[37] Wyoming,[38] Pennsylvania,[39] Ohio,[40] West Virginia,[41] and Texas.[42] These sorts of problems at the well are not uncommon. Dr. Ingraffea of Cornell has noted an 8.9 percent failure rate for wells in the Marcellus Shale.[43] Also, the Draft EPA Investigation of Ground Water Contamination near Pavillion, Wyoming, found that chemicals found in samples of groundwater were from fracked wells.[44] These results have been confirmed with follow-up analyses.[45] Moreover, another study based on

[33] Myers, Tom, Potential Contamination Pathways from Hydraulically Fractured Shale to Aquifers, National Groundwater Association (2012).

[34] Natural Resources Defense Council, Water Facts: Hydraulic Fracturing can potentially Contaminate Drinking Water Sources (2012) at 2; Food & Water Watch, The Case for a Ban on Gas Fracking (2012) at 7.

[35] Kusnetz, Nicholas, North Dakota's Oil Boom Brings Damage Along with Prosperity, ProPublica, June 13, 2012; Lustgarten, Abraham, Polluted Water Fuels a Battle for Answers, ProPublica (2012); Lustgarten, Abraham, Injection Wells: The Poison Beneath Us, ProPublica (2012) at 2; Lustgarten, Abraham, Whiff of Phenol Spells Trouble, ProPublica (2012).

[36] U.S. EPA, Hydraulic Fracturing for Oil and Gas: Impacts from the Hydraulic Fracturing Water Cycle on Drinking Water Resources in the United States at ES-30 (Dec. 2016) ("EPA 2016").

[37] Gross, Sherilyn A. et al., Abstract: Analysis of BTEX groundwater concentrations from surface spills associated with hydraulic fracturing operations, 63 J. Air and Waste Mgmt. Assoc. 4, 424 doi: 10.1080/10962247.2012.759166 (2013).

[38] U.S. EPA, Draft Investigation of Ground Water Contamination near Pavillion, Wyoming (2011) ("EPA 2011").

[39] Darrah, Thomas H. et al., Noble Gases Identify the Mechanisms of Fugitive Gas Contamination in Drinking-Water Wells Overlying the Marcellus and Barnett Shales, Proc. Natl. Acad. Of Sciences Early Edition, doi: 10.1073/pnas.1322107111 (2014) ("Darrah 2014").

[40] Begos, Kevin, Some States Confirm Water Pollution from Oil, Gas Drilling, Seattle Times, Jan. 6, 2014, (accessed July 29, 2015) ("Begos, Seattle Times, Jan 6, 2014"). *See also*, ODNR, Report on the Investigation of the Natural Gas Invasion of Aquifers in Bainbridge Township of Geauga County, Ohio (2008), *supra*.

[41] Begos, Seattle Times, Jan 6. 2014.

[42] Darrah 2014.

[43] Ingraffea, Anthony R., Some Scientific Failings within High Volume Hydraulic Fracturing Proposed Regulations 6 NYCRR Parts 550-556, 560, Comments and Recommendations Submitted to the NYS Dept. of Environmental Conservation (Jan 8, 2013).

[44] U.S. EPA 2011.

[45] Drajem, Mark, Wyoming Water Tests in Line with EPA Finding on Fracking, Bloomberg, Oct. 11, 2012; U.S. EPA, Investigation of Ground Water Contamination near Pavillion, Wyoming Phase V Sampling Event - Summary of Methods and Results (2012); Myers, Tom, Review of DRAFT: Investigation of Ground Water Contamination near Pavillion Wyoming Prepared by the Environmental Protection Agency, Ada OK (Apr. 30, 2012).

modeling found that active transport of fracking fluid from a fracked well to an aquifer could occur in less than 10 years.[46]

Neither current federal nor state of Nevada rules do not ensure well integrity. The well casing can potentially fail over time and potentially create pathways for contaminants to reach groundwater. Well casing failure can occur due to improper or negligent construction. The EA should study the rates of well casing failures over time and evaluate the likelihood that well casing failures can lead to groundwater contamination.

Also, fluids and hydrocarbons may contaminate groundwater by migrating through newly created or natural fractures.[47] Many unconventional techniques intentionally fracture the formation to increase the flow of gas or oil. New cracks and fissures can allow the additives or naturally occurring elements such as natural gas to migrate to groundwater. "Migration pathways to drinking water resources could develop as a result of changes in the subsurface flow or pressure regime associated with hydraulic fracturing; via fractures that extend beyond the intended formation or that intersect existing natural faults or fractures; and via fractures that intersect offset wells or other artificial structures."[48] Fluids can also migrate through pre-existing and natural faults and fractures that may become pathways once the fracking or other method has been used.

According to the EPA, evidence of any fracturing-related fluid migration affecting a drinking water resources could take years to discover. EPA states:

> While some of the types of impacts . . . can occur quickly (i.e., on the scale of days or weeks, as with mechanical integrity problems or well communication events), other impacts (e.g., in slow-moving, deep groundwater) may be detectable only on much longer timescales. Without comprehensive collection and review of information about how hydraulic fracturing operations perform, fluid movement could occur without early detection, which could, in turn, increase the severity of any resultant impacts to drinking water quality. For example, testing the mechanical integrity of wells, monitoring the extent of the fractures that form, and conducting pre- and post-hydraulic fracturing water quality monitoring can detect fluid movement (or the potential for fluid movement) and provide opportunities to mitigate or minimize the severity of impacts associated with unforeseen events. [49]

BLM must consider long-term studies on the potential for fluid migration through newly created subsurface pathways. Fluid migration is of particular concern when oil and gas operations are close to drinking water supplies.

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[46] Myers, Tom, Potential Contaminant Pathways from Hydraulically Fractured Shale to Aquifers (Feb. 2012).

[47] U.S. EPA 2011; Warner, Nathaniel R., et al., Geochemical Evidence for Possible Natural Migration of Marcellus Formation Brine to Shallow Aquifers in Pennsylvania, PNAS Early Edition (2012).

[48] EPA 2016 at 6-39.

[49] EPA 2016 at 6-77.

Fracking fluid can also spill at the surface during the fracking process. For instance, mechanical failure or operator error during the process has caused leaks from tanks, valves, and pipes.[50] At the surface, pits or tanks can leak fracking fluid or waste.[51] Surface pits, in which wastewater is often dumped, are a major source of pollution. In California, a farmer was awarded $8.5 million in damages after his almond trees died when he irrigated them with well water that had been contaminated by nearby oil and gas operations. The contamination was traced to unlined pits where one of California's largest oil and gas producers for decades dumped billions of gallons of wastewater that slowly leached pollutants into nearby groundwater.[52] Also, New Mexico data shows, over the course of 3 decades, 743 instances of all types of oil and gas operations polluting groundwater—the source of drinking water for 90 percent of the state's residents.[53]

Unfiltered drinking water supplies, such as drinking water wells, are especially at risk because they have no readily available means of removing contaminants from the water. Even water wells with filtration systems are not designed to handle the kind of contaminants that result from unconventional oil and gas extraction.[54] In some areas hydraulic fracturing may occur at shallower depths or within the same formation as drinking water resources, resulting in direct aquifer contamination.[55] The EIS must disclose where the potential for such drilling exists.

Setbacks may not be adequate to protect groundwater from potential fracking fluid contamination. A recent study by the University of Colorado at Boulder suggests that setbacks of even up to 300-feet may not prevent contamination of clean water resources.[56] The study found that 15 organic compounds found in hydraulic fracturing fluids may be of concern as groundwater contaminants based on their toxicity, mobility, persistence in the environment, and frequency of use. These chemicals could have 10 percent or more of their initial concentrations remaining at a transport

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[50] Natural Resources Defense Council, Water Facts: Hydraulic Fracturing can potentially Contaminate Drinking Water Sources at 2 (2012) ("NRDC, Water Facts"); Food & Water Watch, The Case for a Ban on Gas Fracking (2012) ("Food & Water Watch 2012") at 5.

[51] *See*, E&E Staff Writer, Fracking Fluid leaks from wellhead in Colo., E&E News, Feb 14, 2013. ("At least 84,000 gallons of water contaminated from hydraulic fracturing seeped from a broken wellhead and into a field . . . ."); Michaels, Craig, et al., Fractured Communities: Case Studies of the Environmental Impacts of Industrial Gas Drilling, Riverkeeper (2010) at 12; NRDC Petition for Rulemaking at 20.

[52] *See* Sharp, Renee & Bill Allayaud, No Fracking, Speak No Fracking, Environmental Working Group (2012) at 6; *See also* Miller, Jeremy, Oil and Water Don't Mix with California Agriculture, High Country News (2012).

[53] New Mexico Oil and Conservation Division, OGAP Analysis of data provided in New Mexico Energy, Minerals and Natural Resources Dep't, Oil and Conservation Div., Cases Where Pit Substances Contaminated New Mexico's Ground Water (2008); *See* Natural Resources Defense Council, Petition for Rulemaking Pursuant to Section 6974(a) of the Resource Conservation and Recovery Act Concerning the Regulation of Wastes Associated with the Exploration, Development, or Production of Crude Oil or Natural Gas or Geothermal Energy (2010); Kusnetz, N., A Fracking First in Pennsylvania: Cattle Quarantine, ProPublica, July 2, 2010.

[54] Physicians Scientist & Engineers for Healthy Energy, Letter from Robert Howarth Ph.D. and 58 other scientists to Andrew M. Cuomo, Governor of New York State re: municipal drinking water filtration systems and hydraulic fracturing fluid (Sept 15, 2011) (accessed July 29, 2015).

[55] U.S. EPA 2016 at 6-69.

[56] University of Colorado-Boulder, New study identifies organic compounds of potential concern in fracking Fluids (July 1, 2015) (accessed July 29, 2015).

distance of 300 feet, the average "setback" distance in the U.S. The effectiveness and feasibility of any proposed setbacks must be evaluated.

C. Impacts to Surface Water Quality

Surface waters can be contaminated in many ways from unconventional well stimulation. In addition to storm water runoff, surface water contamination may also occur from chemical and waste transport, chemical storage leaks, and breaches in pit liners.[57] The spilling or leaking of fracking fluids, flowback, or produced water is a serious problem. Harmful chemicals present in these fluids can include volatile organic compounds ("VOCs"), such as benzene, toluene, xylenes, and acetone.[58] As much as 25 percent of fracking chemicals are carcinogens,[59] and flowback can even be radioactive.[60] As described below, contaminated surface water can result in many adverse effects to wildlife, agriculture, and human health and safety. It may make waters unsafe for drinking, fishing, swimming and other activities, and may be infeasible to restore the original water quality once surface water is contaminated. BLM should consider this analysis in the EA.

Massive volumes of chemicals and wastewater used or produced in oil and gas operations have the potential to contaminate local watersheds. Over 1 million gallons of chemicals are injected on average per hydraulically fracked well depending on the number of chemicals injected.[61] Several billions of gallons of wastewater are produced by oil and gas production per year.[62] Onshore oil and gas operations in the United States create about 56 million barrels of produced water *per day*.[63] California wells, for instance, produced roughly 3 billion barrels of wastewater in 2013, which is about 15 times the amount of oil the state produced.[64] This waste can reach fresh water aquifers and drinking water.[65]

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[57] Vengosh 2014.

[58] U.S. EPA, Plan to Study the Potential Impacts of Hydraulic Fracturing on Drinking Water Resources (2011) ("EPA Plan to Study Fracking Impacts").

[59] Colborn, Theo et al., Natural Gas Operations from a Public Health Perspective, 17 Human and Ecological Risk Assessment 1039 (2011).

[60] U.S. EPA, Plan to Study Fracking Impacts; White, Ivan E., Consideration of radiation in hazardous waste produced from horizontal hydrofracking, National Council on Radiation Protection (2012).

[61] U.S. EPA 2016 at ES-22.

[62] California Division of Oil, Gas, and Geothermal Resources, 2014 Preliminary Report of California Oil and Gas Production Statistics at 3 (July 2015); California Department of Conservation Division of Oil, Gas, and Geothermal Resources, Producing Wells and Production of Oil, Gas, and Water by County - 2011, Excerpted from Final Report of 2011 California Oil and Gas Production Statistics (2012).

[63] U.S. Government Accountability Office, Energy-Water Nexus: Information on the Quantity, Quality, and Management of Water Produced during Oil and Gas Production, Report to the Ranking Member, Committee on Science, Space and Technology, House of Representatives at 13 (2012).

[64] California Division of Oil, Gas, and Geothermal Resources, 2014 Preliminary Report of California Oil and Gas Production Statistics at 3 (July 2015); California Department of Conservation Division of Oil, Gas, and Geothermal Resources, Producing Wells and Production of Oil, Gas, and Water by County - 2011, Excerpted from Final Report of 2011 California Oil and Gas Production Statistics (2012).

[65] NRDC Petition for Rulemaking at 17.

Fluids must be transported to and/or from the well, which presents opportunities for spills.[66] Unconventional well stimulation relies on numerous trucks to transport chemicals to the site as well as collect and carry disposal fluid from the site to processing facilities. A U.S. GAO study found that up to 1,365 truckloads can be required just for the drilling and fracturing of a single well pad,[67] while the New York Department of Conservation estimated the number of "heavy truck" trips to be about 3,950 per horizontal well (including unloaded and loaded trucks).[68] Accidents during transit may cause leaks and spills that result in the transported chemicals and fluids reaching surface waters. Chemicals and waste transported by pipeline can also leak or spill. There are also multiple reports of truckers dumping waste uncontained into the environment.[69]

Produced waters that fracking operations force to the surface from deep underground can contain high levels of total dissolved solids, salts, metals, and naturally occurring radioactive materials.[70] If spilled, the effects of produced water or brine can be more severe and longer-lasting than oil spills, because salts do not biodegrade or break down over time. The only way to deal with them is to remove them.[71] Flowback waters (i.e., fracturing fluids that return to the surface) may also contain similar constituents along with fracturing fluid additives such as surfactants and hydrocarbons.[72] Given the massive volumes of chemicals and wastewater produced and their potentially harmful constituents, and their persistence in the environment, the potential for environmental disaster is real.

The EA should evaluate how often accidents can be expected to occur, and the effect of chemical and fluid spills. Such analysis should also include identification of the particular harms faced by communities near oil and gas fields. The EA must include specific mitigation measures and alternatives based on a cumulative impacts assessment, and the particular vulnerabilities of environmental justice communities in both urban and rural settings.

On-site storage of chemicals is also an issue warranting analysis. Thousands of gallons of chemicals can be potentially stored on-site and used during hydraulic fracturing and other unconventional well stimulation activities.[73] These chemicals can be susceptible to accidental spills and leaks. Natural occurrences such as storms and earthquakes may cause accidents, as can negligent operator practices.

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[66] Warco, Kathy, Fracking truck runs off road; contents spill, Observer Reporter, Oct 21, 2010.

[67] U.S. Government Accountability Office, Oil and Gas: Information on Shale Resources, Development, and Environmental and Public Health Risks, GAO 12-732 (2012) at 33.

[68] New York Department of Environmental Conservation, Final Supplemental Generic Environmental Impact Statement on the Oil, Gas and Solution Mining Regulatory Program, Ch. 6 Potential Environmental Impacts (2015) at 6-306.

[69] Kusnetz North Dakota; E&E News, Ohio man pleads not guilty to brine dumping, Feb. 15, 2013.

[70] Brittingham, Margaret C. et al., Ecological Risks of Shale Oil and Gas Development to Wildlife, Aquatic Resources and their Habitats, 48 Environ. Sci. Technol. 11034-11047, p. 11039 (2014).

[71] King, Pamela, Limited study supports findings on bigger brine spill risks, E&E News, Nov. 4, 2015.

[72] *Id*.

[73] U.S. EPA 2016 at ES-22.

Some sites may also use on-site wastewater treatment facilities. Improper use or maintenance of the processing equipment used for these facilities may result in discharges of contaminants. Other spill causes include equipment failure (most commonly, blowout preventer failure, corrosion and failed valves) and failure of container integrity.[74] Spills can result from accidents, negligence, or intentional dumping.[75]

D. The Water Resources Stipulation is Inadequate.

Rather than deferring the tens of thousands of acres of proposed leases which have substantial conflict with water resources, BLM has elected to implement a water resources stipulation. Although we commend BLM's acknowledgment of its authority to consider and add lease stipulations at the leasing stage, the particular stipulation relied upon here would do little to protect water resources and the wildlife which depend on them.

The stipulation is CSU, not NSO, meaning it has only a weak level of protection. It permits BLM to move a well up to 500 feet from a water source. This is a laughable level of protection. Contamination of an aquifer due to fracking would affect the entire aquifer, causing impacts to water sources as far as miles away. A 500 foot buffer does nothing to protect water resources. This stipulation also offers extensive discretion to BLM to accommodate developers in the form of exceptions, modifications, and waivers. This stipulation provides no tangible protections for water resources.

III. The EA Fails to Adequately Disclose or Analyze the Leasing Decision's Impacts to Threatened and Endangered Species.

The lack of any substantive analysis of impacts of the proposed action to threatened and endangered (T&E) species in Section 3.2.7 is an unlawful violation of both NEPA and the ESA. In particular, due to its proximity to and presence in the same hydrographic basin as some of the lease parcels, BLM is legally obligated to analyze potential impacts of the proposed action to the Railroad Valley springfish (*Crenichthys nevadae*), a threatened fish.

Given the potential for impacts to the Railroad Valley springfish, BLM has unlawfully neglected to prepare a biological assessment (BA) for the proposed action. 50 CFR § 402.12 states, "A biological assessment shall evaluate the potential effects of the action on listed and proposed species and designated and proposed critical habitat and determine whether any such species or habitat are likely to be adversely affected by the action and is used in determining whether formal consultation or a conference is necessary." The information provided in the T&E species section of the EA is so sparse and lacking in substance that it in no way meets the various criteria for a biological assessment set forth in 50 CFR § 402.12(f).

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[74] U.S. EPA 2015 at 5-31 to 5-46.

[75] *See*, *e.g*., Fontenot, Brian, et al., An evaluation of water quality in private drinking water wells near natural gas extraction sites in the Barnett Shale Formation, Environ. Sci. Technol. doi: 10.1021/es4011724 (2013); Jackson, Robert B., et al., Increased stray gas abundance in a subset of drinking water wells near Marcellus shale gas extraction, 110 PNAS 28 (2013).

Additionally, due to the potential for impacts to the Railroad Valley springfish, BLM is required to undergo a formal consultation with U.S. Fish and Wildlife Service, to comply with Section 7 of the Endangered Species Act. This consultation would result in a Biological Opinion. No such document has been proffered by BLM, implying that no such consultation has occurred, in violation of the law.

As was outlined above in Section II of this letter, there is the distinct possibility of substantial impacts to groundwater and surface water from the proposed action. Impacts to such waters have the potential to jeopardize the continued existence of these species, and adversely modify the critical habitat of those species for which it has been so designated.

As stated above, BLM cannot rely on the Nevada State Engineer to provide an environmental review of potential impacts from groundwater use. The Nevada State Engineer does not consider impacts to the environment as a part of their evaluation as to whether to award new or changed water rights. As such, it is necessary for BLM to do its own evaluation of the environmental impacts. Additionally, the state engineer makes no determination as to the potential of actions to affect the water quality of surface discharge. The high potential for contamination of aquifers from fracking needs to be analyzed with regard to potential impacts to T&E fish and designated critical habitat.

The Railroad Valley springfish is known from only two locations in the Railroad Valley – the Lockes Ranch spring complex, and the spring complex located on the Duckwater Reservation. Both locations contain designated critical habitat, and while the basin they lie within (173B) is not designated, there are significant groundwater withdrawals currently taking place. As outlined above, the fact that a basin is not overappropriated does not mean that groundwater withdrawals are not affecting surface water features. Additionally, localized effects of pumping need to be examined with close scrutiny for impacts to critical habitat adjacent to Parcel Group D, because the parcels are located extremely close to the Duckwater spring complex. Even the slightest perturbation in the aquifers that give rise to the Lockes Ranch and Duckwater spring complexes poses an existential threat to the fish, and will result in adverse modification of its critical habitat.[76]

As was outlined in Section II, there are numerous potential impacts from the proposed action to groundwater and surface water resources. And as has been laid out in this section, there are numerous T&E fishes which depend on those water resources for their survival. The BLM must prepare a Biological Assessment of the potential for impacts to these fishes, and must formally consult with FWS and obtain a BiOp finding of no jeopardy and no adverse modification if the BLM insists on proceeding with this lease sale. Anything less will be a violation of Section 7 of the Endangered Species Act.

[76] U.S. FWS, Determination of Threatened Status and Critical Habitat for the Railroad Valley Springfish, 51 Federal Register 6, 10857-10865 (1986).

IV. The EA Fails to Adequately Disclose or Analyze the Leasing Decision's Harm to Greater Sage-Grouse.

The greater sage-grouse is a BLM sensitive species. In September 2015, all BLM resource management plans for Nevada and Northeastern California, including Tonopah, were amended as part of an effort to secure adequate regulatory mechanisms to prevent the listing of the greater sage-grouse under the Endangered Species Act.[77] Because oil and gas development and associated infrastructure has numerous well-documented adverse effects on GRSG survival, breeding, and behavior, these plan amendments prescribe management measures for BLM-permitted activities, including oil and gas leasing, within sage-grouse habitat,[78] and prescribed stipulations for all new fluid mineral leases within those designated habitats.[79]

A. No Information on Existing Conditions or Anticipated Impacts Is Provided

Given the significance of the potential impacts that oil and gas development could have on the species, proper investigation here is crucial. BLM is required under NEPA to collect data particular to the region affected by the leases.[80] Despite the acknowledged presence of greater sage-grouse habitat (i.e., sagebrush)[81] within the areas proposed for leasing, the draft EA provides absolutely no discussion of the location, nature, or significance of impacts to sage-grouse populations within the project area. This approach clearly does not provide the "hard look" that NEPA requires.[82] The December 2020 Battle Mountain EA not only includes no site-specific analysis, it includes no analysis whatsoever of what sage-grouse populations and habitats will be affected, to what degree, and how those impacts may or may not be mitigated.

The EA omits local or even regional sage-grouse population information and thus does not provide the public with the information necessary to assess the likely impacts of oil and gas

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[77] *See* U.S. BLM, Nevada and Northeastern California Greater Sage-Grouse Approved Resource Management Plan Amendment (Sept. 2015) ("NV/NE CA RMPA"). The 2015 sage-grouse plans apply to this lease sale because the 2019 plan revisions have been enjoined by the Federal District Court for the District of Idaho.

[78] NV/NE CA RMPA at 2-29 to 2-30.

[79] NV/NE CA RMPA Appendix G.

[80] *See Center. for Biological Diversity*, 937 F. Supp. 2d at 1159 (Preparation of an EIS "is mandated where uncertainty may be resolved by further collection of data, or where collection of such data may prevent speculation on potential effects.").

[81] The Migratory Birds section of the document titled Supplemental Information for the December 2020 Competitive Oil and Gas Lease Sale EA" acknowledges the potential of three sagebrush obligate bird species to occur in the lease sale area (sage thrasher, Brewer's sparrow and sage sparrow), "while loggerhead shrike and green-tailed towhee also have potential to occur in the sagebrush habitats" at unnumbered page 8/50. The potential presence of migratory sagebrush obligates and other birds that utilize sagebrush habitats shows there is also potential for greater sage-grouse to be present. But this lease sale's NEPA documents focus on migratory birds, an approach that excludes greater sage-grouse. Available at https://eplanning.blm.gov/public_projects/2000539/200379813/20022095/250028299/20200720_December2020_O+G%20LeaseSale_SupplementalInfo.pdf.

[82] *Id*. (Held BLM did not provide the "hard look" that NEPA requires because it "never collected any data particular to the region affected by the leases, instead opting to summarize general data.").

leasing on GRSG in the lease area. This is disturbing because Garton et al. (2015) found that the estimated minimum number of GRSG males declined 33% from 2007 to 2013 in the Southern Great Basin population of GRSG and that this estimated decline "exemplifies the observed declines over the last 2 decades." Garton et al. at 15-16.[83] Even if the public acquires recent Nevada GRSG population data on its own, it is still not possible to match that data to the lease parcels because the EA does not identify the parcels by Lek Names, Lek ID Numbers, or even GRSG Population Management Units. Because of these limitations on the public's ability to assess current numbers and recent trends in the local GRSG population, it is all the more problematic that BLM did not include site-specific GRSG population and population trends in its EA.

Holloran (2005) found that sage grouse avoided habitats within 3.1 miles of active oil and gas drilling operations, and within 2 miles of roads or wellpads during the production phase of oil and gas extraction.[84] The failure to consider the acreage of habitat lost due to abandonment of otherwise suitable habitats adjacent to roads and well sites, and the failure to even quantify the amount of habitats critical to the life cycles of sage-grouse that occur on individual leases (much less evaluate the site-specific topography and how that might mitigate or exacerbate impacts of oil and gas development), constitute failures of NEPA's hard look requirements.

V. The EA Fails to Adequately Disclose or Analyze the Leasing Decision's Harm to Air Quality in violation of NEPA and the Clean Air Act.

Oil and gas operations emit numerous air pollutants, including volatile organic compounds (VOCs), NOX, particulate matter, hydrogen sulfide, and methane. Hydraulic fracturing ("fracking") operations are particularly harmful, emitting especially large amounts of pollution, including air toxic air pollutants. Permitting fracking and other well stimulation techniques will greatly increase the release of harmful air emissions in these and other regions. BLM failed to analyze air quality impacts from new development in conjunction with the existing air quality landscape for the lease parcels. BLM must analyze increased emissions from foreseeable oil and gas development for these lease parcels in order to prevent further degradation of local air quality, respiratory illnesses, premature deaths, hospital visits, as well as missed school and work days.

The EA does not adequately consider the impact of increased oil and gas development, triggered by additional leasing, on the formation of air pollutants. The BMPs and voluntary air quality programs for oil and natural gas development and operations listed in the EA are inadequate to address the current and anticipated violations of national and state health standards for ozone and PM2.5.[85] Failure to identify adequate mitigation measures in a NEPA document violates NEPA's

[83] Garton, Edward O., et al., Greater Sage-Grouse Population Dynamics and Probability of Persistence: Final Report to Pew Charitable Trusts (2015).

[84] Holloran, Matthew, Greater Sage-Grouse (*Centrocercus urophasianus*) Population Response to Natural Gas Field Development in Western Wyoming (2005).

[85] EA at 3.3.1, p. 28.

requirement that the agency identify mitigation measures,[86] and consider all reasonable alternatives.[87]

NEPA is intended to provide both disclosure and analysis of impacts. While the EA provides disclosure of potential emissions from a "representative well," it unlawfully provides no analysis of the effects of those impacts. Forecasting air quality impacts from the leasing and resource management of fossil fuel development is required by well-established law.[88] Due to the lack of analysis, the only time the cumulative impacts of oil and gas development projects could be analyzed is when the last oil and gas well in a given area is proposed—a result that contravenes NEPA's intent, to study and analyze potential significant and cumulative environmental effects of a proposed action before they occur.

BLM must review both (a) the foreseeable site-specific emission sources from the proposed lease parcels and (b) the sources of air emissions from existing, permitted, and other leased sources, and analyze how increased emissions from future oil and gas development will impact, cause or contribute to exceedances of the NAAQS.

BLM can readily identify oil and gas volume estimates for lease parcels by utilizing their own EPCA Phase III spatial data and overlaying the lease parcel boundary map provided in the lease sale notice.[89] Estimating emissions from production of oil and gas wells per volume produced can be readily calculated using a number of EPA emissions inventory calculation tools.[90] The type, quantity and future impact of additional air emissions from this new potential development can and must be analyzed in conjunction with the existing air quality landscape in this region. Failure to do so renders BLM's EA inadequate for purposes of NEPA review.

BLM should look no further than a recent interagency guidance outlining proper air quality analysis and modeling in lease sale decisions. In 2011, the Environmental Protection Agency (EPA), the Department of Interior, and the Department of Agriculture entered into a Memorandum of Understanding (MOU) to establish a "a clearly defined, efficient approach to compliance with

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[86] 40 C.F.R. § 1508.25.

[87] *Center for Biological Diversity v. Nat'l Highway Traffic Safety Admin.*, 538 F.3d 1172, 1217 (9th Cir. 2008) (citing 40 C.F.R. § 1502.14(a)).

[88] *WildEarth Guardians v. United States Office of Surface Mining Reclamation & Enforcement*,104 F. Supp. 3d 1208, 1227-1228 (D. Colo. 2015) ("The question posed by the plaintiff is not whether the increased mining will result in a release of particulate matter and ozone precursors in excess of the NAAQS, but whether the increased emissions will have a significant impact on the environment. One can imagine a situation, for example, where the particulate and ozone emissions from each coal mine in a geographic area complied with Clean Air Act standards but, collectively, they significantly impacted the environment. It is the duty of OSM to determine whether a mining plan modification would contribute to such an effect, whether or not the mine is otherwise in compliance with the Clean Air Act's emissions standards."(internal citations omitted)).

[89] U.S. DOA, United States Department of Energy, United States Department of the Interior, Inventory of Onshore Federal Oil and Natural Gas Resources and Restrictions to Their Development (2008) ("EPCA Phase III Inventory").

[90] Russell, James, Alison Pollack and Greg Yarwood, An Emission Inventory of Non-point Oil and Gas Emissions Sources in the Western Region, ENVIRON International Corporation; *See also* Bar-Ilan, Amnon et al., A Comprehensive Emissions Inventory of Upstream Oil and Gas Activities in the Rocky Mountain States (2010).

[NEPA] regarding air quality . . . in connection with oil and gas development on Federal lands."[91] The MOU "provides for early interagency consultation throughout the NEPA process; common procedures for determining what type of air quality analyses are appropriate and when air modeling is necessary; specific provisions for analyzing and discussing impacts to air quality and for mitigating such impacts; and a dispute resolution process to facilitate timely resolution of differences among agencies."[92] The goal of this process is to ensure that "[F]ederal oil and gas decisions do not cause or contribute to exceedances of the National Ambient Air Quality Standards (NAAQS)."[93] The MOU outlines recommended technical, quantitative procedures to follow, which include identifying the reasonably foreseeable number of oil and gas wells and conducting an emissions inventory of criteria pollutants. Further air quality modeling is required if certain criteria are met, based on the level of emissions impact and the geographic location of the action.[94] The MOU indicates that "[e]xisting reasonably foreseeable development scenarios can be used to identify the number of wells."[95]

Given the likelihood that fracking and other similarly harmful techniques would be employed in the exploration and development of the parcels, BLM has an obligation to analyze and disclose the potential impacts resulting from such frequently used practices. The purpose of an environmental assessment is for BLM to look at the impacts in total, and to take a hard look at all "reasonably foreseeable" impacts now, before leasing the land. NEPA regulations and case law clearly establish that uncertainty about the precise extent and nature of environmental impacts does not relieve an agency of the obligation to disclose and analyze those impacts utilizing the best information available. *See* 40 C.F.R. § 1502.22(a),(b).

A. Types of Air Emissions

BLM failed to provide any analysis of the type, extent, or source of emissions from unconventional oil and gas extraction methods, such as fracking. The rapid expansion of unconventional oil and gas extraction makes the impacts associated with fracking foreseeable.

Unconventional oil and gas operations emit large amounts and a wide array of toxic air pollutants,[96] also referred to as Hazardous Air Pollutants, which are known or suspected to cause cancer or other serious health effects, such as reproductive effects or birth defects, or adverse environmental effects.[97] Air pollutants emitted by unconventional oil and gas production include toxic BTEX compounds (benzene, toluene, ethylbenzene, and xylene); volatile organic compounds (VOCs)

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[91] U.S. DOA, Memorandum of Understanding Among the U.S. Department of Agriculture, U.S. Department of the Interior, and U.S. Environmental Protection Agency, regarding Air Quality Analyses and Mitigation for Federal Oil and Gas Decisions through the National Environmental Policy Act Process, Preamble (2011).

[92] *Id*. at 4.

[93] *Id*. at 1, 2.

[94] *Id.* § V.E.1., pg. 9.

[95] *Id*.

[96] Sierra Club et al. comments on New Source Performance Standards: Oil and Natural Gas Sector; Review and Proposed Rule for Subpart OOOO (Nov. 30, 2011) ("Sierra Club Comments") at 13.

[97] *See* U.S. EPA, About Hazardous Air Pollutants at, Hazardous Air Pollutants, (accessed Jan 5, 2017).

such as methylene chloride; nitrogen oxides (NOx); particulate matter (including diesel exhaust); alkanes (methane, ethane, propane); formaldehyde; hydrogen sulfide; silica; acid mists; sulfuric oxide; and radon gas.[98] These toxic air contaminants and smog-forming chemicals (such as VOCs, NOx, methane and ethane) threaten local communities and regional air quality.

The reporting requirements recently implemented by the California South Coast Air Quality Management District ("SCAQMD") have shown that at least 44 chemicals known to be air toxics have been used in fracking and other types of unconventional oil and gas recovery in California.[99] Through the implementation of these new reporting requirements, it is now known that operators have been using several types of air toxics, including crystalline silica, methanol, hydrochloric acid, hydrofluoric acid, 2-butoxyethanol, ethyl glycol monobutyl ether, xylene, amorphous silica fume, aluminum oxide, acrylic polymer, acetophenone, and ethylbenzene. Many of these chemicals also appear on the U.S. EPA's list of hazardous air pollutants.[100] EPA has also identified six "criteria" air pollutants that must be regulated under the National Ambient Air Quality Standards (NAAQS) due to their potential to cause primary and secondary health effects. As detailed below, concentrations of many of these pollutants—ozone, particulate matter, carbon monoxide, nitrogen oxides, sulfur dioxide and lead—have been shown to increase in regions where unconventional oil and gas recovery techniques are permitted.

VOCs, from car and truck engines as well as the drilling and completion stages of oil and gas production, make up about 3.5 percent of the gases emitted by oil or gas operations.[101] The VOCs emitted include the BTEX compounds—benzene, toluene, ethyl benzene, and xylene – which are listed as Hazardous Air Pollutants.[102] There is substantial evidence showing the grave harm from these pollutants.[103] Recent studies and reports confirm the pervasive and extensive amount of VOCs emitted by unconventional oil and gas extraction.[104] For example, a study covering sites near oil and gas wells in five different states including Colorado, Wyoming, Ohio, Pennsylvania, and Arkansas, found that concentrations of eight toxic volatile chemicals, including benzene, formaldehyde and hydrogen sulfide, exceeded federal health and safety standards, at times by

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[98] McKenzie, Lisa M. et al., Human Health Risk Assessment of Air Emissions From Development of Unconventional Natural Gas Resources, 424 Science of the Total Environment 79 (2012) ("McKenzie 2012); Shonkoff, Seth B.C. et al., Environmental Public Health Dimensions of Shale and Tight Gas Development, 122 Environmental Health Perspectives 787 (2014) ("Shonkoff 2014").

[99] Center for Biological Diversity, Air Toxics One Year Report (2014) at 1.

[100] U.S. EPA, The Clean Air Act Amendments of 1990 List of Hazardous Air Pollutants, Technology Transfer Network Air Toxics Web Site (accessed July 29, 2015).

[101] Brown, Heather, Memorandum to Bruce Moore, U.S.EPA/OAQPS/SPPD re Composition of Natural Gas for use in the Oil and Natural Gas Sector Rulemaking, July 28, 2011 ("Brown Memo") at 3.

[102] 42 U.S.C. § 7412(b).

[103] Colborn, T. et al., Natural Gas Operations from a Public Health Perspective, 17 Human and Ecological Risk Assessment 1039 (2011) ("Colborn 2011"); McKenzie 2012.

[104] McCawley, Michael, Air, Noise, and Light Monitoring Plan for Assessing Environmental Impacts of Horizontal Gas Well Drilling Operations (ETD-10 Project), West Virginia University School of Public Health, Morgantown, WV (2013) ("McCawley 2013"); Center for Biological Diversity, Dirty Dozen: The 12 Most Commonly Used Air Toxics in Unconventional Oil Development in the Los Angeles Basin (2013).

several orders of magnitude.[105] Another study determined that vehicle traffic and engine exhaust were likely the sources of intermittently high dust and benzene concentrations observed near well pads.[106] Recent studies have found that oil and gas operations are likely responsible for elevated levels of hydrocarbons such as benzene downwind of the Denver-Julesburg Fossil Fuel Basin, north of Denver.[107] Another study found that oil and gas operations in this area emit approximately 55percent of the VOCs in northeastern Colorado. [108]

VOCs, NOx, methane, and ethane are potent ground-level (tropospheric) ozone precursors that are emitted by oil and gas drilling and fracking operations. Ozone can result in serious health conditions, including heart and lung disease and mortality.[109] Exposure to elevated levels of ozone is estimated to be cause ~10,000 premature deaths per year in the United States.[110] VOCs can form ground-level (tropospheric) ozone when combined with nitrogen oxides (“NO_X”) from compressor engines, turbines, other engines used in drilling, and flaring,[111] in the presence of sunlight. This reaction can diminish visibility and air quality and harm vegetation. Many regions around the country with substantial oil and gas operations are now suffering from extreme ozone levels due to heavy emissions of these pollutants.[112] A recent study of ozone pollution in the Uintah Basin of northeastern Utah, a rural area that experiences hazardous tropospheric ozone concentrations, found that oil and gas operations were responsible for 98 to 99 percent of VOCs and 57 to 61 percent of NO_X emitted from sources within the Basin considered in the study’s inventory.[113]

Ground-level ozone can also be caused by methane, which is leaked and vented at various stages of unconventional oil and gas development, as it interacts with nitrogen oxides and sunlight.[114] In

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[105] Macey, Gregg P. et al., Air Concentrations of Volatile Compounds Near Oil and Gas Production: A Community-Based Exploratory Study, 13 Environmental Health 82 (2014) at 1.

[106] McCawley 2013.

[107] Pétron, G. et al., Hydrocarbon Emissions Characterization in the Colorado Front Range – A Pilot Study, 117 J. Geophysical Research D04304 (2012) at 8, 13 (“Pétron 2012).

[108] Gilman, Jessica B. et al., Source Signature of Volatile Organic Compounds from Oil and Natural Gas Operations in Northeastern Colorado, 47 Environmental Science & Technology 1297 (2013) at 1297, 1303 (“Gilman 2013”).

[109] U.S. EPA, Integrated Science Assessment (ISA) for Ozone (O3) and Related Photochemical Oxidants (2013).

[110] Caiazzo, Fabio et al., Air Pollution and Early Deaths in the United States. Part I: Quantifying the Impact of Major Sectors in 2005, 79 Atmospheric Environment 198 (2013).

[111] *See, e.g.*, U.S. EPA, Oil and Gas Sector: Standards of Performance for Crude Oil and Natural Gas Production, Transmission, and Distribution: Background Technical Support Document for Proposed Standards at 3-6 (2011); Armendariz, Al, Emissions for Natural Gas Production in the Barnett Shale Area and Opportunities for Cost-Effective Improvements (2009) (“Armendariz 2009”) at 24.

[112] Armendariz 2009 at 1, 3, 25-26; Koch, Wendy, Wyoming’s Smog Exceeds Los Angeles' Due to Gas Drilling, USA Today, May 9, 2011; Craft, Elena, Environmental Defense Fund, Do Shale Gas Activities Play a Role in Rising Ozone Levels? (2012); Colorado Dept. of Public Health and Environment, Conservation Commission, Colorado Weekly and Monthly Oil and Gas Statistics (July 6, 2012) at 12.

[113] Lyman, Seth & Howard Shorthill, Final Report: 2012 Uintah Basin Winter Ozone & Air Quality Study, Utah Department of Environmental Quality (2013) (“Lyman 2013”); *See also* Gilman 2013.

[114] Fiore, Arlene et al., Linking Ozone Pollution and Climate Change: The Case for Controlling Methane, 29 Geophys. Res Letters 19 (2002) (“Fiore 2002”); U.S. EPA, Oil and Gas Sector: New Source Performance Standards and

addition to its role as a potent greenhouse gas, methane's effect on ozone concentrations can be substantial. One paper modeled reductions in various anthropogenic ozone precursor emissions and found that "[r]educing anthropogenic CH_4 emissions by 50% nearly halves the incidence of U.S. high-O_3 events."[115]

Ethane is also a potent precursor of ground-based ozone pollution as it breaks down and reacts with sunlight to create smog, as well as being a greenhouse gas. Ethane emissions have risen steeply in recent years due to U.S. oil and gas production. A recent study documented that ethane emissions in the Northern Hemisphere increased by about 400,000 tons annually between 2009 and 2014, with the majority coming from North American oil and gas activity, reversing a decades-long decline in ethane emissions.[116] Shockingly, about 60 percent of the drop in ethane levels that occurred over the past 40 years has already been made up in the past five years. At this rate, U.S. ethane levels are expected to hit 1970s levels in about three years. About two percent of global ethane emissions originate from the Bakken Shale oil and gas field alone, which emits 250,000 tons of ethane per year.[117] Because global ethane levels were decreasing until 2009, the U.S. shale gas boom is thought to be responsible for the global increase in levels since 2010.

Oil and gas operations can also emit hydrogen sulfide. The hydrogen sulfide is contained in the natural gas and makes that gas "sour."[118] Hydrogen sulfide may be emitted during all stages of operation, including exploration, extraction, treatment and storage, transportation, and refining. Long-term exposure to hydrogen sulfide is linked to respiratory infections, eye, nose, and throat irritation, breathlessness, nausea, dizziness, confusion, and headaches.[119]

The oil and gas industry is also a major source of particulate matter. The heavy equipment regularly used in the industry burns diesel fuel, generating fine particulate matter[120] that is especially harmful.[121] Vehicles traveling on unpaved roads also kick up fugitive dust, which is particulate matter.[122] Further, both NO_X and VOCs, which as discussed above are heavily emitted by the oil

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National Emission Standards for Hazardous Air Pollutants Reviews Proposed Rule, 76 Federal Register 52738 (Aug 23, 2011).

115 Fiore 2002; *See also* Martin, Randal et al., Final Report: Uinta Basin Winter Ozone and Air Quality Study Dec 2010 - March 2011 (2011) at 7.

116 Helmig, Detlev et al., Reversal of Global Atmospheric Ethane and Propane Trends Largely Due to US Oil and Natural Gas Production, 9 Nature Geoscience 490 (2016).

117 Kort, Eric A. et al., Fugitive Emissions From the Bakken Shale Illustrate Role of Shale Production in Global Ethane Shift, 43 Geophysical Research Letters 4617 (2016).

118 Sierra Club Comments.

119 U.S. EPA, Office of Air Quality Planning and Standards, Report to Congress on Hydrogen Sulfide Air Emissions Associated with the Extraction of Oil and Natural Gas (EPA-453/R-93-045) (Oct. 1993) at i ("USEPA 1993").

120 Earthworks, Sources of Oil and Gas Pollution (2011).

121 Bay Area Air Quality Management District, Particulate Matter Overview, Particulate Matter and Human Health (2012).

122 U.S. EPA, Regulatory Impact Analysis for the Proposed Revisions to the National Ambient Air Quality Standards for Particulate Matter (June 2012) ("EPA RIA").

and gas industry, are also particulate matter precursors.[123] Some of the health effects associated with particulate matter exposure are "premature mortality, increased hospital admissions and development of chronic respiratory disease."[124]

Fracking results in additional air pollution that can create a severe threat to human health. One analysis found that 37 percent of the chemicals found at fracked gas wells were volatile, and that of those volatile chemicals, 81 percent can harm the brain and nervous system, 71 percent can harm the cardiovascular system and blood, and 66 percent can harm the kidneys.[125] The SCAQMD has identified three areas of dangerous and unregulated air emissions from fracking: (1) the mixing of the fracking chemicals; (2) the use of the silica, or sand, as a proppant, which causes the deadly disease silicosis; and (3) the storage of fracking fluid once it comes back to the surface.[126] Preparation of the fluids used for well completion often involves onsite mixing of gravel or proppants with fluid, a process which potentially results in major amounts of particulate matter emissions.[127] Further, these proppants often include silica sand, which increases the risk of lung disease and silicosis when inhaled.[128] Finally, as flowback returns to the surface and is deposited in pits or tanks that are open to the atmosphere, there is the potential for organic compounds and toxic air pollutants to be emitted, which are harmful to human health as described above.[129]

The EA should study the potential for oil and gas operations sites in the planning area to emit such air toxics and any other pollutants that may pose a risk to human health, paying particular attention to the impacts of air pollution on environmental justice communities that already bear the burden of disproportionately high levels of air pollution.

The EA should rely on the most up-to-date information regarding the contribution of oil and gas operations to air pollution levels. Numerous studies demonstrate that state and federal emissions inventories significantly underestimate the levels of hazardous air pollution coming from oil and gas drilling and fracking operations. For example, aerial surveys of more than 8,000 oil and gas wells in seven US regions found that well pads emit considerably more methane and VOCs that captured by existing inventories.[130] Recent studies in Weld County, Colorado, show that existing emissions inventories likely underestimate the contribution of oil and gas operations to VOC levels

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[123] EPA RIA at 2-2.

[124] U.S. EPA, National Ambient Air Quality Standards for Particulate Matter Proposed Rule, 77 Fed. Reg. 38,890, 38,893 (June 29, 2012).

[125] Colborn 2011 at 8.

[126] South Coast Air Quality Management District, Draft Staff Report on Proposed Rule 1148.2 - Notification and Reporting Requirements for Oil and Gas Wells and Chemical Suppliers (2013) at 15 ("SCAQMD Draft Staff Report PR1148-2").

[127] *Id.*

[128] South Coast Air Quality Management District, Response to Questions re Air Quality Risks of Hydraulic Fracturing in California, Submission to Joint Senate Hearing (2013) at 3.

[129] SCAQMD Draft Staff Report PR1148-2 at 15.

[130] Lyon, David R. et al., Aerial Surveys of Elevated Hydrocarbon Emissions From Oil and Gas Production Sites, 50 Environmental Science & Technology 4877 (2016).

by at least a factor of two, and that benzene emissions are underestimated by four to nine times[131] These studies suggest that the health risk assessments conducted using these inventories are inaccurate and underestimate exposures and health risks.[132] Similarly, the assessment of fracking in California by the California Council on Science and Technology found that current inventory methods underestimate methane and VOC emissions from oil and gas operations.[133]

B. Sources of Air Emissions

Harmful air pollutants are emitted during every stage of unconventional oil and gas development, including drilling, completion, well stimulation, production, and disposal, as well as from transportation of water, sand, chemicals, and to and from the well pad.[134] The well stimulation stage can emit diesel exhaust, VOCs, particulate matter, ozone precursors, silica, and acid mists.[135] Drilling and casing the wellbore require substantial power from large equipment. The engines used typically run on diesel fuel, which emits particularly harmful types of air pollutants when burned. Similarly, high-powered pump engines are used in the fracturing and completion phase. This too can amount in large volumes of air pollution. Flaring, venting, and fugitive emissions of gas are also a potential source of air emissions. Gas flaring and venting can occur in both oil and gas recovery processes when underground gas rises to the surface and is not captured as part of production. Emissions from flaring typically include carbon monoxide, nitrogen oxides, benzene, formaldehyde and xylene, but levels of these smog-forming compounds are seldom measured directly.[136]

Fugitive emissions can occur at every stage of extraction and production, often leading to high volumes of gas being released into the air. Methane emissions from oil and gas production are as much as 270 percent greater than previously estimated by calculation.[137] Recent studies show that emissions from pneumatic valves (which control routine operations at the well pad by venting methane during normal operation) and fugitive emissions are higher than EPA estimates.[138]

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[131] Pétron 2012 at 1, 18 (noting state and federal inventories likely underestimate hydrocarbon emissions from oil and gas operations by as much as factor of two); Pétron, Gabrielle et al., A New Look at Methane and Non-Methane Hydrocarbon Emissions from Oil and Natural Gas Operations in the Colorado Denver-Julesburg Basin, 119 Journal Geophysical Research: Atmospheres (2014) at 6836 (“Pétron 2014”).

[132] Pétron 2014.

[133] Brandt, Adam et al., Ch 3: Air quality impacts from well stimulation, An Independent Assessment of Well Stimulation in California, Volume 2, California Council on Science and Technology (2015) (“CCST 2015”).

[134] Shonkoff 2014.

[135] *Id.*

[136] Physicians for Social Responsibility and Concerned Health Professionals of NY, Compendium of Scientific, Medical, and Media Findings Demonstrating Risks and Harms of Fracking, Fourth Edition, November 17, 2016 (“PSR 2016”).

[137] Miller 2013.

[138] Allen, David et al., Measurements of Methane Emissions at Natural Gas Production Sites in The United States, 110 PNAS 17768 (2013) (“Allen 2013”); Harriss, Robert et al., Using Multi-Scale Measurements to Improve Methane Emission Estimates from Oil and Gas Operations in the Barnett Shale Region, Texas, 49 Environ. Sci. Technol. 7524 (2015).

Evaporation from pits can also contribute to air pollution. Pits that store drilling waste, produced water, and other waste fluid may be exposed to the open air. Chemicals mixed with the wastewater—including the additives used to make fracking fluids, as well as volatile hydrocarbons, such as benzene and toluene, brought to the surface with the waste—can escape into the air through evaporation. Some pits are equipped with pumps that spray effluents into the air to hasten the evaporation process. For example, evaporation from fracking waste pits in western Colorado was found to have added tons of toxic chemicals to the air, increasing air pollution in Utah.[139] In Texas, toxic air emissions from fracking waste pits are unmonitored and unregulated.[140] In California, unlined disposal pits for drilling and fracking waste are documented sources of contamination.[141] Even where waste fluid is stored in so-called "closed loop" storage tanks, fugitive emissions can escape from tanks.

As mentioned above, increased truck traffic will lead to more air emissions. Trucks capable of transporting large volumes of chemicals and waste fluid typically use large engines that run on diesel fuel. Air pollutants from truck engines will be emitted not only at the well site, but also along truck routes to and from the site.

The EA must provide an adequate analysis and disclosure of the effects the lease sale could have on air quality, including the impacts that would result from fracking. The EA cannot postpone the discussion of air pollution impacts until site-specific plans are proposed. Because BLM must analyze impacts at "the earliest practicable time," and no benefit would be gained from postponing the analysis, BLM must discuss these cumulative impacts before the lease sale.

C. Impact of Increased Air Pollution.

The potential harms resulting from increased exposure to the dangerous air pollutants from unconventional oil and gas development are serious and wide-ranging. A growing body of scientific research has documented adverse public health impacts from unconventional oil and gas development, including studies showing air pollutants at levels associated with reproductive and developmental harms and the increased risk of morbidity and mortality.[142] A comprehensive review of the risks and harms of fracking to public health came to several key findings related to air pollution: (1) "drilling and fracking emissions contribute to toxic air pollution and smog

[139] Maffy, Brian, Utah grapples with toxic water from oil and gas industry, The Salt Lake Tribune, August 28, 2014; The company responsible for the waste pits was found to have operated without a permit, underreported emissions and provided erroneous data to regulators.

[140] Center for Public Integrity, Open Pits Offer Cheap Disposal for Fracking Sludge But Health Worries Mount, October 2, 2014.

[141] Stringfellow, William T. et al., Ch 2: Impacts of Well Stimulation on Water Resources, An Independent Assessment of Well Stimulation in California, Volume 2, California Council on Science and Technology (2015) ("CCST 2015") at 110-113.

[142] Hays, Jake & Seth B.C. Shonkoff , Towards an Understanding of the Environmental and Public Health Impacts of Unconventional Natural Gas Development: A Categorical Assessment of the Peer-Reviewed Scientific Literature, 11 PLoS ONE e0154164 (2016); Shonkoff 2014; Webb, Ellen et al., Developmental and reproductive effects of chemicals associated with unconventional oil and natural gas operations, 29 Rev Environ Health 307 (2014); McKenzie 2012; Clean Air Task Force, Fossil Fumes: A Public Health Analysis of Toxic Air Pollution From the Oil and Gas Industry (2016).

(ground-level ozone) at levels known to have health impacts," (2)"public health problems associated with drilling and fracking, including reproductive impacts and occupational health and safety problems, are increasingly well documented"; and (3)"fracking infrastructure poses serious potential exposure risks to those living near it."

Air toxics and hazardous air pollutants, by definition, can result in harm to human health and safety. Understanding the full extent of the health effects of exposure is still far from being complete, but already there are numerous studies that have found these chemicals to have serious health consequences for humans exposed to even minimal amounts. The negative effects of criteria pollutants are well documented and are summarized by the U.S. EPA's website:

> *Nitrogen oxides* (NOx) react with ammonia, moisture, and other compounds to form small particles. These small particles penetrate deeply into sensitive parts of the lungs and can cause or worsen respiratory disease, such as emphysema and bronchitis, and can aggravate existing heart disease, leading to increased hospital admissions and premature death. NO_x and volatile organic compounds react in the presence of heat and sunlight to form ozone.
>
> *Particulate matter* (PM)—especially fine particles—contains microscopic solids or liquid droplets that are so small that they can get deep into the lungs and cause serious health problems. Numerous scientific studies have linked particle pollution exposure to a variety of problems, including: premature death in people with heart or lung disease, increased mortality, nonfatal heart attacks, irregular heartbeat, aggravated asthma, decreased lung function, and increased respiratory symptoms, such as irritation of the airways, coughing or difficulty breathing.[143]
>
> *Sulfur Dioxide* (SO_2) – has been shown to cause an array of adverse respiratory effects including bronchoconstriction and increased asthma symptoms.[144] Studies also show a connection between short-term exposure and increased visits to emergency departments and hospital admissions for respiratory illnesses, particularly in at-risk populations including children, the elderly, and asthmatics.[145]
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> *Carbon Monoxide* (CO) can cause harmful health effects by reducing oxygen delivery to the body's organs (like the heart and brain) and tissues. At extremely high levels, CO can cause death.[146] Exposure to CO can reduce the oxygen-carrying capacity of the blood. People with several types of heart disease already have a reduced capacity for pumping oxygenated blood to the heart, which can cause them to experience myocardial ischemia (reduced oxygen to the heart), often accompanied by chest pain (angina), when exercising or under increased

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[143] U.S. Environmental Protection Agency, Particulate Matter, (PM) (accessed July 30, 2015); Ostro, Bart et al., Long-term Exposure to Constituents of Fine Particulate Air Pollution and Mortality: Results from the California Teachers Study, 118 Environmental Health Perspectives 3 (2010).

[144] U.S. Environmental Protection Agency, Sulfur Dioxide (accessed July 29, 2015).

[145] *Id.*

[146] U.S. EPA, Carbon Monoxide (accessed July 29, 2015).

> stress.[147] For these people, short-term CO exposure further affects their body's already compromised ability to respond to the increased oxygen demands of exercise or exertion.[148]
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> *Ozone* (O_3) can trigger or worsen asthma and other respiratory ailments.[149] Ground level ozone can have harmful effects on sensitive vegetation and ecosystems. Ozone may also lead to loss of species diversity and changes to habitat quality, water cycles, and nutrient cycles.

The range of illnesses that can result from the wide array of air pollutants from fracking were summarized in a study by Dr. Theo Colburn, which charts which chemicals have been shown to be linked to certain illnesses.[150] This study analyzed air samples taken during drilling operations near natural gas wells and residential areas in Garfield County, and detected 57 chemicals between July 2010 and October 2011, including 44 with reported health effects.[151] For example:

> Thirty-five chemicals were found to affect the brain/nervous system, 33 the liver/metabolism, and 30 the endocrine system, which includes reproductive and developmental effects. The categories with the next highest numbers of effects were the immune system (28), cardiovascular/blood (27), and the sensory and respiratory systems (25 each). Eight chemicals had health effects in all 12 categories. There were also several chemicals for which no health effect data could be found.[152]

The study found extremely high levels of methylene chloride, which may be used as cleaning solvents to remove waxy paraffin that is commonly deposited by raw natural gas in the region. These deposits solidify at ambient temperatures and build up on equipment.[153] While none of the detected chemicals exceeded governmental safety thresholds of exposure, the study noted that such thresholds are typically based on "exposure of a grown man encountering relatively high concentrations of a chemical over a brief time period, for example, during occupational exposure."[154] Consequently, such thresholds may not apply to individuals experiencing "chronic, sporadic, low-level exposure," including sensitive populations such as children, the elderly and pregnant women.[155] For example, the study detected polycyclic aromatic hydrocarbon (PAH) levels that could be of "clinical significance," as recent studies have linked low levels of exposure to lower mental development in children who were prenatally exposed.[156] In addition, government

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147 *Id.*

148 *Id.*

149 U.S. EPA, Ground Level Ozone (accessed July 29, 2015).

150 Colborn 2011; Colborn 2012; *See* note 120.

151 Colborn 2012 at pp. 21-22.

152 Colborn 2012 at 11.

153 *Id*. at 10.

154 *Id*. at 11-12.

155 *Id*. at. 12.

156 *Id*. at 10-11.

safety standards do not take into account “the kinds of effects found from low-level exposure to endocrine disrupting chemicals . . . , which can be particularly harmful during prenatal development and childhood.[157]

Adverse health impacts documented among residents living near drilling and fracking operations include reproductive harms, increased asthma attacks, increased rates of hospitalization, ambulance runs, emergency room visits, self-reported respiratory problems and rashes, motor vehicle fatalities, trauma, and drug abuse. A recent review concluded:

> By several measures, evidence for fracking-related health problems is emerging across the United States. In Pennsylvania, as the number of gas wells increase in a community, so do rates of hospitalization. Drilling and fracking operations are correlated with elevated motor vehicle fatalities (Texas), asthma (Pennsylvania), self-reported skin and respiratory problems (southwestern Pennsylvania), ambulance runs and emergency room visits (North Dakota), infant deaths (Utah), birth defects (Colorado), high risk pregnancies (Pennsylvania), premature birth (Pennsylvania), and low birthweight (multiple states). Benzene levels in ambient air surrounding drilling and fracking operations are sufficient to elevate risks for future cancers in both workers and nearby residents, according to studies. Animal studies show that two dozen chemicals commonly used in fracking operations are endocrine disruptors that can variously disrupt organ systems, lower sperm counts, and cause reproductive harm at levels to which people can be realistically exposed.[158]

A rigorous study by Johns Hopkins University, which examined 35,000 medical records of people with asthma in Pennsylvania, found that people who live near a higher number of, or larger, active gas wells were 1.5 to 4 times more likely to suffer from asthma attacks than those living farther away, with the closest groups having the highest risk.[159] Increased asthma risks occurred during all phases of well development. A recent Yale University study identified numerous fracking chemicals that are known, probable, or possible human carcinogens (20 air pollutants) and/or are linked to increased risk for leukemia and lymphoma (11 air pollutants), including benzene, 1,3-butadiene, cadmium, diesel exhaust, and polycyclic aromatic hydrocarbons.[160]

Numerous studies suggest that higher maternal exposure to fracking and drilling can increase the incidence of high-risk pregnancies, premature births, low-birthweight babies and birth defects. A study of 9,384 pregnant women in Pennsylvania found that women who live near active drilling and fracking sites had a 40 percent increased risk for having premature birth and a 30 percent

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[157] *Id*. at 12.

[158] PSR 2016 at 93.

[159] Rasmussen, Sara G. et al., Association Between Unconventional Natural Gas Development in the Marcellus Shale and Asthma Exacerbations, 176 JAMA Internal Medicine 1334 (2016).

[160] Elliot, Elise G. et al., A Systematic Evaluation of Chemicals in Hydraulic-Fracturing Fluids and Wastewater for Reproductive and Developmental Toxicity, 27 Journal of Exposure Science and Environmental Epidemiology 90 (2016).

increased risk for having high-risk pregnancies.[161] Another study found that pregnant women who had greater exposure to gas wells (measured in terms of proximity and density of wells) had a much higher risk of having low-birthweight babies; the researchers identified air pollution as the likely route of exposure.[162] In rural Colorado, mothers with greater exposure to natural gas wells were associated with a higher risk of having babies with congenital heart defects and possibly neural tube defects.[163]

Other studies have found that residents living closer to drilling and fracking operations had higher hospitalization rates[164] and reported more health symptoms, including upper respiratory problems and rashes.[165]

Workers suffer high risks from toxic exposure and accidents.[166] As summarized by a recent review:

> Drilling and fracking jobs are among the most dangerous jobs in the nation with a fatality rate that is five times the national average and shows no sign of abating. Occupational hazards include head injuries, traffic accidents, blunt trauma, burns, inhalation of hydrocarbon vapors, toxic chemical exposures, heat exhaustion, dehydration, and sleep deprivation. An investigation of occupational exposures found high levels of benzene in the urine of wellpad workers, especially those in close proximity to flowback fluid coming up from wells following fracturing activities. Exposure to silica dust, which is definitively linked to silicosis and lung cancer, was singled out by the National Institute for Occupational Safety and Health as a particular threat to workers in fracking operations where silica sand is used. At the same time, research shows that many gas field workers, despite these serious occupational hazards, are uninsured or underinsured and lack access to basic medical care.[167]

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[161] Casey, Joan A., Unconventional Natural Gas Development and Birth Outcomes in Pennsylvania, USA, 27 Epidemiology 163 (2016).

[162] Stacy, Shaina L. et al., Perinatal Outcomes and Unconventional Natural Gas Operations in Southwest Pennsylvania, 10 PLoS ONE e0126425 (2015).

[163] McKenzie, Lisa M., Birth Outcomes and Maternal Residential Proximity to Natural Gas Development in Rural Colorado, 122 Environmental Health Perspectives 412 (2014).

[164] Jemielita, Thomas et al., Unconventional Gas and Oil Drilling Is Associated with Increased Hospital Utilization Rates, 10 PLoS ONE e0131093 (2015).

[165] Rabinowitz, Peter M. et al., Proximity to Natural Gas Wells and Reported Health Status: Results of a Household Survey in Washington County, Pennsylvania, 123 Environmental Health Perspectives 21 (2015).

[166] Esswein, Eric J. et al., Occupational Exposures to Respirable Crystalline Silica During Hydraulic Fracturing, 10 Journal of Occupational and Environmental Hygiene 347 (2013); Esswein, Eric et al., Evaluation of Some Potential Chemical Exposure Risks during Flowback Operations in Unconventional Oil and Gas Extraction: Preliminary Results, 11 Journal of Occupational and Environmental Hygiene D174 (2013); Harrison, Robert J. et al., Sudden Deaths Among Oil and Gas Extraction Workers Resulting from Oxygen Deficiency and Inhalation of Hydrocarbon Gases and Vapors — United States, January 2010–March 2015. 65 MMWR Morb Mortal Wkly Rep 6 (2016); PSR 2016.

[167] PSR 2016 at 80.

Methods of collecting and analyzing emissions data often underestimate health risks by failing to adequately measure the intensity, frequency, and duration of community exposure to toxic chemicals from fracking and drilling; failing to examine the effects of chemical mixtures; and failing to consider vulnerable populations.[168] Of high concern, numerous studies highlight that health assessments drilling and fracking emissions often fail to consider impact on vulnerable populations including environmental justice communities[169] and children.[170] For example, a recent analysis of oil and gas development in California found that 14 percent of the state's population (5.4 million people) live within a mile of at least one oil and gas well. More than a third of these people (1.8 million) also live in areas most burdened by environmental pollution.[171]

The EA should incorporate a literature review of the harmful effects of each of these chemicals known to be used in fracking and other unconventional oil and gas extraction methods. Without knowing the effects of each chemical, the EA cannot accurately project the true impact of unconventional oil and gas extraction.

VI. The EA Fails to Accurately Analyze the Leasing Decision's Impact on Climate Change.

Meaningful consideration of greenhouse gas emissions (GHGs) is clearly within the scope of required NEPA review.[172] As the Ninth Circuit has held, in the context of fuel economy standard rules:

> The impact of greenhouse gas emissions on climate change is precisely the kind of cumulative impacts analysis that NEPA requires agencies to conduct. Any given rule setting a CAFE standard might have an "individually minor" effect on the environment, but these rules are "collectively significant actions taking place over a period of time." [173]

The courts have ruled that federal agencies consider indirect GHG emissions resulting from agency policy, regulatory, and leasing decisions. For example, agencies cannot ignore or dismiss as speculative the indirect air quality and climate change impact of decisions that would open up

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168 Brown, David et al., Understanding Exposure From Natural Gas Drilling Puts Current Air Standards to the Test. 29 Reviews on Environmental Health 277 (2014).

169 Natural Resources Defense Council, Drilling in California: Who's At Risk?, October 2014 ("NRDC 2014"); Clough, Emily & Derek Bell, Just Fracking: A Distributive Environmental Justice Analysis of Unconventional Gas Development in Pennsylvania, USA, 11 Environmental Research Letters 025001 (2016); McKenzie, Lisa M. et al., Population Size, Growth, and Environmental Justice Near Oil and Gas Wells in Colorado, 50 Environmental Science & Technology 11471 (2016).

170 Webb, Ellen et al., Potential Hazards of Air Pollutant Emissions From Unconventional Oil and Natural Gas Operations on The Respiratory Health of Children And Infants, 31 Reviews on Environmental Health 225 (2016).

171 NRDC 2014.

172 *Center for Biological Diversity v. Nat'l Highway Traffic Safety Admin*., 538 F.3d 1172, 1217 (9th Cir. 2008).

173 *Center for Biological Diversity v. Nat'l Highway Traffic Safety Admin*., 538 F.3d 1172, 1216 (9th Cir. 2008)(quoting 40 C.F.R. § 1508.7).

access to coal reserves. [174] Moreover, the U.S. Tenth Circuit Court of Appeals for the Tenth Circuit reaffirmed in strikingly clear language that the National Environmental Policy Act does not allow the BLM to dismiss downstream combustion effects of fossil fuel leasing decisions based on the unsupported assumption that leasing actions will have no net effect on greenhouse gas emissions. In *Wildearth Guardians v. U.S. Bureau of Land Management*, the Court of Appeals ruled unanimously that BLM "failed to comply with the National Environmental Policy Act (NEPA) when it concluded that issuing the leases would not result in higher national carbon dioxide emissions than would declining to issue them."[175] The BLM cannot ignore basic economic principles and assume that there will be no net effect on oil and gas production, markets, price, and ultimate consumption when it opens new federal minerals to oil and gas exploration and development.

The EA's analysis of the direct and indirect greenhouse gas emissions that would result from this lease sale is grossly inadequate. Recent EAs for BLM oil and gas lease sales in western states have acknowledged that "direct" greenhouse gas emissions will be emitted during the development and production phases of new oil and gas wells.[176] GHGs emitted during the well development phase come from sources including construction, surface disturbance, and well stimulation. During the production phase, GHGs come from well operation and maintenance, including EOR and secondary recovery techniques, and vents and fugitive emissions.

Fugitive methane emissions that escape from wells, oil storage, and processing equipment are a "major source of global CH_4 emissions." Methane is a highly potent greenhouse gas with a large global warming potential (GWP). The 2013 IPCC Fifth Assessment Report established a GWP of 87 for fossil fuel sources of methane over a 20-year time period, and a GWP of 36 over a 100-year time period.[177] That means that over a 20-year period, methane is 87 times stronger in trapping heat than CO_2. However, the EA fails to quantify the fugitive and non-fugitive CH_4 emissions that would come from the wells.

The EA also fails completely to quantify or even acknowledge the indirect downstream emissions from the end-use combustion of oil and gas produced by the wells. Furthermore, the EA must provide estimates of the indirect methane and N_2O emissions that would be produced from combustion of oil and gas.

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[174] *See Mid States Coal. for Progress v. Surface Transp. Bd*., 345 F.3d 520, 532, 550 (8th Cir. 2003); *High Country Conservation Advocates v. U.S. Forest Serv*., 52 F.Supp. 3d 1174, 1197-98 (D.Colo. 2014).

[175] *Wildearth Guardians v. U.S. Bureau of Land Mgmt*, No. 15-8109 (10th Cir. Sept. 15, 2017), slip op. at 2-3.

[176] *See* for example, U.S. BLM. 2017. Environmental Assessment DOI-BLM-WY-R000-2017-0001-EA, BLM-Wyoming, August 2017 Competitive Oil & Gas Lease Sale, Wind River/Bighorn Basin District, at page 3-23; BLM. 2017. Environmental Assessment DOI-BLM-WY-P000-2017-0001-EA, BLM-Wyoming, High Plains District Portion of the August 2017 Competitive Oil and Gas Lease Sale, at 56-57.

[177] Myhre, G., D. Shindell et al., 2013. Anthropogenic and Natural Radiative Forcing. Pp 659-740 in Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change IPCC. Stocker, T.F. et al., eds. Cambridge University Press, Cambridge UK and New York USA, at Table 8.7.

A robust body of scientific research has established that most fossil fuels must be kept in the ground to avoid the worst dangers of climate change. Human-caused climate change is already causing widespread damage from intensifying global food and water insecurity, the increasing frequency of heat waves and other extreme weather events, flooding of coastal regions by sea level rise and increasing storm surge, the rapid loss of Arctic sea ice and Antarctic ice shelves, increasing species extinction risk, and the worldwide collapse of coral reefs.[178] The Third National Climate Assessment makes clear that "reduc[ing] the risks of some of the worst impacts of climate change" will require "aggressive and sustained greenhouse gas emission reductions" over the course of this century.[179]

The United States has committed to the climate change target of holding the long-term global average temperature "to well below 2°C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels"[180] under the Paris Agreement.[181] The United States signed the Paris Agreement on April 22, 2016 as a legally binding instrument through executive agreement,[182] and the treaty entered into force on November 4, 2016. The Paris Agreement codifies the international consensus that climate change is an "urgent threat" of global concern.[183] The Agreement also requires a "well below 2°C" climate target because 2°C of warming is no longer considered a safe guardrail for avoiding catastrophic climate impacts and runaway climate change.[184] Despite the President's recent equivocation on the matter, the United States is still party to the Paris Agreement at least until November 4, 2020.

Immediate and aggressive greenhouse gas emissions reductions are necessary to keep warming well below 2°C rise above pre-industrial levels. The IPCC Fifth Assessment Report and other expert assessments have established global carbon budgets, or the total amount of carbon that can be burned while maintaining some probability of staying below a given temperature target. According to the IPCC, total cumulative anthropogenic emissions of CO_2 must remain below about

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[178] Melillo, Jerry M., Climate Change Impacts in the United States: The Third National Climate Assessment, Terese (T.C.) Richmond, and Gary W. Yohe, Eds., U.S. Global Change Research Program, (2014).

[179] *Id.* at 13, 14, and 649.

[180] *See* United Nations Framework Convention on Climate Change, Conference of the Parties, Nov. 30-Dec. 11, 2015, Adoption of the Paris Agreement Art. 2, U.N. Doc. FCCC/CP/2015/L.9, (Dec. 12, 2015) ("Paris Agreement").

[181] On December 12, 2015, 197 nation-state and supra-national organization parties meeting in Paris at the 2015 United Nations Framework Convention on Climate Change Conference of the Parties consented to the Paris Agreement committing its parties to take action so as to avoid dangerous climate change.

[182] *See* United Nations Treaty Collection, Chapter XXVII, 7.d Paris Agreement, List of Signatories; U.S. Department of State, Background Briefing on the Paris Climate Agreement, (Dec. 12, 2015). Although not every provision in the Paris Agreement is legally binding or enforceable, the U.S. and all parties are committed to perform the treaty commitments in good faith under the international legal principle of *pacta sunt servanda* ("agreements must be kept"); Vienna Convention on the Law of Treaties, Art. 26.

[183] *See* Paris Agreement, Recitals.

[184] *See* the comprehensive scientific review under the United Nations Framework Convention on Climate Change (UNFCCC) of the global impacts of 1.5°C versus 2°C warming: U.N. Subsidiary Body for Scientific and Technological Advice, Report on the Structured Expert Dialogue on the 2013-2015 review, FCCC/SB/2015/1NF.1 (2015); Schleussner, Carl-Friedrich et al., Differential climate impacts for policy-relevant limits to global warming: the case of 1.5C and 2C, 7 Earth Systems Dynamics 327 (2016).

1,000 gigatons ($GtCO_2$) from 2011 onward for a 66 percent probability of limiting warming to 2°C above pre-industrial levels, and to 400 $GtCO_2$ from 2011 onward for a 66 percent probability of limiting warming to 1.5°C.[185] These carbon budgets have been reduced to 850 $GtCO_2$ and 240 $GtCO_2$, respectively, from 2015 onward.[186]

Published scientific studies have estimated the United States' portion of the global carbon budget by allocating the remaining global budget across countries based on factors including equity and economics. Estimates of the U.S. carbon budget vary depending on the temperature target used by the study (1.5°C versus 2°C), the likelihood of meeting the temperature target (50% or 66% probability), the equity principles used to apportion the global budget among countries, and whether a cost-optimal model was employed. The U.S. carbon budget for limiting temperature rise to well below 2°C has been estimated at 38 $GtCO_2$, while the estimated budget for limiting temperature rise to 2°C ranges from 34 $GtCO_2$ to 158 $GtCO_2$.

Du Pont et al. (2017) averaged across five IPCC-AR5 sharing principles (e.g. capability, equal per capita, greenhouse development rights, equal cumulative per capita, and constant emissions ratio) to estimate the U.S. carbon budget through 2100 based on a cost-optimal model.[187] Du Pont et al. (2017) estimated the U.S. carbon budget at 57 $GtCO_2eq$ (equal to ~ 38 $GtCO_2$) [188] for a 50% chance of returning global average temperature rise to 1.5°C by 2100, which is the only target among the studies that is consistent with the "well below 2°C" temperature commitment of the Paris Agreement. The U.S. carbon budget for a 66% probability of keeping warming below 2°C was estimated at 104 $GtCO_2eq$ (equal to ~ 69 $GtCO_2$). [189]

For a 66% probability of keeping warming below 2°C, Peters et al. (2015) estimated the U.S. carbon budget at 34 $GtCO_2$ based on an equity approach for allocating the global carbon budget, and 123 $GtCO_2$ under an inertia approach.[190] The "inertia" approach bases sharing on countries' current emissions, while the "equity" approach bases sharing on population size and provides for equal per-capita emissions across countries. Similarly using a 66% probability of keeping warming below 2°C, Gignac et al. (2015) estimated the U.S. carbon budget at 78 to 97 $GtCO_2$, based on a contraction and convergence framework, in which all countries adjust their emissions over time to

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[185] IPCC, "2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change; Summary for Policymakers," (2013), at 25; IPCC, "Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change," [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland (2014), at 63-64 and Table 2.2.

[186] Rogelj, Joeri et al., "Differences between carbon budget estimates unraveled," 6 Nature Climate Change 245, (2016), at Table 2.

[187] Du Pont, Yann Robiou et al., Equitable mitigation to achieve the Paris Agreement goals, 7 Nature Climate Change 38 (2017).

[188] *See* Meinshausen, Malte et al., Greenhouse gas emission targets for limiting global warming to 2 degrees Celsius, 458 Nature 1158 (2009); we used a conversion factor of 1 $GtCO_2$ = 1.5 $GtCO_2eq$ based on Table 1 in Meinshausen et al. 2009.

[189] *Id.* 1 $GtCO_2$ = 1.5 $GtCO_2eq$ based on Table 1 in Meinshausen et al. 2009.

[190] Peters, Glen P. et al., Measuring a fair and ambitious climate agreement using cumulative emissions, 10 Environmental Research Letters 105004 (2015).

achieve equal per-capita emissions.[191] Although the contraction and convergence framework corrects current emissions inequities among countries over a specified time frame, it does not account for inequities stemming from historical emissions differences. When accounting for historical responsibility, Gignac et al. (2015) estimated that the United States has an additional cumulative carbon debt of 100 $GtCO_2$ as of 2013. Using a non-precautionary 50% probability of limiting global warming to 2°C, Raupach et al. (2014) estimated the U.S. carbon budget at 158 $GtCO_2$ based on a "blended" approach of sharing principles that averages the "inertia" and "equity" approaches.[192]

Under any scenario, the remaining U.S. carbon budget consistent with limiting global average temperature rise to 1.5°C or 2°C is extremely small and is rapidly being consumed. In 2015 alone, global CO_2 emissions totaled 36 $GtCO_2$[193] and U.S. emissions totaled 6.5 $GtCO_2eq$.[194]

A large body of scientific research has established that the vast majority of global and U.S. fossil fuels must stay in the ground in order to hold temperature rise to well below 2°C.[195] Studies estimate that 68 to 80 percent of global fossil fuel reserves must not be extracted and burned to limit temperature rise to 2°C based on a 1,000 $GtCO_2$ carbon budget.[196] For a 50 percent chance of limiting temperature rise to 1.5°C, 85 percent of known fossil fuel reserves must stay in the ground.[197] Effectively, fossil fuel emissions must be phased out globally within the next few decades.[198]

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[191] Gignac, Renaud and H. Damon Matthews, Allocating a 2C cumulative carbon budget to countries, 10 Environmental Research Letters 075004 (2015). In a contraction and convergence approach, national emissions are allowed to increase or decrease for some period of time until they converge to a point of equal per capita emissions across all regions at a given year, at which point all countries are entitled to the same annual per capita emissions.

[192] Raupach, Michael et al., Sharing a quota on cumulative carbon emissions, 4 Nature Climate Change 873 (2014) at Supplementary Figure 7.

[193] *See* Le Quéré, Corrine, et al., Global Carbon Budget 2016, 8 Earth Syst. Sci. Data 605 (2016).

[194] U.S. EPA, Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2013 (2015).

[195] The IPCC estimates that global fossil fuel reserves exceed the remaining carbon budget for staying below 2°C by 4 to 7 times, while fossil fuel resources exceed the carbon budget for 2°C by 31 to 50 times. *See* Bruckner, Thomas et al., "2014: Energy Systems. In: Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change," Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, at Table 7.2.

[196] To limit temperature rise to 2°C based on a 1,000 $GtCO_2$ carbon budget from 2011 onward, studies indicate variously that 80 percent (Carbon Tracker Initiative 2013), 76 percent (Raupach et al. 2014), and 68 percent (Oil Change International, "The Sky's Limit: Why the Paris Climate Goals Require A Managed Decline of Fossil Fuel Production," (September 2016), of global fossil fuel reserves must stay in the ground. *See* Carbon Tracker Initiative. "Unburnable Carbon – Are the world's financial markets carrying a carbon bubble?" (2013); Raupach, Michael et al., "Sharing a quota on cumulative carbon emissions," 4 Nature Climate Change 873; Oil Change International, "The Sky's Limit: Why the Paris Climate Goals Require A Managed Decline of Fossil Fuel Production," (September 2016).

[197] Oil Change International, "The Sky's Limit: Why the Paris Climate Goals Require A Managed Decline of Fossil Fuel Production," (September 2016), at 6.

[198] Rogelj et al. (2015) estimated that a reasonable likelihood of limiting warming to 1.5° or 2°C requires global CO_2 emissions to be phased out by mid-century and likely as early as 2040-2045. *See* Rogelj, Joeri et al., "Energy

A 2016 global analysis found that potential carbon emissions from developed reserves in currently operating oil and gas fields and mines would lead to global temperature rise beyond 2°C.[199] Excluding coal, currently operating oil and gas fields alone would take the world beyond 1.5°C.[200] To stay well below 2°C, the clear implication is that no new fossil fuel extraction or transportation infrastructure should be built, and governments should grant no new permits for new fossil fuel extraction and infrastructure.[201] Moreover, some fields and mines, primarily in rich countries, must closed before fully exploiting their resources. The analysis concludes that, because "existing fossil fuel reserves considerably exceed both the 2°C and 1.5°C carbon budgets[, i]t follows that exploration for new fossil fuel reserves is at best a waste of money and at worst very dangerous."[202]

According to a U.S.-focused analysis,[203] the United States alone has enough recoverable fossil fuels, split about evenly between federal and non-federal resources, that if extracted and burned, would exceed the global carbon budget for a 1.5°C limit, and would consume nearly the entire global budget for a 2°C limit.[204] Specifically, the analysis found:

> Potential greenhouse gas emissions of federal fossil fuels (leased and unleased) if developed would release up to 492 gigatons (Gt) of carbon dioxide equivalent pollution (CO_2e), representing 46 percent to 50 percent of potential emissions from all remaining U.S. fossil fuels.
>
> Of that amount, up to 450 Gt CO_2e have not yet been leased to private industry for extraction. Releasing those 450 Gt CO_2e (the equivalent annual pollution of more than 118,000 coal-fired power plants) would be greater than any proposed U.S. share of global carbon limits that would keep emissions well below 2°C.[205]

Fracking has also opened up vast resources that otherwise would not be available, increasing the potential for future greenhouse gas emissions. The long-lived GHG emissions and fossil fuel

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system transformations for limiting end-of-century warming to below 1.5°C," 5 Nature Climate Change 519 (2015). Climate Action Tracker indicated that the United States must phase out fossil fuel CO_2 emissions even earlier—between 2025 and 2040—for a reasonable chance of staying below 2ºC. *See, e.g*. Climate Action Tracker, "USA," (last updated 25 January 2017).

[199] Oil Change International, The Sky's Limit: Why the Paris Climate Goals Require A Managed Decline of Fossil Fuel Production (September 2016), at 5.

[200] *Id.* at 5.

[201] *Id.* at 5.

[202] *Id.* at 17.

[203] Ecoshift Consulting, et al., The Potential Greenhouse Gas Emissions of U.S. Federal Fossil Fuels, Prepared for Center for Biological Diversity & Friends of the Earth. (2015).

[204] *Id.* at 4.

[205] For the United States, Raupach et al. (2014) provided a mid-range estimate of the U.S. carbon quota of 158 $GtCO_2$ for a 50 percent chance of staying below 2°C, using a "blended" scenario of sharing principles for allocating the global carbon budget among countries. This study estimated US fossil fuel reserves at 716 $GtCO_2$, of which coal comprises the vast majority, indicating that most fossil fuel reserves in the US must remain unburned to meet a well below 2°C carbon budget. Raupach, Michael et al., Sharing a quota on cumulative carbon emissions, 4 Nature Climate Change 873, at Supplementary Figure 7.

infrastructure that would result from this project will contribute to undermining national and state climate commitments and increase climate change impacts, at a time when there is urgent need to keep most fossil fuels in the ground.

Inadequate analysis of climate change impacts also violates NEPA. NEPA requires "reasonable forecasting," which includes the consideration of "reasonably foreseeable future actions . . . even if they are not specific proposals."[206] That BLM cannot "accurately" calculate the total emissions expected from full development is not a rational basis for cutting off its analysis. "Because speculation is . . . implicit in NEPA," agencies may not "shirk their responsibilities under NEPA by labeling any and all discussion of future environmental effects as crystal ball inquiry."[207] Indeed, the EA for a relatively recent lease sale in Utah undercuts BLM's assertion here that GHGs cannot be quantified at the leasing stage.[208]

The final CEQ *Guidance on Consideration of Greenhouse Gas Emissions and the Effects of Climate Change in NEPA review* is dispositive on the issue of federal agency review of greenhouse gas emissions as foreseeable direct and indirect effects of the proposed action. 81 Fed. Reg. 51,866 (Aug. 5, 2016). The CEQ guidance provides clear direction for BLM to conduct a lifecycle greenhouse gas analysis because the modeling and tools to conduct this type of analysis are readily available to the agency:

> If the direct and indirect GHG emissions can be quantified based on available information, including reasonable projections and assumptions, agencies should consider and disclose the reasonably foreseeable direct and indirect emissions when analyzing the direct and indirect effects of the proposed action. Agencies should disclose the information and any assumptions used in the analysis and explain any uncertainties. To compare a project's estimated direct and indirect emissions with GHG emissions from the no-action alternative, agencies should draw on existing, timely, objective, and authoritative analyses, such as those by the Energy Information Administration, the Federal Energy Management Program, or Office of Fossil Energy of the Department of Energy. In the absence of such analyses, agencies should use other available information.[209]

CEQ's guidance even provides an example of where a lifecycle analysis is appropriate in a leasing context at footnote 42:

> The indirect effects of such an action that are reasonably foreseeable at the time would vary with the circumstances of the proposed action. For actions such as a

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[206] *N. Plains Res. Council, Inc. v. Surface Transp. Bd.*, 668 F.3d 1067, 1079 (9th Cir. 2011) (citation omitted).

[207] *Id*.

[208] U.S. BLM, Environmental Assessment for West Desert District, Fillmore Field Office, August 2015 Oil and Gas Lease Sale, pp. 57-58 (2015); U.S. BLM, Greenhouse Gases Estimate (West Desert District Nov 2015 Lease Sale). *See also High Country Conservation Advocates v. United States Forest Serv.*, 52 F. Supp. 3d 1174, 1196 (D. Colo. 2014) (decision to forgo calculating mine's reasonably foreseeable GHG emissions was arbitrary "in light of the agencies' apparent ability to perform such calculations").

[209] 81 Fed. Reg. 51,866 at 16 (Aug. 5, 2016) (citations omitted).

> Federal lease sale of coal for energy production, the impacts associated with the end-use of the fossil fuel being extracted would be the reasonably foreseeable combustion of that coal.[210]

Although the 2016 CEQ guidance has been withdrawn,, the underlying requirement to consider climate change impacts under NEPA, including indirect and cumulative combustion impacts foreseeably resulting from fossil fuels leasing decisions, has not changed.[211]

VII. The EA Fails to Consider Fossil Fuel Impacts on Induced Seismicity.

Despite the foreseeability of a higher risk of induced earthquake activity resulting from new oil and gas development, the EA contains no mention of the possibility of induced earthquakes resulting from fracking or injection of oil and gas wastes. As detailed below, the BLM must consider the state of scientific research on induced seismicity from oil and gas development and the large body of scientific evidence linking wastewater disposal, fracking, and other oil and gas development practices to induced earthquakes in Colorado and other parts of the country, including damaging earthquakes.

A. BLM Must Consider Scientific Research on Induced Seismicity from Oil and Gas Development.

Well activities that cause earthquakes typically fall into two major classifications: those activities largely related to fluid injection and the resulting increased pore fluid pressure that it may cause, or those activities that appear to have occurred in areas experiencing massive withdrawals of subsurface gas or fluid.[212]

Studies have documented wastewater-injection-induced earthquakes in at least nine states, as well as fracking-induced earthquakes ranging up to magnitude 4.6. New studies also suggest that there is no upper bound on the size of fracking and wastewater-induced earthquakes, meaning that large and dangerous earthquakes can be induced by oil and gas development activities.[213] For example, Van der Elst (2016) concluded that:

> If induced earthquakes occur on tectonic faults oriented favorably with respect to the tectonic stress field, then they may be limited only by the regional tectonics and connectivity of the fault network. In this study, we show that the largest magnitudes observed at fluid injection sites are consistent with the sampling statistics of the

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[210] *Id.*

[211] *See S. Fork Band*, 588 F.3d at 725; *Center for Biological Diversity*, 538 F.3d at 1214-15; *Mid States Coalition for Progress*, 345 F.3d at 550; *WildEarth Guardians*, 104 F. Supp. 3d at 1230; *Dine Citizens Against Ruining Our Env't*, 82 F. Supp. 3d at 1201; *High Country Conservation Advocates*, 52 F. Supp. 3d at 1174.

[212] Nicholson, C. & Wesson, R.L., Triggered Earthquakes and Deep Well Activities, Pure and Applied Geophysics, 139, 563 (1992).

[213] Atkinson, G.M. et al., Hydraulic fracturing and seismicity in the Western Canada Sedimentary Basin 87 Seismological Research Letters May/June (2016); Van der Elst, N.J. et al., Induced earthquake magnitudes are as large as (statistically) expected, 121 J. Geophys. Res. Solid Earth 4575 (2016) ("Van der Elst 2016").

> Gutenberg-Richter distribution for tectonic earthquakes, assuming no upper-magnitude bound . . . [T]he results imply that induced earthquake magnitudes should be treated with the same maximum magnitude bound that is currently used to treat seismic hazard from tectonic earthquakes.[214]

B. BLM Must Consider Scientific Research Linking Wastewater Injection and Other Oil and Gas Development Practices with Induced Earthquakes in Colorado.

Earthquake activity in much of the central United States has dramatically increased since 2009, principally in Oklahoma but also in Colorado, New Mexico, Arkansas, Kansas, and Texas.[215] Over 300 earthquakes with magnitudes ≥ 3.0 have occurred from 2010 through 2012, compared with the observed average rate of 21 events per year from 1967 to 2000.[216] Numerous published case studies and the space-time distribution of the amplified seismicity indicate that the increase is of anthropogenic origin, primarily driven by the injection of wastewater coproduced with oil and gas from tight formations.[217] In addition, enhanced oil recovery and long-term production contribute to seismicity at some locations.[218]

In 1968, the possibility for inducing earthquakes via wastewater injection was recognized as a risk for underground waste management.[219] That was the same year the connection between injection at the Rocky Mountain Arsenal and the Denver earthquakes was firmly established.[220] These earthquakes occurred as far as 10 km from the injection point, and were the first to be identified as related to deep, underground injection.[221] Until 2011, the largest earthquake in the sequence was magnitude 4.9, but many more injection-induced earthquakes have been identified since then, the largest being the August 2011 magnitude 5.3 earthquake in Trinidad, Colorado, and the November 2011 magnitude 5.6 earthquake in Prague, Oklahoma.[222]

One of the earliest seismicity examples related to fluid injection occurred near Denver in the 1960s.[223] In 1961, the U.S. Army Corps of Engineers drilled a deep injection well at the Rocky Mountain Arsenal ("RMA") to dispose of contaminated wastewater.[224] The well was drilled 3671

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[214] Van der Elst 2016 at 4575.

[215] Ellsworth, W.L. et al., Increasing seismicity in the U. S. midcontinent: Implications for earthquake hazard, 34 The Leading Edge 618, 625 (2015) ("Ellsworth 2015").

[216] Ellsworth, W.L., Injection-induced earthquakes, 341 Science 143 (2015).

[217] Ellsworth 2015 at 618, 625.

[218] *Id.*

[219] *Id.* at 620.

[220] *Id.*

[221] Rubinstein, J.L. & Mahani, A.B (2015), Myths and Facts on Wastewater Injection, Hydraulic Fracturing, Enhanced Oil Recovery, and Induced Seismicity, 86 Seismological Research Letters 4 (2015).

[222] *Id.*

[223] McGarr, A. et al., 40 Case histories of induced and triggered seismicity, 81A International Geophysics 654 (2002).

[224] Hseih, P. & Bredehoeft, J., A reservoir analysis of the Denver earthquakes: A case of induced seismicity, 86(B2) J. Geophys. Res. 903 (1981).

m deep into crystalline Precambrian bedrock.[225] The injection began in 1962, and shortly after minor earthquakes were detected around Denver, a region that had previously experience little to no earthquake activity.[226] From April 1962 to August 1967, over 1,500 "Denver earthquakes" were recorded—some exceeding Richter magnitudes of 3.0 and 4.0.[227]

In 1965, David Evans, a Denver geologist, suggested a direct correlation between fluid injection at the RMA well and the Denver earthquakes.[228] His hypothesis was based on "(1) an apparent correlation between the volume of fluid injected into the well and the frequency of the earthquakes and (2) a study by Wang (1965) which showed that the majority of the earthquakes had epicenters within 8 km of the well."[229] As a result of Evans' suggested injection-earthquake connection, the RMA waste disposal operation was discontinued.[230] A number of more detailed studies conducted by the U.S. Geological Survey, the Colorado School of Mines, and the U.S. Army Corps of Engineers followed.[231]

Even though pumping ceased in late 1966, over the next two years earthquakes continued to occur up to 6 km from the well as the anomalous pressure front, which had been established around the well during injection, migrated outward from the injection point.[232] There were three earthquakes between magnitudes 5.0 and 5.5, the largest of which caused about $0.5 million in damages in 1967.[233] While these induced earthquakes were not completely devastating, they did draw concern and led, at least in the Denver case, to the termination of all related injection well operations.[234] After 1967, earthquake numbers began to decline, and as of present, the earthquake activity that occurred between 1962 and 1967 has virtually disappeared.[235] A number of cases have shown that seismicity can eventually be stopped either by ceasing the injection or by lowering pumping pressure.[236] However, the occurrence of the largest RMA earthquakes a year after all pumping had ceased indicates that the process, once underway, may not be controlled completely or easily.[237]

Although several investigators have indicated, "the three major earthquakes of 1967 reduced the quality of Evans' original correlation between injected volume and the number of earthquakes," Healy et al. (1968) provided a theory that explained the earthquake activity that occurred after

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[225] *Id.*

[226] *Id.*

[227] *Id.*

[228] *Id.*

[229] *Id.*

[230] *Id.*

[231] *Id.*

[232] Nicholson, C. & Wesson, R.L., Triggered Earthquakes and Deep Well Activities, 139 Pure and Applied Geophysics 569-70 (1992).

[233] *Id.*

[234] *Id.*

[235] Hseih & Bredehoeft at 903.

[236] Nicholson & Wesson at 569-70.

[237] *Id.*

injection was discontinued.[238] Their theory was based on a conceptual model that assumed the Precambrian bedrock contains a large number of fractures, and they theorized that earthquakes were triggered by the increase in fluid pressure in the fractures.[239] As noted by Healy et al. (1968), "cessation of fluid injection results in a rapid reduction of pressure near the well but in a continued advance of the pressure front at greater distance from the well."[240] The pressure front advance explained the earthquake activities after 1966.[241] Studies have showing that the ceasing of pumping indicates that once underway, the process, may not be controlled completely or easily. Thus, BLM must consider a "no-leasing-no-fracking" alternative in order to prevent induced seismicity.

C. BLM Must Acknowledge the Large Body of Research Linking Induced Seismicity to Wastewater Disposal, Fracking, and Other Oil and Gas Development Activities Across the United States

BLM must acknowledge the large body of published scientific research documenting that oil and gas development activities, including wastewater injection, fracking, enhanced oil recovery, and fluid (oil and water) extraction, have induced earthquakes across many regions of the United States.[242]

When considering alternatives, BLM must realize that fracking can induce larger earthquakes than previously thought, and that fracking is increasingly recognized as a significant source of seismic hazard.[243] Scientific research has linked fracking with induced earthquakes ranging up to magnitude 4.6.[244] Induced earthquakes have been linked to fracking in Ohio,[245] Oklahoma,[246] England,[247] British Columbia, and Alberta,[248] including larger events of magnitudes 3.0 and 4.0.

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[238] Hseih & Bredehoeft at 903.

[239] *Id.*

[240] *Id.*

[241] *Id.*

[242] Ellsworth, W.L., Injection-induced earthquakes, 341 Science 1225942 (2013); Nicholson, C. and R. Wesson, Triggered earthquakes and deep well activities, 139 Pure Appl. Geophys. 561 (1992); National Research Council, Induced Seismicity Potential in Energy Technologies, National Academies Press (2013).

[243] Atkinson, G.M. et al. 2016.

[244] Schultz, R. et al., Hydraulic fracturing and the Crooked Lake Sequences: Insights gleaned from seismic networks, 42 Geophysical Research Letters (2015); Schultz, R. et al., A seismological overview of the induced earthquakes in the Duvernay play near Fox Creek, Alberta, 122 J. Geophys. Res. Solid Earth 492 (2017).

[245] Skoumal, R., et al., Earthquakes induced by hydraulic fracturing in Poland Township, Ohio, Bulletin of the Seismological Society of America 105 (2015); Friberg, P.A. et al., Characterization of an earthquake sequence triggered by hydraulic fracturing in Harrison County, Ohio, 85 Seismological Research Letters 6 (2014).

[246] Holland, A., Earthquakes Triggered by Hydraulic Fracturing in South-Central Oklahoma, 103 Bulletin of the Seismological Society of America 3:1784 (2013).

[247] Clarke, H. et al., Felt seismicity associated with shale gas hydraulic fracturing: The first documented example in Europe, 41 Geophysical Research Letters 8308 (2014).

[248] Farahbod, A.M. et al., Investigation of regional seismicity before and after hydraulic fracturing in the Horn River Basin, northeast British Columbia, 52 Canadian Journal of Earth Sciences 112 (2014); Atkinson, G. et al., Abstract: Ground motions from three recent earthquakes in Western Alberta and Northeastern British Columbia

Research also indicates that maximum earthquake size induced by fracking may be controlled by the size of the fault surface in a critical stress state, rather than the net injected fluid volume, meaning that large fracking-induced earthquakes are possible.[249]

Atkinson et al. (2016) cautioned that fracking in the United States may be causing higher-than-recognized induced earthquake activity that is being masked by more abundant wastewater-induced earthquakes:

> In the United States basins where the pace of development has been even greater [than in Canada], previous assertions that hazards from HF [fracked] wells are negligible (National Research Council, 2013) warrant re-examination. In particular, it is possible that a higher-than-recognized fraction of induced earthquakes in the United States are linked to hydraulic fracturing, but their identification may be masked by more abundant wastewater-induced events.[250]

The injection of oil and gas wastewater, often associated with fracking, has been linked to the dangerous proliferation of earthquakes in many parts of the country, including damaging earthquakes.[251] For example, a magnitude 5.8 induced earthquake near Pawnee, Oklahoma, in 2016 caused at least one injury and severe structural damage; a magnitude 5.7 induced earthquake outside Oklahoma City in 2011[252] injured two people, destroyed 14 homes, and caused millions of dollars' worth of damage to buildings and infrastructure.[253] A magnitude 5.3 induced earthquake near Trinidad, Colorado, in 2011[254] and a magnitude 4.8 near Timpson, Texas, in 2012[255] also caused significant structural damage. In the central and eastern U.S., a U.S. Geological Survey analysis found that seven million people live and work in areas vulnerable to damaging injection-induced earthquakes.[256]

Published research has linked oil and gas wastewater injection to induced earthquakes in at least nine states, including Colorado. Oklahoma's earthquake activity has skyrocketed because of the

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and their implications for induced seismicity hazard in eastern regions. Seismological Research Letters (2015); Schultz, R. et al. 2015); Atkinson, G.M. et al. 2016.

[249] Atkinson, G.M. et al. 2016.

[250] Atkinson, G.M. et al. 2016, at 13.

[251] Ellsworth, W.L. 2013.

[252] Keranen, K.M. et al., Potentially induced earthquakes in Oklahoma, USA: Links between wastewater injection and the 2011 Mw 5.7 earthquake sequence, 41 Geology 699 (2013); Keranen, K.M. et al., Sharp increase in Central Oklahoma seismicity since 2008 induced by massive wastewater injection, 345 Science 448 (2014).

[253] Yeck, W.L. et al., Oklahoma experiences largest earthquake during ongoing regional wastewater injection hazard mitigation efforts, 44 Geophys. Res. Lett. 711 (2017).

[254] Rubinstein, J. et al., The 2001-present induced earthquake sequence in the Raton Basin of northern New Mexico and southern Colorado, 104 Bulletin of the Seismological Society of America 5 (2014).

[255] Frohlich, C. et al., The 17 May 2012 M4.8 earthquake near Timpson, East Texas: An event possibly triggered by fluid injection, 119 Journal of Geophysical Research 581 (2014).

[256] Petersen, M.D. et al., One-year seismic hazard forecast for the Central and Eastern United States from induced and natural earthquakes, U.S. Geological Survey Open-File Report 2016-1035 (2016).

massive amounts of wastewater disposal resulting from fracking.[257] In 2015, earthquake activity was 600 times greater than it was prior to 2008, according to the Oklahoma Geological Survey,[258] and earthquake swarms are occurring over roughly 15 percent of the state's area.[259] Large earthquakes linked to wastewater injection in Oklahoma include the 2016 magnitude 5.8 earthquake near Pawnee, which was the largest in the state's history; the 2011 magnitude 5.7 near Prague; the 2016 magnitude 5.2 near Fairview; and the 2016 magnitude 5.0 near Cushing beneath the United States' largest oil storage facility.[260]

Scientific research has linked oil and gas wastewater injection to induced earthquakes in Colorado, including a 5.3 quake near Trinidad, Kansas,[261] including a 4.9 quake;[262] Arkansas, including a 4.7 quake near Guy, Ohio,[263] including a 3.9 quake;[264] southeastern New Mexico;[265] and Utah.[266]

In Texas, recent analysis indicates that oil and gas development activities have induced earthquakes in many regions of the state over the past 90 years due to wastewater injection, fluid withdrawal, and enhanced oil recovery—with recent increases in induced earthquake activity attributed primarily to wastewater injection.[267] Published research has linked wastewater injection to induced earthquakes in the heavily populated Dallas-Fort Worth region,[268] Timpson,[269] Azle

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[257] Keranen, K.M. et al. 2014.

[258] Oklahoma Geological Survey, Statement on Oklahoma Seismicity (2015).

[259] *Id.*

[260] Yeck, W.L. et al., Far-field pressurization likely caused one of the largest injection induced earthquakes by reactivating a large preexisting basement fault structure, 43 Geophys. Res. Lett. 10,198 (2016).

[261] Rubinstein, J. et al., The 2001-present induced earthquake sequence in the Raton Basin of northern New Mexico and southern Colorado, 104 Bulletin of the Seismological Society of America 5 (2014).

[262] Choy, G.L. et al., Abstract: A Rare Moderate-Sized (Mw 4.9) Earthquake in Kansas: Rupture Process of the Milan, Kansas, Earthquake of 12 November 2014 and Its Relationship to Fluid Injection, 87 Seismological Research Letters 1433 (2016).

[263] Horton, S., Disposal of hydrofracking waste fluid by injection into subsurface aquifers triggers earthquake swarm in Central Arkansas with potential for damaging earthquake, 83 Seismological Research Letters 2:250 (2011); Ogwari, P.O. et al., Characteristics of induced/triggered earthquakes during the setup phase of the Guy-Greenbrier earthquake in North-Central Arkansas, 87 Seismological Research Letters 3 (2016).

[264] Kim, W-Y, Induced seismicity associated with fluid injection into a deep well in Youngstown, Ohio, 118 Journal of Geophysical Research 3506 (2013).

[265] Zhang, Y. et al., Exploring the potential linkages between oil-field brine reinjection, crystalline basement permeability, and triggered seismicity for the Dagger Draw Oil field, southeastern New Mexico, USA, using hydrologic modeling, 16 Geofluids 971 (2016).

[266] Brown, M.R.M. and M. Liu, Injection-induced seismicity in Carbon and Emery Counties, central Utah, 16 Geofluids 801 (2016).

[267] Frohlich, C. et al., A historical review of induced earthquakes in Texas, 87 Seismological Research Letters 1 (2016).

[268] Frohlich, C. et al., The Dallas–Fort Worth earthquake sequence: October 2008 through May 2009, the Leading Edge (March 2010); Hornbach, M.J. et al., Ellenburger wastewater injection and seismicity in North Texas, 261 Physics of the Earth and Planetary Interiors 54 (2016).

[269] Frohlich, C. et al., The 17 May 2012 M4.8 earthquake near Timpson, East Texas: An event possibly triggered by fluid injection, 119 Journal of Geophysical Research 581 (2014); Shirzaei, M. et al., Surface uplift and time-dependent seismic hazard due to fluid injection. Science 353: 1416-1419 (2016).

and Reno,[270] and Cleburne.[271] Enhanced oil recovery was linked to a magnitude 4.6 earthquake near Snyder, Texas.[272]

Fluid extraction (oil and water) has also been documented to induce earthquakes. A recent study investigating earthquake activity near Azle, Texas concluded that "[i]t is notable that we observe earthquake swarms in the Ellenburger [i.e., the area of study] apparently associated with extraction, not just injection."[273] The authors explained:

> Earthquakes caused by fluid extraction near faults are not a new phenomenon in the United States or even Texas. Induced seismicity is often associated with subsurface pressure changes, and extensional stresses will concentrate on the boundary of the fluid draw-down region, promoting normal faulting. It is therefore perhaps no coincidence that we observe swarms of normal-faulting events in regions where more significant near fault stress changes occur.[274]

Another study in Texas found that "the majority of small earthquakes may be triggered/induced by human activity" in this region and "are more often associated with fluid extraction than with injection."[275] The study noticed several examples of increased fluid extraction (i.e., oil and water) preceding earthquakes of substantial magnitude (3.4 to 4.8), suggesting a link between the two.[276]

The National Resource Council's review of human induced seismicity notes the well-documented causes of induced seismicity resulting from fluid extraction:

> Fluid extraction from a reservoir can cause declines in the pore pressure that can reach hundreds of bars. The declining pore pressure causes large contraction of the reservoir, which itself induces stress changes in the surrounding rock (Segall, 1989), in particular increasing horizontal stresses above and below the reservoir that could lead to reverse faulting (Figure 2.2). Grasso (1992) estimates that volume contraction of reservoirs from fluid withdrawal can cause earthquakes up to M 5.0.[277]

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[270] Hornbach, M.J. et al., Causal factors for seismicity near Azle, Texas, 6 Nature Communications 6728 (2016).

[271] Justinic, A.H. et al., Analysis of the Cleburne, Texas, Earthquake Sequence from June 2009 to June 2010, 103 Bulletin of the Seismological Society of America 6 (2013).

[272] Gan, W. and C. Frohlich, Gas injection may have triggered earthquakes in the Cogdell oil field, Texas, 110 PNAS 18786 (2013).

[273] Hornbach, M.J. et al., Causal factors for seismicity near Azle, Texas, 6 Nature Communications 6728 (2016).

[274] *Id*. at 7.

[275] Frohlich, Cliff and Michael Brunt, Two-year survey of earthquakes and injection/production wells in the Eagle Ford Shale, Texas, prior to the MW4.8 20, 402 Earth and Planetary Science Letters 15, 257 (2014).

[276] *Id*. at 263.

[277] Natural Resources Defense Council, Drilling in California: Who's At Risk? (2014), at 44-45.

VIII. BLM Must Consider Fossil Fuel Development Impacts on Human Health

Oil and gas leasing and foreseeably-resulting fracking entail significant public health risks that should compel BLM to consider alternatives banning these practices. BLM must consider the potential threats that oil and gas leasing pose to human health and safety, such as carcinogenic, developmental, reproductive, and endocrine disruption effects.

Ample scientific evidence indicates that well development and well stimulation activities have been linked to an array of adverse human health effects, including carcinogenic, developmental, reproductive, and endocrine disruption effects. The EA does not disclose how close development could potentially take place to residences, communities, or public lands utilized for recreational, agricultural, or other activities. Just as troubling, is how much is *unknown* about the chemicals used in well stimulation activities.[278]

While all phases of oil and gas production put people at risk, in recent years, attention has focused on the new dangers of fracking and other forms of well stimulation which use hundreds of chemicals, the majority of which are known to have adverse human health effects. A study of gas production in Colorado yielded 632 chemicals used in 944 different products that were known to have been used.[279] Of these chemicals, 75 percent have been shown to cause harm to the skin, eyes, and other sensory organs; approximately 40–50 percent could affect the brain/nervous system, immune and cardiovascular systems, and the kidneys; 37 percent could affect the endocrine system; and 25 percent could cause cancer and mutations.[280] These chemicals must be transported, mixed, stored, injected, captured, and disposed of. Each step creates a risk for communities near the well site, transportation route, or disposal site. Chemicals used during the drilling process showed many of the same dangers.[281] Chemicals identified in evaporation pits were also linked to the same array of harms.[282]

Due to the heavy and frequent use of chemicals, proximity to fracked wells is associated with higher rates of cancer, birth defects, poor infant health, and acute health effects for nearby residents who must endure long-term exposure:

> In one study, residents living within one-half mile of a fracked well were significantly more likely to develop cancer than those who live more than one-half mile away, with exposure to benzene being the most significant risk.[283]
>
> Another study found that pregnant women living within 10 miles of a fracked well were more likely to bear children with congenital heart defects and possibly neural

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[278] *See, e.g.* U.S. EPA 2016.

[279] Colborn 2011 at 1045.

[280] *Id.* at 1046.

[281] *Id.*

[282] *Id.* at 1048.

[283] McKenzie, L. et al., Human Health Risk Assessment of Air Emissions from Development of Unconventional Natural Gas Resources, 424 Science of the Total Environment 79 (2012) ("McKenzie 2012").

tube defects.[284] A separate study independently found the same pattern; infants born near fracked gas wells had more health problems than infants born near sites that had not yet conducted fracking.[285,286] Further studies have raised substantial questions regarding air pollution from Uinta Basin drilling, for example, and its public health effects on stillborns.[287]

A study analyzed Pennsylvania birth records from 2004 to 2011 to assess the health of infants born within a 2.5-kilometer radius of natural-gas fracking sites. They found that proximity to fracking increased the likelihood of low birth weight by more than half, from about 5.6 percent to more than nine percent.[288] The chances of a low Apgar score, a summary measure of the health of newborn children, roughly doubled to more than five percent.[289] Another recent Pennsylvania study found a correlation between proximity to unconventional gas drilling and higher incidence of lower birth weight and small-for-gestational-age babies.[290]

A recent study found increased rates of cardiology-patient hospitalizations in zip codes with greater number of unconventional oil and gas wells and higher well density in Pennsylvania.[291] The results suggested that if a zip code went from having zero wells to well density greater than 0.79 wells/km^2, the number of cardiology-patient hospitalizations per 100 people (or "cardiology inpatient prevalence rate") in that zip code would increase by 27 percent. If a zip code went from having zero wells to a well density of 0.17 to 0.79 wells/km^2, a 14 percent increase in cardiology inpatient prevalence rates was expected. Further, higher rates of neurology-patient hospitalizations were correlated with zip codes with higher well density.

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[284] McKenzie, L. et al., Birth Outcomes and Maternal Residential Proximity to Natural Gas Development in Rural Colorado, Advance Publication Environmental Health Perspectives (Jan. 28, 2014) ("McKenzie 2014").

[285] Hill, Elaine L., Unconventional Natural Gas Development and Infant Health: Evidence from Pennsylvania, Cornell University (2012).

[286] Whitehouse, M., Study Shows Fracking is Bad for Babies, Bloomberg View, Jan. 4, 2014.

[287] *See* Siddika, N. et al., Prenatal ambient air pollution exposure and the risk of stillbirth: systematic review and meta-analysis of the empirical evidence, Occup Environ Med. (2016) doi: 10.1136/oemed-2015-103086; *See also* Knox, Annie, At Vernal forum, questions about air pollution, pregnancies, research, Salt Lake Tribune, April 19, 2015; Solotaroff, Paul, What's Killing the Babies of Vernal, Utah? Rolling Stone Magazine, June 22, 2015.

[288] *Id*., citing Janet Currie of Princeton University, Katherine Meckel of Columbia University, and John Deutch and Michael Greenstone of the Massachusetts Institute of Technology.

[289] *Id.*

[290] Stacy, S. L. et al., Perinatal Outcomes and Unconventional Natural Gas Operations in Southwest Pennsylvania, 10 PLoS ONE 6: e0126425, doi:10.1371/journal.pone.0126425 (2015).

[291] Jemielital, T. et al., Unconventional Gas and Oil Drilling Is Associated with Increased Hospital Utilization Rates 10 PLoS ONE 7: e0131093 (2015).

> Recently published reports indicate that people living in proximity to fracked gas wells commonly report skin rashes and irritation, nausea or vomiting, headache, dizziness, eye irritation, and throat irritation.[292]
>
> In Texas, a jury awarded nearly $3 million to a family who lived near a well that was hydraulically fractured.[293] The family complained that they experienced migraines, rashes, dizziness, nausea, and chronic nosebleeds. Medical tests showed one of the plaintiffs had more than 20 toxic chemicals in her bloodstream.[294] Air samples around their home also showed the presence of BTEX—benzene, toluene, ethylbenzene and xylene—colorless, but toxic chemicals typically found in petroleum products.[295]

Chemicals used for fracking also put nearby residents at risk of endocrine disruption effects. A study that sampled water near active wells and known spill sites in Garfield County, Colorado found alarming levels of estrogenic, antiestrogenic, androgenic, and antiandrogenic activities, indicating that endocrine system disrupting chemicals ("EDC") threaten to contaminate surface and groundwater sources for nearby residents.[296] The study concluded:

> [M]ost water samples from sites with known drilling-related incidents in a drilling-dense region of Colorado exhibited more estrogenic, antiestrogenic, and/or antiandrogenic activities than the water samples collected from reference sites[,] and 12 chemicals used in drilling operations exhibited similar activities. Taken together, the following support an association between natural gas drilling operations and EDC activity in surface and ground water: [1] hormonal activities in Garfield County spill sites and the Colorado River are higher than those in reference sites in Garfield County and in Missouri[;] [2] selected drilling chemicals displayed activities similar to those measured in water samples collected from a drilling-dense region[;] [3] several of these chemicals and similar compounds were detected by other researchers at our sample collection sites[;] and [4] known spills of natural gas fluids occurred at these spill sites.

The study also noted a linkage between EDCs and "negative health outcomes in laboratory animals, wildlife, and humans":

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[292] Rabinowitz, P.M. et al., Proximity to Natural Gas Wells and Reported Health Status: Results of a Household Survey in Washington County, Pennsylvania. Environmental Health Perspectives Advance Publication (2014); Bamberger, Michelle and R.E. Oswald, Impacts of Gas Drilling on Human and Animal Health, 22 New Solutions 51 (2012); Steinzor, N. et al., Gas Patch Roulette: How Shale Development Risks Public Health in Pennsylvania, Earthworks Gas & Oil Accountability Project (2012).

[293] *Parr v. Aruba Petroleum, Inc*., Case No. 11-01650-E (Dallas Cty., filed Sept.13, 2013).

[294] Deam, J., Jury Awards Texas Family Nearly $3 million in Fracking Case, Los Angeles Times (Apr. 3, 2014).

[295] *Id*.

[296] Kassotis, C. D. et al., Estrogen and Androgen Receptor Activities of Hydraulic Fracturing Chemicals and Surface and Ground Water in a Drilling-Dense Region, 155 Endocrinology 3:897 (2014).

> Despite an understanding of adverse health outcomes associated with exposure to EDCs, research on the potential health implications of exposure to chemicals used in hydraulic fracturing is lacking. Bamberger and Oswald (26) analyzed the health consequences associated with exposure to chemicals used in natural gas operations and found respiratory, gastrointestinal, dermatologic, neurologic, immunologic, endocrine, reproductive, and other negative health outcomes in humans, pets, livestock, and wildlife species.
>
> Of note, site 4 in the current study was used as a small-scale ranch before the produced water spill in 2004. This use had to be discontinued because the animals no longer produced live offspring, perhaps because of the high antiestrogenic activity observed at this site. There is evidence that hydraulic fracturing fluids are associated with negative health outcomes, and there is a critical need to quickly and thoroughly evaluate the overall human and environmental health impact of this process. It should be noted that although this study focused on only estrogen and androgen receptors, there is a need for evaluation of other hormone receptor activities to provide a more complete endocrine-disrupting profile associated with natural gas drilling.[297]

Operational accidents also pose a significant threat to public health. For example, in August 2008, Newsweek reported that an employee of an energy-services company got caught in a fracking fluid spill and was taken to the emergency room, complaining of nausea and headaches.[298] The fracking fluid was so toxic that it ended up harming not only the worker, but also the emergency room nurse who treated him. Several days later, after she began vomiting and retaining fluid, her skin turned yellow and she was diagnosed with chemical poisoning.[299]

Harmful chemicals are also found in the flowback fluid after well stimulation events. Flowback fluid is a key component of oil-industry wastewater from stimulated wells. A survey of chemical analyses of flowback fluid dating back to April 2014 in California revealed that concentrations of benzene, a known carcinogen, were detected at levels over 1,500 times the federal limits for drinking water.[300] Of the 329 available tests that measured for benzene, the chemical was detected at levels in excess of federal limits in 320 tests (97 percent).[301] On average, benzene levels were around 700 times the federal limit for drinking water.[302] Among other carcinogenic or otherwise

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[297] *Id*. at 905.

[298] Wiseman, Hannah, Untested Waters: the Rise of Hydraulic Fracturing in Oil and Gas Production and the Need to Revisit Regulation, 115 Fordham Envtl. Law Rev. 138 (2009).

[299] *Id*.

[300] California Department of Conservation Division of Oil, Gas, & Geothermal Resources, California Well Stimulation Public Disclosure Report, The highest concentration was 7,700 parts per billion ("ppb") for a well with API number 03052587. The US EPA's maximum contaminant level for benzene is 5 ppb.

[301] *Id*.

[302] *Id*., S*ee also* Cart, J., High Levels of Benzene Found in Fracking Wastewater, Los Angeles Times, Feb. 11, 2015.

dangerous chemicals found in flowback fluid from fracked wells are toluene and chromium-6.[303] These hazardous substances were detected in excess of federal limits for drinking water in over 100 tests. This dangerous fluid is commonly disposed of in injection wells, which often feed into aquifers, including some that could be used for drinking water and irrigation.

Acidizing presents similar alarming risks to public health and safety. In acidizing operations, large volumes of hydrochloric and hydrofluoric acids are transported to the site and injected underground. These chemicals are highly dangerous due to their corrosive properties and ability to trigger tissue corrosion and damage to sensory organs through contact.

While many risks are known, much more is unknown about the hundreds of chemicals used in fracking. The identity and effects of many of these additives is unknown, due to operators' claims of confidential business information. But, as the EPA recognizes, chemical identities are "necessary to understand their chemical, physical, and toxicological properties, which determine how they might move through the environment to drinking water resources and any resulting effects."[304] Compounds in mixtures can have synergistic or antagonistic effects, but again, it is impossible to know these effects without full disclosure.[305] The lack of this information also precludes effective remediation: "Knowing their identities would also help inform what chemicals to test for in the event of suspected drinking water impacts and, in the case of wastewater, may help predict whether current treatment systems are effective at removing them."[306]

Even where chemical identities are known, chemical safety data may be limited. In the EPA's study of the hazards of fracking chemicals to drinking water, the EPA found that "[o]ral reference values and oral slope factors meeting the criteria used in this assessment were not available for the majority of chemicals used in hydraulic fracturing fluids [87 percent], representing a significant data gap for hazard identification."[307] Without this data, the EPA could not adequately assess potential impacts on drinking water resources and human health.[308] Further, of the 1,076 hydraulic fracturing fluid chemicals identified by the EPA, 623 did not have estimated physiochemical properties reported in the EPA's toxics database; although this information is "essential to predicting how and where it will travel in the environment."[309] The data gaps are actually much larger, because the EPA excluded 35 percent of fracking chemicals reported to FracFocus from its analysis because it could not assign them standardized chemical names.[310]

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[303] *Id*.; S*ee also* Center for Biological Diversity, Cancer-causing Chemicals Found in Fracking Flowback from California Oil Wells (2015).

[304] U.S. EPA 2015 at 10-18.

[305] Souther, Sara et al, Biotic Impacts of Energy Development from Shale: Research Priorities and Knowledge Gaps, 12 Front Ecol. Environ 6: 334 (2014).

[306] U.S. EPA 2015 at 10-18.

[307] *Id*. at 10-7, 9-7.

[308] *Id*. at 9-37-38.

[309] *Id*. at 5-73.

[310] *Id*. at 9-38.

The advent of improved well stimulation technologies within the last decade, including horizontal drilling, "massive" fracking, and multi-stage fracturing, has increased the overall capacity for new oil and gas development, including in previously undeveloped areas of Nevada. These technologies have opened up new areas that would otherwise remain untouched and have prolonged the life of existing well fields. Multi-well pads and a higher density of wells are now viable with these techniques, allowing operators to maximize the surface area exposed by widespread fracturing of underlying rock formations.

IX. Conclusion

The proposed action entails a wide variety of impacts which BLM has unlawfully neglected to disclose and analyze in the EA, in violation of NEPA, the ESA, and the Clean Air Act. Impacts to groundwater and surface water, threatened and endangered species, greater sage-grouse, air quality, climate, seismicity, and human health are severe and in most cases unmitigable. We strongly encourage the selection of the No Action Alternative. Thank you for your consideration of these comments.

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LIST OF CITED REFERENCES

Allen, David et al., Measurements of methane emissions at natural gas production sites in the United States, PNAS Early Edition, doi:10.1073/pnas.1304880110 (2013)

Armendariz, Al, Emissions for Natural Gas Production in the Barnett Shale Area and Opportunities for Cost-Effective Improvements (2009)

Atkinson, G. et al., Abstract: Ground motions from three recent earthquakes in Western Alberta and Northeastern British Columbia and their implications for induced-seismicity hazard in eastern regions. Seismological Research Letters (2015)

Atkinson, G.M. et al., Hydraulic fracturing and seismicity in the Western Canada Sedimentary Basin 87 Seismological Research Letters May/June (2016)

Bamberger, Michelle and R.E. Oswald, Impacts of Gas Drilling on Human and Animal Health, 22 New Solutions 51 (2012)

Bar-Ilan, Amnon, et al., A Comprehensive Emissions Inventory of Upstream Oil and Gas Activities in the Rocky Mountain States, ENVIRON (2010)

Bay Area Air Quality Management District, Particulate Matter Overview, Particulate Matter and Human Health (2012)

Begos, Kevin, Some States Confirm Water Pollution from Oi*l, Gas Drilling*, Seattle Times Jan. 6, 2014, http://www.seattletimes.com/business/some-states-confirm-water-pollution-from-oil-gas-drilling/

Brandt, Adam et al., Ch 3: Air quality impacts from well stimulation, An Independent Assessment of Well Stimulation in California, Volume 2, California Council on Science and Technology (2015)

Brittingham, Margaret C. et al. Ecological Risks of Shale Oil and Gas Development to Wildlife, Aquatic Resources and their Habitats, 48 Environ. Sci. Technol. 11034 (2014)

Brown, David et al., Understanding Exposure From Natural Gas Drilling Puts Current Air Standards to the Test, 29 Reviews on Environmental Health 277 (2014)

Brown, Heather, Memorandum to Bruce Moore, USEPA/OAQPS/SPPD re Composition of Natural Gas for Use in the Oil and Natural Gas Sector Rulemaking (July 28, 2011)

Brown, M.R.M. and M. Liu, Injection-induced seismicity in Carbon and Emery Counties, Central Utah, 16 Geofluids 801 (2016).

Bruckner, Thomas et al., 2014: Energy Systems. In: Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the

Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA (2014)

Caiazzo, Fabio et al., Air Pollution and Early Deaths in the United States. Part I: Quantifying the Impact of Major Sectors in 2005, 79 Atmospheric Environment 198 (2013)

California Department of Conservation Division of Oil, Gas, & Geothermal Resources, California Well Stimulation Public Disclosure Report (2015)

California Department of Conservation Division of Oil, Gas, and Geothermal Resources, Producing Wells and Production of Oil, Gas, and Water by County - 2011, Excerpted from Final Report of 2011 California Oil and Gas Production Statistics (2012)

California Division of Oil, Gas, and Geothermal Resources, 2014 Preliminary Report of California Oil and Gas Production Statistics (2015)

Carbon Tracker Initiative, Unburnable Carbon 2013: Wasted capital and stranded assets (2013)

Carbon Tracker Initiative, Unburnable Carbon: Are the world's financial markets carrying a carbon bubble? (2013)

Cart, J., High Levels of Benzene Found in Fracking Wastewater, Los Angeles Times (Feb. 11, 2015)

Casey, Joan A., Unconventional Natural Gas Development and Birth Outcomes in Pennsylvania, USA, 27 Epidemiology 163 (2016)

Center for Biological Diversity, Petition to list 42 species of Great Basin springsnails from Nevada, Utah, and California as threatened or endangered under the Endangered Species Act (2009)

Center for Biological Diversity, Air Toxics One-Year Report: Oil companies used millions of pounds of air-polluting chemicals in Los Angeles Basin neighborhoods (2014)

Center for Biological Diversity, Cancer-causing Chemicals Found in Fracking Flowback from California Oil Wells (2015)

Center for Biological Diversity, Dirty Dozen: The 12 most commonly used air toxics in unconventional oil development in the Los Angeles Basin (2013)

Center for Public Integrity, Open Pits Offer Cheap Disposal for Fracking Sludge But Health Worries Mount (October 2, 2014)

Choy, G.L. et al., Abstract: A Rare Moderate-Sized (Mw 4.9) Earthquake in Kansas: Rupture Process of the Milan, Kansas, Earthquake of 12 November 2014 and Its Relationship to Fluid Injection, 87 Seismological Research Letters 1433 (2016)

Clarke, H. et al., Felt seismicity associated with shale gas hydraulic fracturing: The first documented example in Europe, 41 Geophysical Research Letters 8308 (2014)

Clean Air Task Force, Fossil Fumes: A Public Health Analysis of Toxic Air Pollution From the Oil and Gas Industry (June 2016)

Climate Action Tracker, USA, (last updated 25 Jan. 2017)

Clough, Emily & Derek Bell, Just Fracking: A Distributive Environmental Justice Analysis of Unconventional Gas Development in Pennsylvania, USA, 11 Environmental Research Letters 025001 (2016)

Colborn, Theo et al., Natural Gas Operations from a Public Health Perspective, 17 Human and Ecological Risk Assessment 1039 (2011)

Colorado Department of Public Health, Colorado Conservation Commission, Colorado Weekly & Monthly Oil & Gas Statistics (July 6, 2012)

Craft, Elena, Environmental Defense Fund, Do Shale Gas Activities Play a Role in Rising Ozone Levels? (2012)

Darrah, Thomas H. et al., Noble Gases Identify the Mechanisms of Fugitive Gas Contamination in Drinking-Water Wells Overlying the Marcellus and Barnett Shales, Proc. Natl. Acad. Of Sciences Early Edition, doi: 10.1073/pnas.1322107111 (2014)

Deacon, J.E., et al., Fueling population growth in Las Vegas: How large-scale groundwater withdrawal could bum regional biodiversity, 57 Bioscience 8: 688 (2007)

Deam, J., Jury Awards Texas Family Nearly $3 million in Fracking Case, Los Angeles Times (Apr. 3, 2014), http://www.latimes.com/nation/la-na-fracking-lawsuit-20140424-story.html.

DeLong, Jeff, Fracking Hits Home in Nevada, Reno Gazette-Journal, April 15, 2014

Drajem, Mark, Wyoming Water Tests in Line with EPA Finding on Fracking, Bloomberg (Oct. 11, 2012)

Du Pont, Yann Robiou et al., Equitable mitigation to achieve the Paris Agreement goals, 7 Nature Climate Change 38 (2017)

E&E Staff Writer, Fracking Fluid leaks from wellhead in Colo., E&E News, Feb 14, 2013

E&E News, Ohio man pleads not guilty to brine dumping, Feb. 15, 2013

Earthworks, Sources of Oil and Gas Pollution (2011)

Ecoshift Consulting, The potential Greenhouse Gas Emissions of U.S. Federal Fossil Fuels, Center for Biological Diversity and Friends of the Earth (2015)

Elliot, Elise G. et al., A Systematic Evaluation of Chemicals in Hydraulic-Fracturing Fluids and Wastewater for Reproductive and Developmental Toxicity, 27 Journal of Exposure Science and Environmental Epidemiology 90 (2016)

Ellsworth, W.L. et al., Increasing seismicity in the U. S. midcontinent: Implications for earthquake hazard, 34 The Leading Edge 618 (2015)

Ellsworth, W.L., Injection-induced earthquakes, 341 Science 143 (2013)

Esswein, Eric et al., Evaluation of Some Potential Chemical Exposure Risks during Flowback Operations in Unconventional Oil and Gas Extraction: Preliminary Results, 11 Journal of Occupational and Environmental Hygiene D174 (2014)

Esswein, Eric J. et al., Occupational Exposures to Respirable Crystalline Silica During Hydraulic Fracturing, 10 Journal of Occupational and Environmental Hygiene 347 (2013)

Farahbod, A.M. et al., Investigation of regional seismicity before and after hydraulic fracturing in the Horn River Basin, northeast British Columbia, 52 Canadian Journal of Earth Sciences 112 (2014)

Fiore, Arlene et al., Linking ozone pollution and climate change: The case for controlling methane, 29 Geophys. Res Letters 19 (2002)

Fontenot, Brian, et al., An evaluation of water quality in private drinking water wells near natural gas extraction sites in the Barnett Shale Formation, Environ. Sci. Technol. DOI: 10.1021/es4011724 (2013)

Food & Water Watch, The Case for a Ban on Gas Fracking (2012)

Friberg, P.A. et al., Characterization of an earthquake sequence triggered by hydraulic fracturing in Harrison County, Ohio, 85 Seismological Research Letters 6 (2014)

Frohlich, C. et al., A historical review of induced earthquakes in Texas, 87 Seismological Research Letters 1 (2016).

Frohlich, C. et al., The 17 May 2012 *M*4.8 earthquake near Timpson, East Texas: An event possibly triggered by fluid injection, 119 Journal of Geophysical Research 581 (2014)

Frohlich, C. et al., The Dallas–Fort Worth earthquake sequence: October 2008 through May 2009, the Leading Edge (March 2010)

Frohlich, Cliff and Michael Brunt, Two-year survey of earthquakes and injection/production wells in the Eagle Ford Shale, Texas, prior to the MW4.8 20, 402 Earth and Planetary Science Letters 15, 257 (Sept. 2014)

Gan, W. and C. Frohlich, Gas injection may have triggered earthquakes in the Cogdell oil field, Texas, 110 PNAS 18786 (2013)

Garton, Edward O., et al., Greater Sage-Grouse Population Dynamics and Probability of Persistence (2015)

Gignac, Renaud & Matthews, H. Damon, Allocating a 2°C cumulative carbon budget to countries, 10 Environmental Research Letters 075004 (2015)

Gilman, J.B. et al., Source signature of volatile organic compounds from oil and natural gas operations in Northeastern Colorado, Environment. Science. & Technology (2013)

Gross, Sherilyn A. et al., Abstract: Analysis of BTEX groundwater concentrations from surface spills associated with hydraulic fracturing operations, 63 J. Air and Waste Mgmt. Assoc. 4, 424 doi: 10.1080/10962247.2012.759166 (2013)

Harrison, Robert J. et al., Sudden Deaths Among Oil and Gas Extraction Workers Resulting from Oxygen Deficiency and Inhalation of Hydrocarbon Gases and Vapors — United States, January 2010–March 2015, 65 MMWR Morb Mortal Wkly Rep 6 (2016)

Harriss, Robert et al., Using Multi-Scale Measurements to Improve Methane Emission Estimates from Oil and Gas Operations in the Barnett Shale Region, Texas, 49 Environmental Science & Technology 7524 (2015)

Hays, Jake & Seth B.C. Shonkoff, Towards an Understanding of the Environmental and Public Health Impacts of Unconventional Natural Gas Development: A Categorical Assessment of the Peer-Reviewed Scientific Literature, 11 PLoS ONE e0154164 (2016)

Heath, Ralph C., Basic Groundwater Hydrology, U.S. Geological Survey Water-Supply Paper 2220 (2004)

Helmig, Detlev et al,, Reversal of Global Atmospheric Ethane and Propane Trends Largely Due to US Oil and Natural Gas Production. 9 Nature Geoscience 490 (2016)

Hill, Elaine L., Unconventional Natural Gas Development and Infant Health: Evidence from Pennsylvania, Cornell University (2012)

Holland, A., Earthquakes Triggered by Hydraulic Fracturing in South-Central Oklahoma, 103 Bulletin of the Seismological Society of America 3 (2013)

Holloran, Matthew, Greater Sage-Grouse (*Centrocercus urophasianus*) Population Response to Natural Gas Field Development in Western Wyoming (2005)

Hornbach, M.J. et al., Causal factors for seismicity near Azle, Texas, 6 Nature Communications 6728 (2016)

Hornbach, M.J. et al., Ellenburger wastewater injection and seismicity in North Texas, 261 Physics of the Earth and Planetary Interiors 54 (2016)

Horton, S., Disposal of hydrofracking waste fluid by injection into subsurface aquifers triggers earthquake swarm in Central Arkansas with potential for damaging earthquake, 83 Seismological Research Letters 2 (2012)

Hseih, P. & Bredehoeft, J., A reservoir analysis of the Denver earthquakes: A case of induced seismicity, 86 J. Geophys. Res. B2:903 (1981)

Ingraffea, Anthony R., Some Scientific Failings within High Volume Hydraulic Fracturing Proposed Regulations 6 NYCRR Parts 550-556, 560, Comments and Recommendations Submitted to the NYS Dept. of Environmental Conservation (Jan 8, 2013)

IPCC, 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change; Summary for Policymakers 25 (2013)

IPCC, Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)], IPCC, Geneva, Switzerland (2014)

Jackson, Robert B., et al., Increased stray gas abundance in a subset of drinking water wells near Marcellus shale gas extraction, 110 PNAS 28 (2013)

Jemielita, Thomas et al., Unconventional Gas and Oil Drilling Is Associated with Increased Hospital Utilization Rates. 10 PLoS ONE e0131093 (2015)

Justinic, A.H. et al., Analysis of the Cleburne, Texas, Earthquake Sequence from June 2009 to June 2010, 103 Bulletin of the Seismological Society of America 6 (2013)

Kassotis, C. D. et al., Estrogen and Androgen Receptor Activities of Hydraulic Fracturing Chemicals and Surface and Ground Water in a Drilling-Dense Region, 155 Endocrinology 3 (2014)

Keranen, K.M. et al., Potentially induced earthquakes in Oklahoma, USA: Links between wastewater injection and the 2011 Mw 5.7 earthquake sequence, 41 Geology 699 (2013);

Keranen, K.M. et al., Sharp increase in Central Oklahoma seismicity since 2008 induced by massive wastewater injection, 345 Science 448 (2014)

Kim, Won-Young, Induced seismicity associated with fluid injection into a deep well in Youngstown, Ohio, 118 Journal of Geophysical Research 3506 (2013)

King, Pamela, Limited study supports findings on bigger brine spill risks, E&E News, Nov. 4, 2015

Knox, Annie, At Vernal forum, questions about air pollution, pregnancies, research, Salt Lake Tribune, April 19, 2015

Kort, Eric A. et al., Fugitive Emissions From the Bakken Shale Illustrate Role of Shale Production in Global Ethane Shift, 43 Geophysical Research Letters 4617 (2016)

Kusnetz, N., A Fracking First in Pennsylvania: Cattle Quarantine, ProPublica (July 2, 2010)

Kusnetz, Nicholas, North Dakota's Oil Boom Brings Damage Along with Prosperity, ProPublica (June 7, 2012)

Le Quéré, Corrine, et al., Global Carbon Budget 2016, 8 Earth System Science Data 605 (2016)

Lustgarten, Abraham, Injection Wells: The Poison Beneath Us, ProPublica (2012)

Lustgarten, Abraham, Polluted Water Fuels a Battle for Answers, ProPublica (2012)

Lustgarten, Abraham, Whiff of Phenol Spells Trouble, ProPublica (2012)

Lyman, Seth and Howard Shorthill, Final Report: 2012 Uintah Basin Winter Ozone & Air Quality Study, Utah Dept of Environmental Quality (2013)

Lyon, David R. et al., Aerial Surveys of Elevated Hydrocarbon Emissions From Oil and Gas Production Sites, 50 Environmental Science & Technology 4877 (2016)

Macey, G.P. et al., Air Concentrations of Volatile Compounds Near Oil and Gas Production: A Community-Based Exploratory Study, 13 Environmental Health 82 (2014)

Maffy, Brian, Utah grapples with toxic water from oil and gas industry (The Salt Lake Tribune, August 28, 2014)

Martin, Randal et al., Final Report: Uinta Basin Winter Ozone and Air Quality Study Dec 2010 - March 2011 (2011)

McCawley, M., Air, Noise, and Light Monitoring Plan for Assessing Environmental Impacts of Horizontal Gas Well Drilling Operations (ETD-10 Project), West Virginia University School of Public Health, Morgantown, WV (2013)

McGarr, A. et al., 40 Case histories of induced and triggered seismicity, 81A International Geophysics 654 (2002)

McKenzie, L. et al., Human Health Risk Assessment of Air Emissions from Development of Unconventional Natural Gas Resources, 424 Science of the Total Environment 79 (2012)

McKenzie, Lisa M. et al., Population Size, Growth, and Environmental Justice Near Oil and Gas Wells in Colorado, 50 Environmental Science & Technology 11471 (2016)

McKenzie, Lisa M., Birth Outcomes and Maternal Residential Proximity to Natural Gas Development in Rural Colorado, 122 Environmental Health Perspectives 412 (2014)

Meinshausen, Malte et al., Greenhouse gas emission targets for limiting global warming to 2 degrees Celsius, 458 Nature 1158 (2009)

Melillo, Jerry M., Climate Change Impacts in the United States: The Third National Climate Assessment, Terese (T.C.) Richmond, and Gary W. Yohe, Eds., U.S. Global Change Research Program (2014)

Michaels, Craig, et al., Fractured Communities: Case Studies of the Environmental Impacts of Industrial Gas Drilling, Riverkeeper (2010)

Miller, Jeremy, Oil and Water Don't Mix with California Agriculture, High Country News (2012)

Myers, Tom, Review of DRAFT: Investigation of Ground Water Contamination near Pavillion Wyoming Prepared by the Environmental Protection Agency, Ada OK (Apr. 30, 2012)

Myhre, Gunnar et al., Anthropogenic and Natural Radiative Forcing, Pp 659–740 in Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change IPCC. Stocker, T.F. et al., eds. Cambridge University Press, Cambridge UK and New York USA (2013)

National Research Council, Induced Seismicity Potential in Energy Technologies, National Academies Press (2012)

Natural Resources Defense Council, Drilling in California: Who's At Risk? (October 2014)

Natural Resources Defense Council, Petition for Rulemaking Pursuant to Section 6974(a) of the Resource Conservation and Recovery Act Concerning the Regulation of Wastes Associated with the Exploration, Development, or Production of Crude Oil or Natural Gas or Geothermal Energy (2010)

Natural Resources Defense Council, Water Facts: Hydraulic Fracturing can potentially Contaminate Drinking Water Sources (2012)

Nevada Department of Conservation and Natural Resources, Nevada Water Law 101

Nevada Department of Wildlife, Sage Grouse Conservation Plan, South Central Nevada (2004)

Nevada Natural Heritage Program, At Risk Plant and Animal Tracking List July 2017, Dept. of Conservation and Natural Resources (2017)

New Mexico Oil and Conservation Division, OGAP Analysis of data provided in New Mexico Energy, Minerals and Natural Resources Dep't, Oil and Conservation Div., Cases Where Pit Substances Contaminated New Mexico's Ground Water (2008)

New York Department of Environmental Conservation, Final Supplemental Generic Environmental Impact Statement on the Oil, Gas and Solution Mining Regulatory Program, Ch. 6 Potential Environmental Impacts (2015)

Nicholson, C. & Wesson, R.L., Earthquake Hazard Associated with Deep Well Injection - A report to the U.S. Environmental Protection Agency, USGS Bulletin 1951 (1990)

Nicholson, C. & Wesson, R.L., Triggered Earthquakes and Deep Well Activities, 139 PAGEOPH 3/4 (1992)

Ogwari, P.O. et al., Characteristics of induced/triggered earthquakes during the setup phase of the Guy-Greenbrier earthquake in North-Central Arkansas, 87 Seismological Research Letters 3 (2016)

Ohio Department of Natural Resources, Report on the Investigation of the Natural Gas Invasion of Aquifers in Bainbridge Township of Geauga County, Ohio (2008)

Oil Change International, The Sky's Limit: Why the Paris Climate Goals Require a Managed Decline of Fossil Fuel Production (2016)

Oklahoma Geological Survey, Statement on Oklahoma Seismicity (April 21, 2015)

Ostro, Bart et al., Long-term Exposure to Constituents of Fine Particulate Air Pollution and Mortality: Results from the California Teachers Study, 118 Environmental Health Perspectives 3 (2010)

Peters, Glen P. et al., Measuring a fair and ambitious climate agreement using cumulative emissions, 10 Environmental Research Letters 105004 (2015)

Petersen, M.D. et al., One-year seismic hazard forecast for the Central and Eastern United States from induced and natural earthquakes, U.S. Geological Survey Open-File Report 2016-1035 (2016)

Pétron, Gabrielle et al., A New Look at Methane and Non-Methane Hydrocarbon Emissions from Oil and Natural Gas Operations in the Colorado Denver-Julesburg Basin, 119 J. Geophysical Research: Atmospheres 6836 (2014)

Petron, Gabrielle, et al., Hydrocarbon emissions characterization in the Colorado Front Range: A pilot study, 117 Journal of Geophysical Research (2012)

Physicians for Social Responsibility and Concerned Health Professionals of NY, Compendium of Scientific, Medical, and Media Findings Demonstrating Risks and Harms of Fracking, Fourth Edition (November 17, 2016)

Physicians Scientist & Engineers for Healthy Energy, Letter from Robert Howarth Ph.D. and 58 other scientists to Andrew M. Cuomo, Governor of New York State re: municipal drinking water filtration systems and hydraulic fracturing fluid, Sept 15, 2011

Rabinowitz, P.M. et al., Proximity to Natural Gas Wells and Reported Health Status: Results of a Household Survey in Washington County, Pennsylvania, Environmental Health Perspectives Advance Publication (2014)

Rabinowitz, Peter M. et al., Proximity to Natural Gas Wells and Reported Health Status: Results of a Household Survey in Washington County, Pennsylvania, 123 Environmental Health Perspectives 21 (2015)

Raupach, Michael et al., Sharing a quota on cumulative carbon emissions, 4 Nature Climate Change 873 (2014)

Rogelj, Joeri et al., Differences between carbon budget estimates unraveled, 6 Nature Climate Change 245 (2016)

Rogelj, Joeri et al., Energy system transformations for limiting end-of-century warming to below 1.5°C, 5 Nature Climate Change 519 (2015)

Rubinstein, J. et al., The 2001-present induced earthquake sequence in the Raton Basin of northern New Mexico and southern Colorado, 104 Bulletin of the Seismological Society of America 5 (2014)

Rubinstein, J.L. & Mahani, A.B, Myths and Facts on Wastewater Injection, Hydraulic Fracturing, Enhanced Oil Recovery, and Induced Seismicity, 86 Seismological Research Letters 4 (2015)

Russell, James, et al., An Emission Inventory of Non-point Oil and Gas Emissions Sources in the Western Region, ENVIRON (2006)

Schleussner, Carl-Friedrich et al., Differential climate impacts for policy-relevant limits to global warming: the case of 1.5C and 2C, 7 Earth Systems Dynamics 327 (2016)

Schultz, R. et al., A seismological overview of the induced earthquakes in the Duvernay play near Fox Creek, Alberta, 122 J. Geophys. Res. Solid Earth 492 (2017)

Schultz, R. et al., Hydraulic fracturing and the Crooked Lake Sequences: Insights gleaned from seismic networks, 42 Geophysical Research Letters (2015)

Sharp, Renee and Bill Allayaud, California Regulators: See No Fracking, Speak No Fracking, Environmental Working Group (2012)

Shirzaei, M. et al., Surface uplift and time-dependent seismic hazard due to fluid injection, 353 Science 1416 (2016)

Siddika, N. et al., Prenatal ambient air pollution exposure and the risk of stillbirth: systematic review and meta-analysis of the empirical evidence, Occup Environ Med. (May 24, 2016) doi: 10.1136/oemed-2015-103086

Sierra Club et al. comments on New Source Performance Standards: Oil and Natural Gas Sector; Review and Proposed Rule for Subpart OOOO (Nov. 30, 2011)

Skoumal, R., et al., Earthquakes induced by hydraulic fracturing in Poland Township, Ohio, Bulletin of the Seismological Society of America 105 (2015)

Solotaroff, Paul, What's Killing the Babies of Vernal, Utah? Rolling Stone Magazine (June 22, 2015)

South Coast Air Quality Management District, Draft Staff Report on Proposed Rule 1148.2 - Notification and Reporting Requirements for Oil and Gas Wells and Chemical Suppliers (January 2013)

South Coast Air Quality Management District, Response to Questions re Air Quality Risks of Hydraulic Fracturing in California, Submission to Joint Senate Hearing (2013)

Souther, Sara et al, Biotic Impacts of Energy Development from Shale: Research Priorities and Knowledge Gaps, 12 Front Ecol Environ 6 (2014)

Stacy, S. L. et al., Perinatal Outcomes and Unconventional Natural Gas Operations in Southwest Pennsylvania, 10 PLoS ONE 6: e0126425, doi:10.1371/journal.pone.0126425 (2015)

Steinzor, N. et al., Gas Patch Roulette: How Shale Development Risks Public Health in Pennsylvania, Earthworks Gas & Oil Accountability Project (2012)

Stringfellow, William T. et al., Ch 2: Impacts of Well Stimulation on Water Resources, An Independent Assessment of Well Stimulation in California, Volume 2, California Council on Science and Technology (2015)

U.N. Framework Convention on Climate Change, Conference of the Parties, Nov. 30–Dec. 11, 2015, Adoption of the Paris Agreement Art. 2, U.N. Doc. FCCC/CP/2015/L.9 (Dec. 12, 2015), http://unfccc.int/resource/docs/2015/cop21/eng/l09.pdf

U.N. Subsidiary Body for Scientific and Technological Advice, Report on the Structured Expert Dialogue on the 2013–2015 review, FCCC/SB/2015/1NF.1 (2015)

U.N. Treaty Collection, Chapter XXVII, 7.d Paris Agreement, List of Signatories

University of Colorado--Boulder, New study identifies organic compounds of potential concern in fracking Fluids (July 1, 2015)

U.S. Bureau of Land Management, Tonopah Resource Management Plan. (1997)

U.S. Bureau of Land Management, Environmental Assessment for West Desert District, Fillmore Field Office, August 2015 Oil and Gas Lease Sale (2015)

U.S. Bureau of Land Management, Environmental Assessment June 2017 Competitive Oil and Gas Lease Sale Battle Mountain District, DOI-BLM-NV-B020-2017-0002-EA (2017)

U.S. Bureau of Land Management, Greenhouse Gases Estimate (West Desert District Nov 2015 Lease Sale)

U.S. Bureau of Land Management, Nevada, 2015 Industry Expressions of Interest for Possible Oil and Gas Leasing

U.S. Bureau of Land Management, Nevada, 2016 Industry Expressions of Interest for Possible Oil and Gas Leasing

U.S. Bureau of Land Management, Nevada and Northeastern California Greater Sage-Grouse Approved Resource Management Plan Amendment (2015)

U.S. Bureau of Land Management, Supplemental Information for the December 2020 Competitive Oil and Gas Lease Sale EA. (2020)

U.S. Dept of Agriculture, et al., Inventory of Onshore Federal Oil and Natural Gas Resources and Restrictions to Their Development, EPCA Phase III (2008)

U.S. Dept of Agriculture, U.S. Environmental Protection Agency, and U.S. Department of the Interior, Memorandum of Understanding re Air Quality Analyses and Mitigation for Federal Oil and Gas Decisions through the National Environmental Policy Act Process, Preamble (2011)

U.S. Dept. of Interior & U.S. Bureau of Land Management, IM 2016-143, Implementation of Greater Sage-Grouse Resource Management Plan Revisions or Amendments — Oil & Gas Leasing and Development Sequential Prioritization, Sept. 1, 2016

U.S. Department of State, Background Briefing on the Paris Climate Agreement (2015)

U.S. Environmental Protection Agency, Assessment of the Potential Impacts of Hydraulic Fracturing for Oil and Gas on Drinking Water Resources, External Review Draft (2015)

U.S. Environmental Protection Agency, Carbon Monoxide

U.S. Environmental Protection Agency, Draft Investigation of Ground Water Contamination near Pavillion, Wyoming (2011)

U.S. Environmental Protection Agency, Emission Factors for Greenhouse Gas Inventories (April 4, 2014)

U.S. Environmental Protection Agency, Ground Level Ozone

U.S. Environmental Protection Agency, Hazardous Air Pollutants

U.S. Environmental Protection Agency, Hydraulic Fracturing for Oil and Gas: Impacts from the Hydraulic Fracturing Water Cycle on Drinking Water Resources in the United States (Final Report). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-16/236F (2016)

U.S. Environmental Protection Agency, Integrated Science Assessment (ISA) for Ozone (O3) and Related Photochemical Oxidants (2013)

U.S. Environmental Protection Agency, National Ambient Air Quality Standards for Particulate Matter Proposed Rule, 77 Federal Register 126, June 29, 2012

U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Report to Congress on Hydrogen Sulfide Air Emissions Associated with the Extraction of Oil and Natural Gas (EPA-453/R-93-045) (Oct. 1993)

U.S. Environmental Protection Agency, Oil and Gas Sector: New Source Performance Standards and National Emission Standards for Hazardous Air Pollutants Reviews Proposed Rule, 76 Fed. Reg 52,738 (Aug 23, 2011)

U.S. Environmental Protection Agency, Oil and Gas Sector: Standards of Performance for Crude Oil and Natural Gas Production, Transmission, and Distribution: Background Technical Support Document for Proposed Standards (2011)

U.S. Environmental Protection Agency, Particulate Matter, (PM) (accessed Oct 1, 2013)

U.S. Environmental Protection Agency, Plan to Study the Potential Impacts of Hydraulic Fracturing on Drinking Water Resources (2011)

U.S. Environmental Protection Agency, Sulfur Dioxide

U.S. Environmental Protection Agency, The Clean Air Act Amendments of 1990 List of Hazardous Air Pollutants, Technology Transfer Network Air Toxics Web Site

U.S. Fish & Wildlife Service, Determination of Endangered Status and Designation of Critical Habitat for the White River Spinedace, 50 Federal Register 177 (1985)

U.S. Fish & Wildlife Service, Determination of Threatened Status and Critical Habitat for the Railroad Valley Springfish, 51 Federal Register 61 (1986)

U.S. Fish & Wildlife Service, Final Rule to Determine Endangered Status and Critical Habitat for the White River Springfish and the Hiko White River Springfish, 50 Federal Register 188 (1985)

U.S. Fish and Wildlife Service, Desert Tortoise (Mojave Population) Recovery Plan (1994)

U.S. Fish and Wildlife Service, Pahrump Poolfish

U.S. Fish and Wildlife Service, Revised Recovery Plan for the Mojave Desert Population of the Desert Tortoise (*Gopherus agassizii*) (2011)

U.S. Fish and Wildlife Service. Pahranagat Roundtail Chub Species Information

U.S. Geological Survey, Ground Water and Surface Water: A Single Resource, Circular 1139 (1998)

U.S. Government Accountability Office, Oil and Gas Development: Improved Collection and Use of Data Could Enhance BLM's Ability to Assess and Mitigate Environmental Impacts (2017)

U.S. Government Accountability Office, Energy-Water Nexus: Information on the Quantity, Quality, and Management of Water Produced during Oil and Gas Production, Report to the Ranking Member, Committee on Science, Space and Technology, House of Representatives at 13 (2012)

U.S. Government Accountability Office, Oil and Gas: Information on Shale Resources, Development, and Environmental and Public Health Risks, GAO 12-732 (2012)

Van der Elst, N.J. et al., Induced earthquake magnitudes are as large as (statistically) expected, 121 J. Geophys. Res. Solid Earth 4575 (2016)

Vengosh, Avner, et al., A Critical Review of the Risks to Water Resources from Unconventional Shale Gas Development and Hydraulic Fracturing in the United States, Environ. Sci. Technol., dx.doi.org/10.1021/es405118y (2014)

Vienna Convention on the Law of Treaties, Art. 26

Warco, Kathie, Fracking truck runs off road; contents spill, Observer Reporter, Oct 21, 2010

Warner, Nathaniel R., et al., Geochemical Evidence for Possible Natural Migration of Marcellus Formation Brine to Shallow Aquifers in Pennsylvania, PNAS Early Edition (2012)

Webb, Ellen et al., Developmental and reproductive effects of chemicals associated with unconventional oil and natural gas operations, 29 Rev Environ Health 307 (2014)

White, Ivan E., Consideration of radiation in hazardous waste produced from horizontal hydrofracking, National Council on Radiation Protection (2012)

Whitehouse, M., Study Shows Fracking is Bad for Babies, Bloomberg View, Jan. 4, 2014

Wiseman, Hannah, Untested Waters: the Rise of Hydraulic Fracturing in Oil and Gas Production and the Need to Revisit Regulation, 115 Fordham Envtl. Law Rev. 138 (2009)

Yeck, W.L. et al., Far-field pressurization likely caused one of the largest injection induced earthquakes by reactivating a large preexisting basement fault structure, 43 Geophys. Res. Lett. 10:198 (2016)

Yeck, W.L. et al., Oklahoma experiences largest earthquake during ongoing regional wastewater injection hazard mitigation efforts, 44 Geophys. Res. Lett. 711 (2017)

Zhang, Y. et al. Exploring the potential linkages between oil-field brine reinjection, crystalline basement permeability, and triggered seismicity for the Dagger Draw Oil field, southeastern New Mexico, USA, using hydrologic modeling, 16 Geofluids 971 (2016)

Attachment C

USDOI BLM, Habitat Management Plan for the Railroad Valley Wildlife Management Area (1990).

This is a special Cooperative Habitat Management Plan that covers all of the following Wildlife Habitat Area

Railroad Valley Wildlife Management Area - N6-WHA-T35-51
Big Well - N6-WHA-A1
Chimney Springs - N6-WHA-A2
North Spring & North and South Reynolds Spring - N6-WHA-A5

UNITED STATED DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
BATTLE MOUNTAIN DISTRICT
TONOPAH RESOURCE AREA

HABITAT MANAGEMENT PLAN FOR THE RAILROAD VALLEY WILDLIFE MANAGEMENT AREA 1990

*All Habitat Management Plans developed in consultation with State Wildlife agencies serve as "comprehensive plans" as provided for in the Sikes Act (88 Stat. 1369). BLM Manual 6620-06B.

N6-WHA-T35-51

RAILROAD VALLEY
HABITAT MANAGEMENT PLAN

BATTLE MOUNTAIN DISTRICT

Prepared by:

V. Lee Grover
Wildlife Biologist
Tonopah Resource Area
Battle Muntain District
Bureau of Land Management

With assistance from and in cooperation with:

Randy McNatt, U.S. Fish and Wildlife Service
Donna Withers, Nevada Department of Wildlife
John Sjobert, Nevada Department of Wildlife
Joe Low, Battle Mountain District
Duane Crimmons, Battle Mountain District

Concurred by: Nevada Department of Wildlife

4/1/91 Date ______________________ Regional Supervisor

Approved by: Bureau of Land Management

10/4/90 Date ______________________ Tonopah Area Manager

RAILROAD VALLEY HMP

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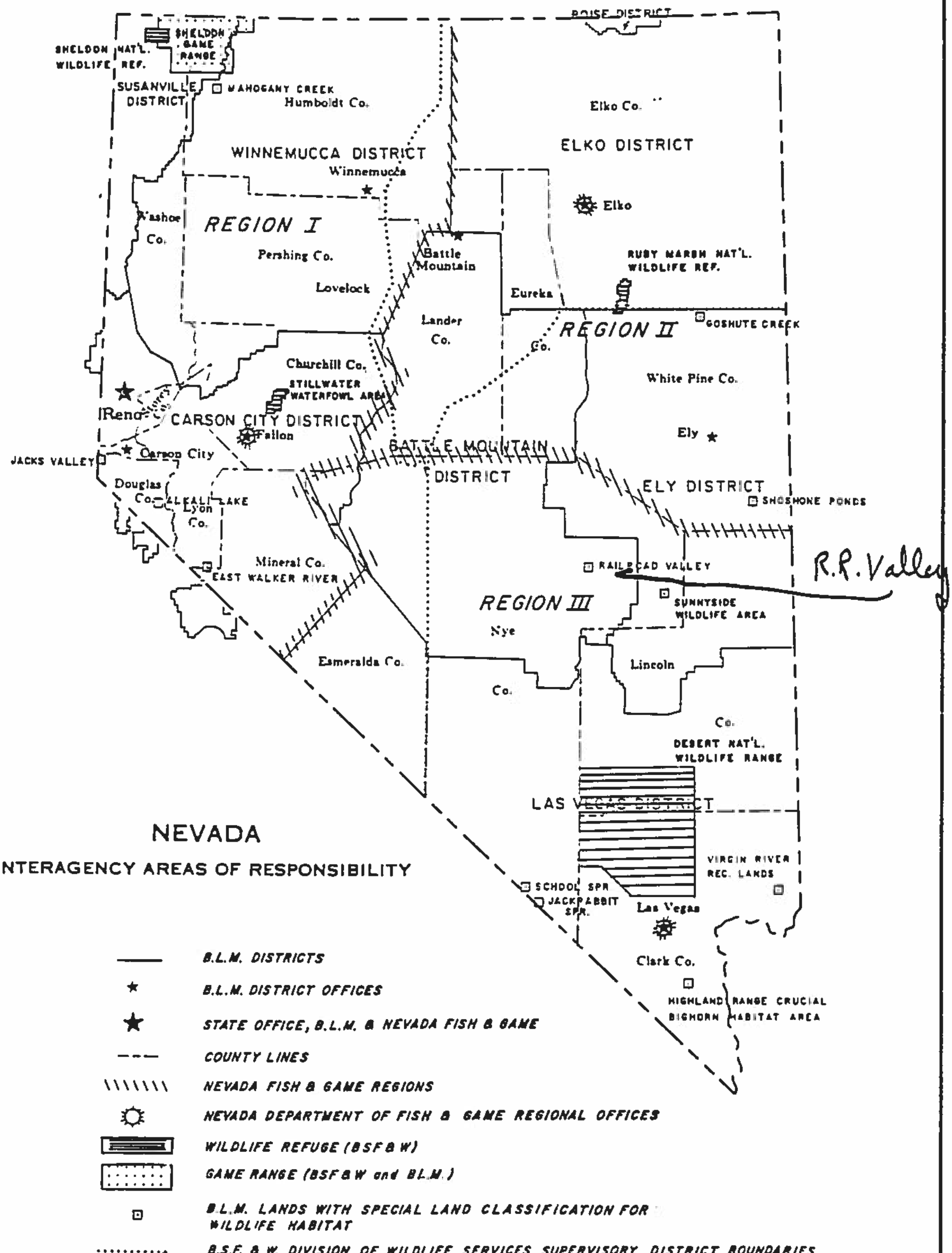
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT



GPO 791-355

ABSTRACT

Railroad Valley HMP is largely on the site of an old U.S. Fish and Wildlife Service Refuge. It is managed jointly by the Bureau of Land Management and the Nevada Department of Wildlife. It is managed for, in priority order: Railroad Springfish (U.S. threatened), waterfowl, large mouth bass.

The major problems are road maintenance, water level maintenance, siltation and budget problems. This area has a high recreational potential once these problems are solved. Without maintenance on the water controls and dikes, there will be a loss of wetlands. Insuring no net loss of our wetlands is a Director's priority n the 1991 AWP.

RAILROAD VALLEY HABITAT MANAGEMENT PLAN
1990

I. Introduction

The Railroad Valley Wildlife Management Area, cooperatively managed with the Nevada Department of Wildlife through an existing Habitat Management Plan (HMP), provides habitat for many species of waterfowl as well an endemic fish. An HMP was developed in 1974 to outline management objectives for this area, now consisting of 14,720 acres, withdrawn for the purpose of waterfowl management. In 1979 the original HMP was revised to include new ideas for waterfowl management, as well as objectives for the Railroad Valley Springfish (Crenichthys nevadae) (an endemic fish species that was being considered for Federal "threatened" status)

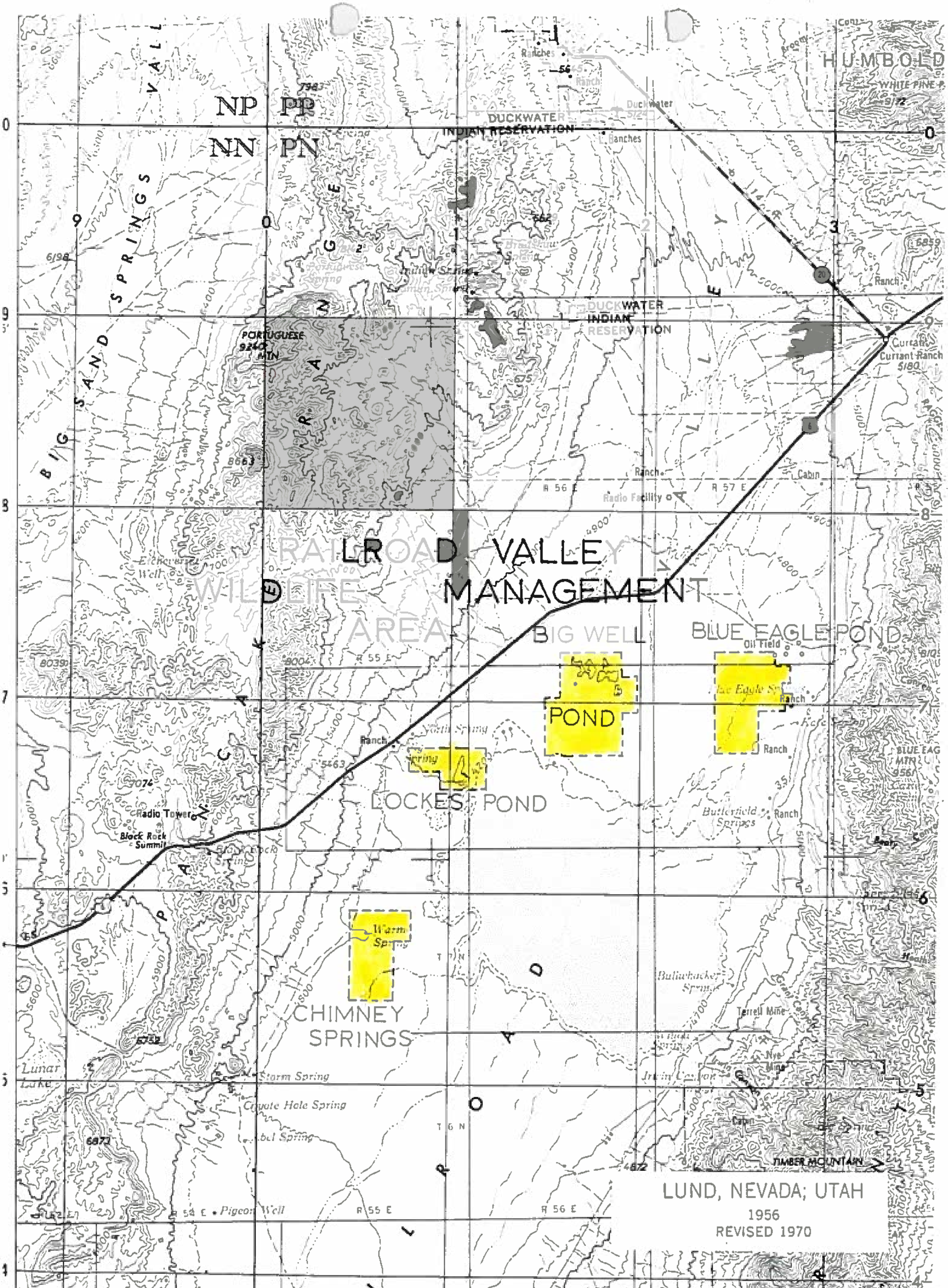
In 1986 the Railroad Valley Springfish was listed as a Federally "threatened" species. It was this action, as well as a changing management scenario that warranted another revision of the HMP. The emphasis for this revision will be placed on the Railroad Valley Springfish (Crenichtyhys nevadae), the unfinished portions of the 1979 HMP and lands outside the WMA which are being added to the HMP area now and in the future.

The acreage of the HMP area will be increased by 3,800 acres to 18,520 acres. It will include 3 springs used by the Railroad Valley Springfish, portions of Lockes Meadow, and areas around Lockes Pond, Big Well Pond and Blue Eagle Pond (see maps pages 5, 6, 7) that are expected to be important in water collecting activities. In addition, private land around Lockes (460 acres) and Tom Spring (1200 acres) will automatically become part of this HMP should this land be exchanged to the BLM.

Many concerns voiced in the original HMPs are still concerns today. Many of the problems have been alleviated, however, some have become new problems due to a lack of maintenance. The lack of road maintenance is causing difficulties in administrative and public access, along with decreased public use. The lack of dike, ditch and water control maintenance is causing ponds to dry up, loss of fish species, loss of waterfowl habitat and loss of wetlands.

The Railroad Valley Wildlife Management Area is a small locally known waterfowl hunting area in Railroad Valley, Nevada. Railroad Valley is located in northeastern Nye County about 60 miles southwest of Ely, Nevada. The dominant feature of the valley is a dry lake bed consisting of approximately 53,000 acres. The lake bed is surrounded by hummocks and low sand dunes. Vegetation is sparse, consisting predominantly of greasewood, rabbitbrush, and other high desert shrubs with intermittent areas of salt grass and other alkali tolerant grasses. The elevation of the lake bed is 4,708 feet.

Several artesian wells were drilled between 1912 and 1915 in connection with potash exploration. Two of these wells are still flowing. Ponds have been formed in natural depressions from the flow of these wells and from the drainage of springs and irrigation systems in the area. These ponds have provided waterfowl habitat and hunting for many years.



NP PP
NN PN
DUCKWATER INDIAN RESERVATION
HUMBOLDT
BIG SAND SPRINGS VALLEY
PANCAKE RANGE
PORTUGUESE MTN 9240
RAILROAD VALLEY
RAILROAD VALLEY WILDLIFE MANAGEMENT AREA
BIG WELL POND
BLUE EAGLE POND
LOCKES POND
CHIMNEY SPRINGS
Currant Ranch
Radio Facility
Radio Tower
Block Rock Summit
Storm Spring
Coyote Hole Spring
Pigeon Well
Butterfield Springs
Terrell Mine
Nye Mine
TIMBER MOUNTAIN
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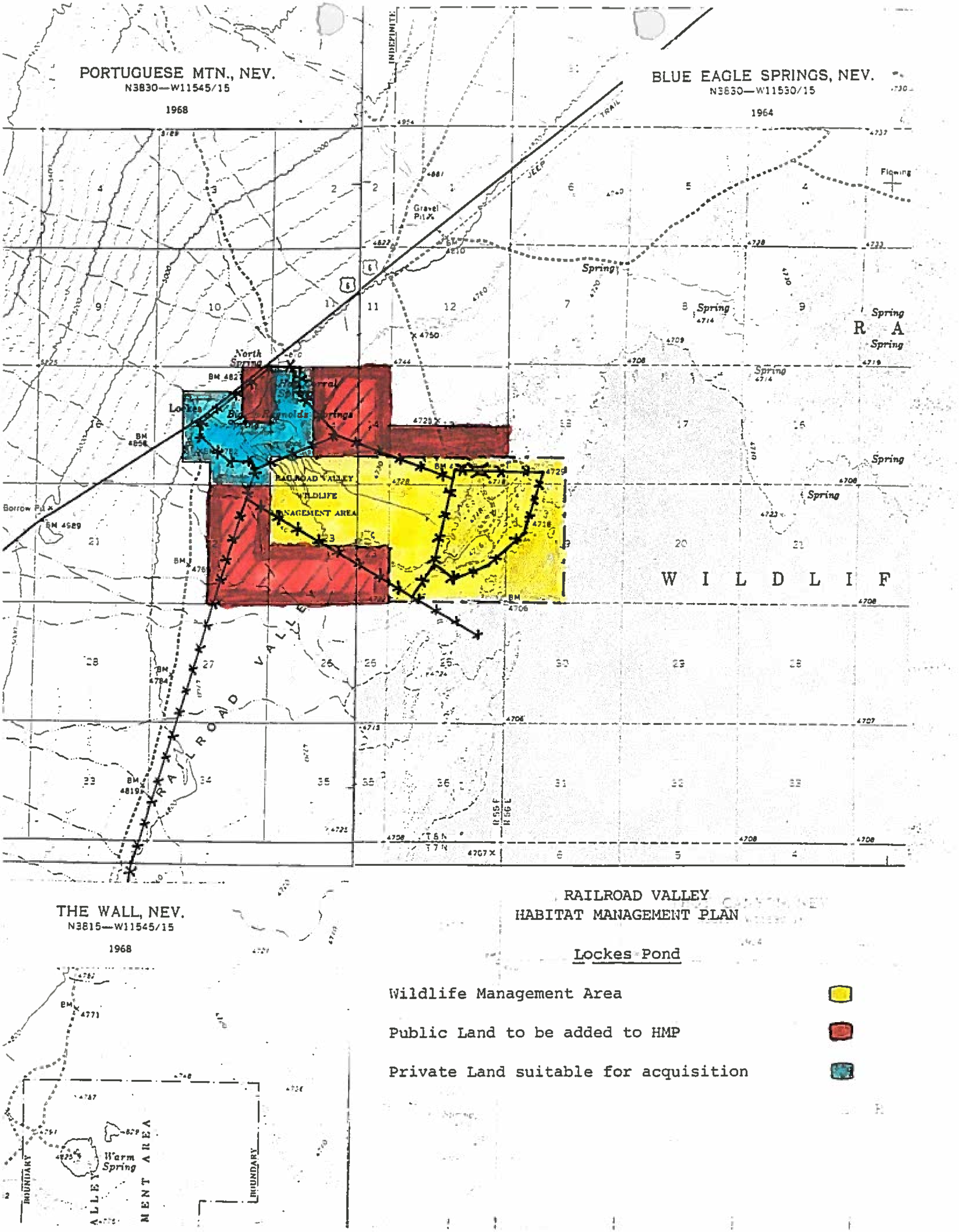


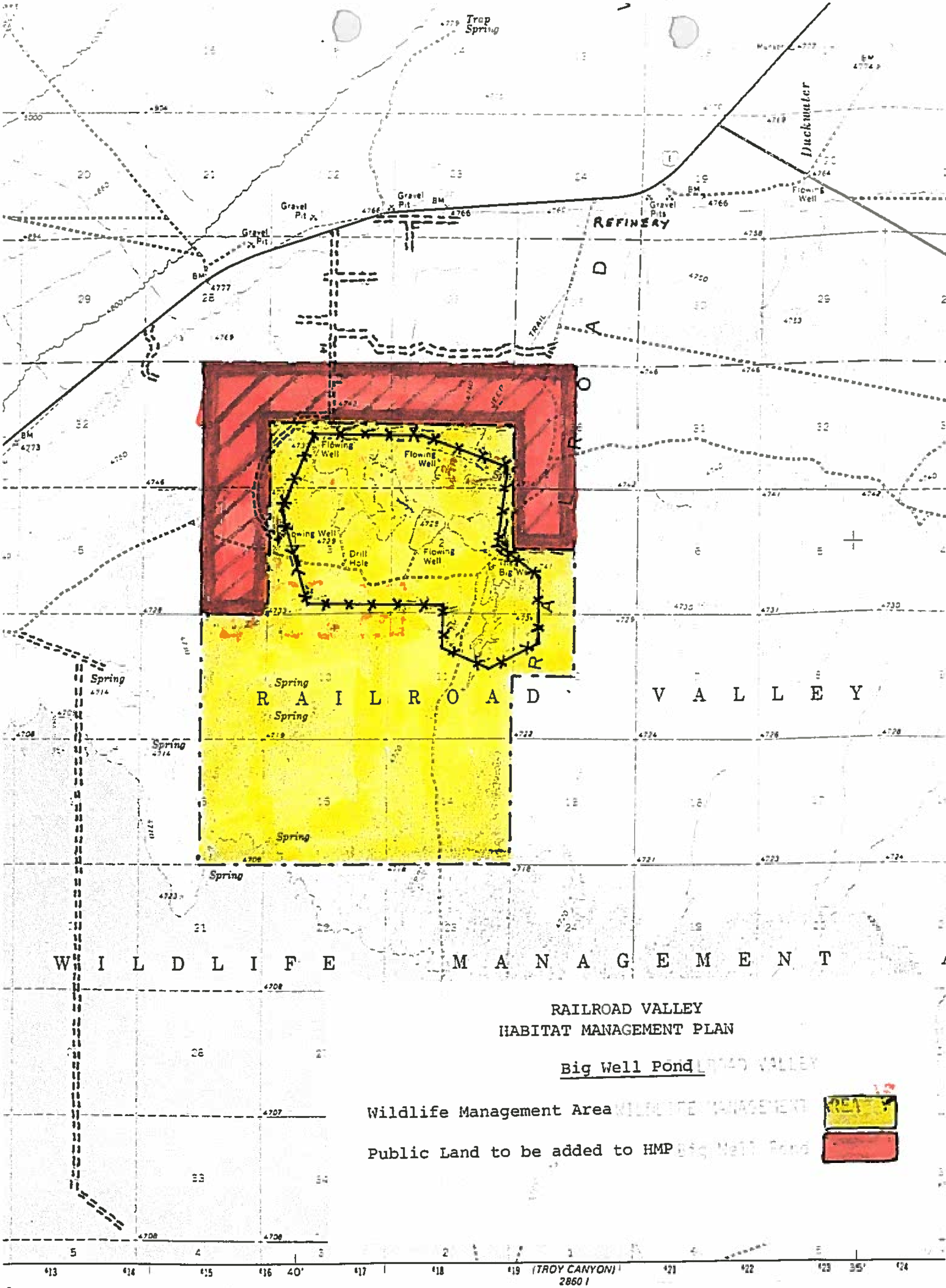
RAILROAD VALLEY
HABITAT MANAGEMENT PLAN

Lockes Pond

Wildlife Management Area

Public Land to be added to HMP

Private Land suitable for acquisition

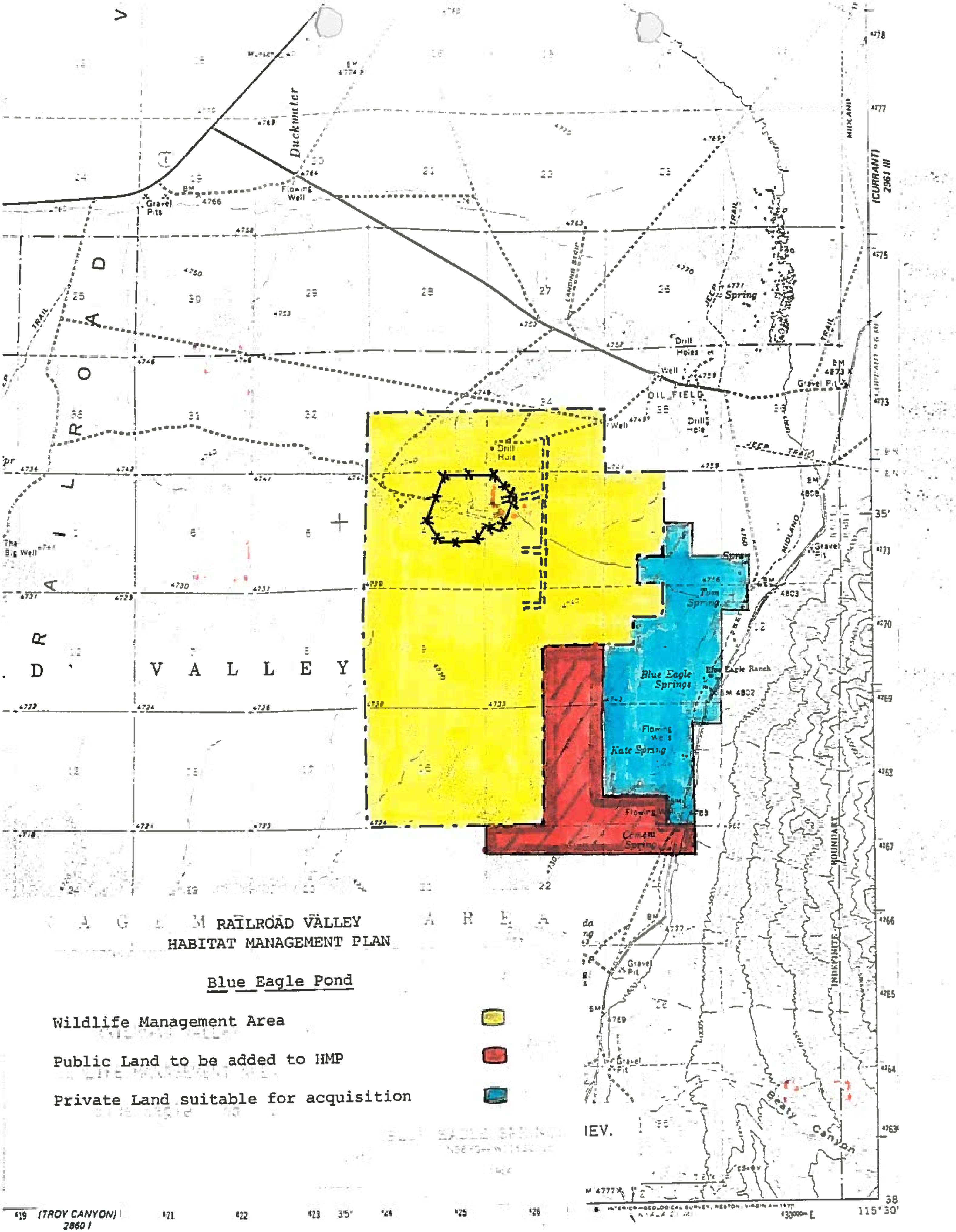


RAILROAD VALLEY
HABITAT MANAGEMENT PLAN

Big Well Pond

Wildlife Management Area

Public Land to be added to HMP



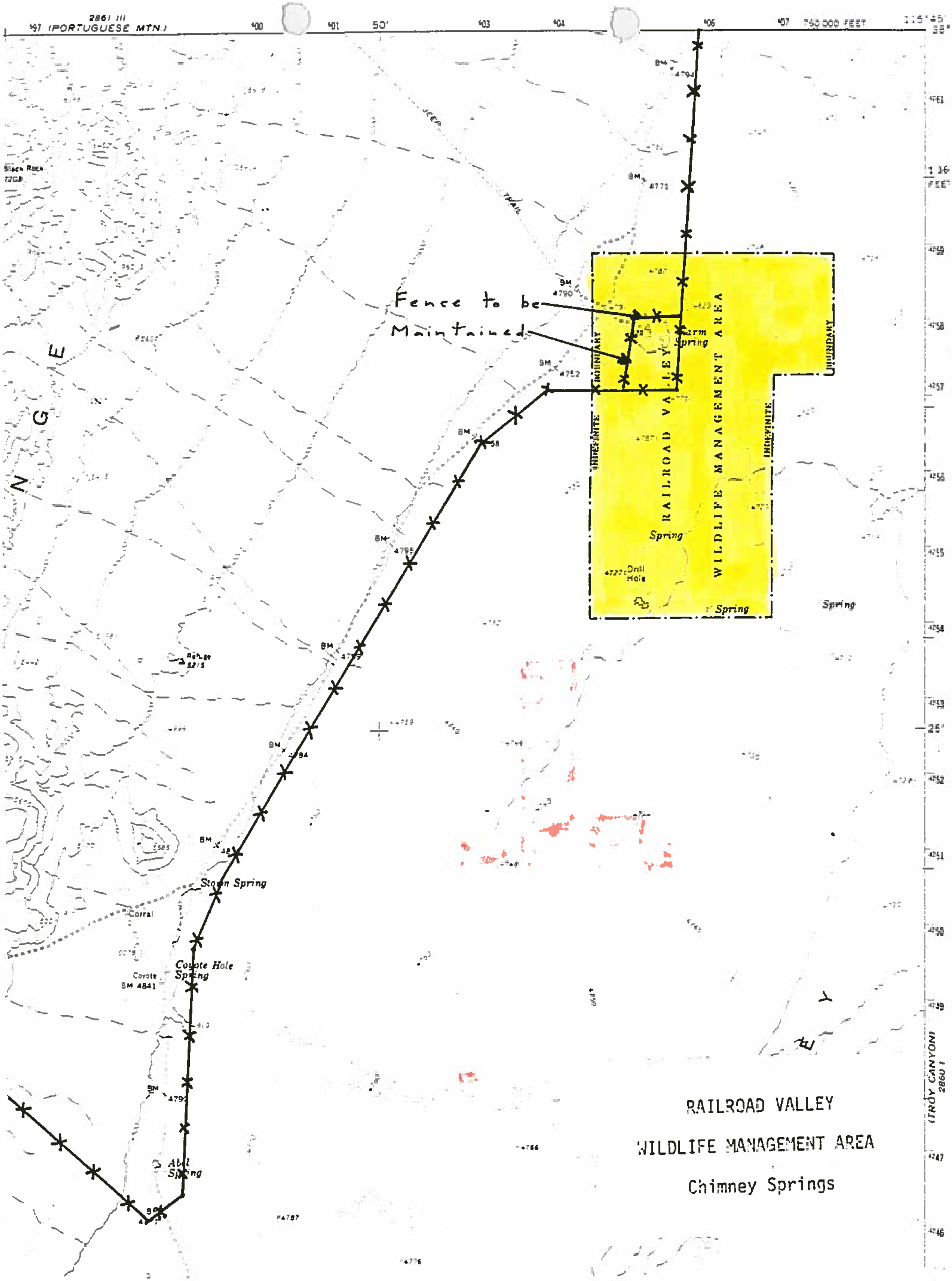
RAILROAD VALLEY
HABITAT MANAGEMENT PLAN

Blue Eagle Pond

Wildlife Management Area

Public Land to be added to HMP

Private Land suitable for acquisition



RAILROAD VALLEY

WILDLIFE MANAGEMENT AREA

Chimney Springs

By Executive Order 6697 of May 2, 1934, 133,396 acres were set aside as the Railroad Valley Migratory Bird Refuge with the Fish and Wildlife Service administering the area until 1950. During that time, the Fish and Wildlife Service drilled several artesian wells in attempts to fill up the dry lake bed. These wells failed to accomplish their objectives, however, additional aquatic habitat was created by ponds in natural depressions from the wells. The Fish and Wildlife Service also did some pond development work by constructing dikes.

On October 24, 1950, an agreement transferred the control of the lands from the Fish and Wildlife Service to the Nevada Department of Fish and Game Commission. NDF & G constructed additional dikes and spillways as well as improved some of the roads into the area. The Department also constructed fences around some of the ponds to protect the vegetation from grazing. Aquatic vegetation was planted in some of the ponds and wildlife population data was gathered during most of this period. The Nevada Department of Fish and Game Commission also acquired water rights to most of the waters on the area. Water quantity and quality data and water rights information and maps are in Appendix 3.

A Public Land Order of 1968 reduced the size of the area to 14,720 acres. (See MTP plats, pages 34-37.) The Public Land Order resulted in four separate areas which included most of the waterfowl habitat in the Railroad Valley. (See map, page 4.) The Order of 1968 also stated that a cooperative agreement covering management of the area would be executed between the Nevada Department of Fish and Game and the Bureau of Land Management. The Director of the Department of Fish and Game and the Nevada Bureau of Land Management State Director met and decided that the cooperative agreement would be in the form of a cooperative habitat management plan (signed by the Battle Mountain District Manager and the Nevada Department of Fish and Game). A cooperative habitat management plan was therefore, prepared in accordance with existing Bureau of Land Management Manual requirements and overall agencies responsibilities found in the "Master Memorandum of Understanding between Nevada Bureau of Land Management and the Nevada Department of Fish and Game" dated December 30, 1972. Cooperative agreements, withdrawals, and memorandums of understanding are in Appendix 1.

The boundaries of the four areas are fenced since livestock is grazed on all sides of the Wildlife Management Area. North Spring and both Reynolds Springs, habitat for the Railroad Valley Springfish, are also fenced. These springs are just outside the boundaries of the Wildlife Management Area, but are part of the HMP. Two nearby springs on private land, Hay Corral and Big Springs, and parts of all the spring drainages are useful as controls since they are not fenced from the livestock .

Railroad Valley also produces most of Nevada's oil. The Eagle Springs and Trap Springs fields are both within a mile of the Wildlife Management Area. Oil production started near the Wildlife Management Area in March 1954. A total of 27,197,815 barrels of oil had been produced in Railroad Valley by February 1990. This is 92.76% of Nevada's total. (State of Nevada, Department of Minerals) While there is always the danger of an oil-related accident damaging the Wildlife Management Area or its occupants, the oil company roads are useful for access in this wet area and the oil company wells can provide good quality water for the ponds in the Wildlife Management Area.

Recreational use of the Wildlife Management Area is primarily by Nye and White Pine County residents for hunting and fishing. Poor road maintenance tends to deter recreational usage.

A great concern is the distance of the area from the Tonopah BLM office as well as the distance from the NDOW headquarters in Las Vegas. These distances have made a regular maintenance schedule within the area very difficult.

More than 100 bird species utilize the Railroad Valley Wildlife Management Area regularly. Particular emphasis is on such waterfowl species as whistling swans, geese, puddle ducks, and diving ducks. Of the 19 waterfowl species using the area, about 14 also nest within the WMA. Annual harvests consist primarily of mallard, pintail, greenwing teal, and canvasbacks, although Canadian geese, widgeon, and gadwalls are also common during the hunting season.

Shorebirds such as killdeer, sandpipers, avocets, black-necked stilts, and phalaropes are present at various times of the year. Grebes, herons, egrets, white-faced ibis, rails, gulls, and terns can also be seen in the WMA.

The area also supports an interesting population of perching birds including swallows, flycatchers, and sparrows. Occasionally such raptors as golden eagles, marsh hawks, and kestrels can also be seen in the WMA.

Railroad Valley HMP Area formerly supported six fish species. Only one has been noted in recent years, although the others may be present in low numbers.

The threatened Railroad Valley springfish (Crenichthys nevadae) is found in good numbers in Big Spring, North and South Reynolds Springs, North Spring and Hay Corral Spring (see map, page 5). An introduced population is present in Chimney Springs (see map, page 8).

The endangered White River Spinedace (~~Crenichthys~~ baileyi: baileyi) was introduced into the Big Well pond ditches. It may still be there, however, no sign of it has been noted in recent years.

The Tui Chub, formerly threatened, inhabits Blue Eagle and Kate Springs just east of the WMA (see map, page 7). It has been suspected of being in Big Well Pond. Large fish bones have been noted on Big Well Pond fence posts, where raptors have eaten them. It is also possible they could be Sacramento Perch (Archoplites interruptus) or Bluegill (Lepomis macrochirus), which were planted there. Largemouth bass (Micropterus salmoides), formerly found in Lockes Pond, are no longer there since the pond dried up in summer, 1989.

II. Land Use Plan Decisions

The Third Edition of the Railroad Valley HMP was authorized by the Tonopah Management Framework Plan, dated 7/16/81. The MFP is a land use plan that provides overall guidance and direction in public land resource management. The MFP is available for review at the Tonopah Resource Area Office. The MFP is currently being revised to a resource management plan (RMP), due to be completed in mid-1993.

Listed below are portions of MFP decision which affect this HMP.

Livestock Forage:

Blue Eagle Allotment	Grazing will be managed within the Blue Eagle Allotment Allotment with the following land uses to be considered in the development of an Allotment Management Plan: oil and gas development; riparian/wetland management (Blue Eagle Pond area).
	Close to livestock grazing approximately 49 acres of riparian habitat in the Blue Eagle Pond area. Livestock use may be allowed in a prescribed manner by temporary, non-renewable grazing license as specified by wildlife management objectives identified within the Railroad Valley Habitat Management Plan.
Butterfield Allotment	Grazing will be managed within the Butterfield Allotment with the following land uses to be considered; oil and gas production, riparian/wetland habitat management (Big Well and Lockes Pond).
	Close to livestock grazing approximately 402 acres of riparian habitat in the Big Well and Lockes Pond areas. Livestock use may be allowed in a prescribed manner by a temporary, non-renewable grazing license as identified by specific wildlife management objectives identified within the Railroad Valley Habitat Management Plan.
Crater Black Allotment	Grazing will be managed within the Crater Black Rock Allotment with the following land uses to be considered; oil and gas development, and riparian habitat management. (120 acres at Chimney Spring.)
	Close to livestock grazing the fenced area around Chimney Spring (120) acres. Livestock use may be allowed in a prescribed manner by a temporary, non-renewable grazing license as identified by specific wildlife management objectives identified within the Railroad Valley Habitat Management Plan.

Wildlife:

Manage wildlife habitat for: (1) protection of sensitive wildlife species; (2) introduction or re-introduction of wildlife species; (3) maintenance and restoration of critical wildlife habitat; (4) protection of habitat areas from off road vehicle (ORV) use and other surface disturbance; (5) insure sustained yield of wildlife habitat; and, (6) prevention of habitat deterioration.

Wildlife habitat management plans (HMP) will be developed to accomplish the above decision.

Recreation:

Designate the entire Tonopah Resource Area as open to off-road vehicles except for the Railroad Valley Wildlife Management Area (and other areas) where vehicles are limited to existing roads.

Manage the following areas as shown on the Tonopah Resource Area Visual Resource Management Map according to the visual guidelines for each class:

Class II - The northern part of Railroad Valley with includes the area covered by this HMP.

Class II Objective. The objective of this class is to retain the existing character of the landscape. The level of change to the characteristic landscape should be low. Management activities may be seen, but should not attract the attention of the casual observer. Any changes must repeat the basic elements of form, line, color, and texture found in the predominant natural features of the characteristic landscape.

III. Information to Support Actions

1. Railroad Valley Springfish

The Railroad Valley Springfish is found in Big Spring (private), North and South Reynolds Springs (BLM), North Spring (BLM), Hay Corral Spring (private), and Chimney Spring (BLM) (introduced). The Chimney Spring population is doing poorly. All others are doing well.

While all the springs are affected by livestock trampling and grazing, North and South Reynolds Springs are by far the worst. Hay Corral Spring has the best riparian vegetation and seems to have the best population of springfish. By building exclosures around North and South Reynolds Springs and North Spring, plus replacing the gate at Chimney Spring, the riparian vegetation has greatly increased. The springfish population seems stable, however, now they use the shelter from the vegetation during hot periods.

Considering the heavy use of these areas during bird migrations, predation is doubtless an imported factor. The cover provided by riparian vegetation will doubtless help here.

2. Waterfowl

Railroad Valley is not reaching its full potential as a waterfowl production area. A few grebes and coots are produced here, both nest in heavy reed growth where they are inaccessible to mammalian predation. Very few ducks or geese are produced because of predation.

No use was seen of the goose nesting platforms or the islands of tires for the ducks. The platforms are in poor maintenance, many not being level. Proper maintenance plus placing tires with some straw on the inside, may entice some birds to nest. Most are in relatively deep water.

Once the tire islands are dry enough to permit nesting, coyotes can easily wade to them and prey on the eggs.

Generally, the areas surrounded by good riparian growth are receiving by far the heaviest waterfowl use. Areas of little riparian vegetation receive light use.

Encouraging riparian vegetation seems dependent upon water quality. Usually, riparian vegetation is lush around artesian springs and flowing wells. Runoff water areas have little or no riparian vegetation. Alkalinity varies from 140 to 300 mg/L on the wells. Runoff is over 1000 mg/L.

This suggests piping ground water to areas in need of riparian vegetation. Once water rights problems have been resolved, use can be made of the good quality water wells available from the oil and gas producers. Also, the flowing well at Big Well Pond has established a small area of riparian vegetation, after which the water flows into a flat and evaporates. Dredging an area immediately downstream from the riparian zone will permit better use of both water and vegetation.

3. Warm Water Fish

Largemouth bass and Bluegill once existed in Lockes Pond. Until the water control devices are replace and Lockes Meadow ditch maintained, the water in Lockes Pond cannot be maintained. Once these area done, a healthy growing population could easily be established again.

Bluegill and Sacramento Perch once existed in Big Well Pond. They still may be present in low levels. Fish skeletons have been found on the wooden fence posts, where raptors were eating them. No other signs of fish have been noted. Populations is obviously very low with little or no reproduction.

All these fish are victims of fluctuating water levels and the lack of spawning gravel. Both are necessary for a stable population.

4. Marsh and Wading Birds

Populations of several species of heron have been good. These are mainly adults, but since they are colonial, tree-nesting birds, they would be expected to nest elsewhere and feed in Railroad Valley.

Adult Avocets, White-faced Ibis, Solitary Sandpipers, Killdeer, and Dowitchers are regularly seen on the Wildlife Management Area. Probably they nest elsewhere. Young killdeer have been seen on the road just west of Lockes Pond, presumably they nested on the nearby flats. Eliminating the fluctuating water levels are bound to improve nesting conditions and success.

5. Predators

Railroad Valley Wildlife Management Area has a good population of predators. Coyotes are the commonest mammalian predator, but signs of foxes and badgers have been noted as well. Evidence of their preying on the waterfowl (eggshells in scat, piles of feathers) are not at all uncommon. A large number of the nests attempted by the waterfowl are lost to these animals.

The goose nesting platforms at Lockes Pond offer a predator-safe resting place and others rest on open water, however, those at other ponds have no safe resting places. A predator control program should be considered in the future when and if management is improved.

Buteos and harriers are the commonest raptors seen. Probably they prey upon the waterfowl to a minor degree. All the local species of raptors are known to nest in the hills nearby, but apparently the falcons and accipiters do not often leave the hills to hunt the Wildlife Management Area.

6. Threatened, Endangered and Sensitive Species

The bald eagle and the peregrine falcon could reasonably be expected in the Wildlife Management Area preying on migrating and wintering waterfowl. Only the bald eagle has been seen in the past and then only rarely.

The Railroad Valley Springfish has been previously discussed. Another fish, the Tui Chub, was formerly given threatened status, but later this status was dropped. It has been noted in Blue Eagle Springs on the east side of the valley.

No T&E or sensitive plants have been sighted in or near the Wildlife Management Area, however, the following plants have been sighted west of U.S. Highway 6, not far from Lockes and the springfish habitat. The habitat in the HMP area is not suitable for them.

a. Eastwood milkweed (Asclepias eastwoodiana), a dwarf milkweed of shallow gravelly drainage and sometimes low alkaline clay hills.

b. Currant milk-vetch (Astragalus unicialis), a dimunitive plant of dry knolls and slopes, saline sand or gravel derived from limestone.

c. Tufted globe-mallow (Sphaeralcea caespitosa), a dwarf plant of graveley limestone soil, sometimes on sandy soil.

7. Hardwood Trees

Attempts to plant hardwood trees have been made in various locations throughout the Wildlife Management Area. Bladdersenna (Colutea arborescens), American plum (Prunus americana), Green ash (Fraxinus lanecolata), Siberian elm (Ulmus pumila), and Italian hybrid poplar (Populus hybrid) plantations were unsuccessful. A few Russian olives (Elaeagnus augustifolia) survived at Lockes Pond. Russian olive and Honey locust (Gleditsia triacanthos) are present and apparently reproducing themselves in fairly well drained soil east of North Spring. Both cottonwood (Populus fremontii) and willow (Saliz sp) are present and thriving at Lockes Ranch.

Since hardwood trees would obviously be valuable as a place for roosting and nesting birds and providing shade and beauty for recreational users, attempts should be continued to find a species that will survive in and around the Wildlife Management Area. One possibility that should be considered would be planting cottonwoods on the sand dune areas near the ponds. Supplemental watering may be necessary the first year, but once the tree reached the basin floor with its root system, cottonwoods do well in these situations. Cottonwoods are often found in the sand dunes in New Mexico. The trees are usually somewhat stunted, but respond well to fertilization Planting cottonwoods would be contingent upon someone being available to water them occasionally the first summer. Salinity would render planting success in most other situations doubtful, except for salt cedar (Tamarix sp.) which is naturally spreading in some of the wetter areas.

8. Maintenance Difficulties

Railroad Valley Wildlife Management Area has proven to be a difficult area to work and maintain. The U.S. Fish and Wildlife Service, operating from headquarters about 145 miles away, gave up on the area. The Nevada Department of Wildlife, operating from a headquarters even further away in Las Vegas, is experiencing similar difficulties. BLM, only 110 miles away, still has difficulty achieving its plans for the area with the travel time involved. The use of volunteers is also made difficult by the distances involved and the fact that Las Vegas is the most likely source of volunteers.

For optimum use of this area, consideration should be given to a local (Lockes or Current) staff person. He will need at the very least, a four-wheel drive pick-up. He should be familiar with constructing and power equipment. An arrangement of this nature has worked successfully in the past.

IV. Management Objectives

A. Protect the Railroad Valley Springfish and its habitat.

Rationale

The Railroad Springfish is considered a threatened species by the U.S. Fish and Wildlife Service. North Spring, Hay Corral Spring, Big Spring, and North and South Reynolds Springs are considered critical habitat for this species. There is another population at Chimney Springs, however, it was transplanted by man. The naturally occurring populations at North Spring and North and South Reynolds Springs are the only populations known to exist on Federal land.

Two ponds in the western Hot Creek Valley also have an established population of the springfish on private land inside the Toiyabe National Forest. It is approximately 28 miles west of Railroad Valley. A pond inside the Duckwater Indian Reservation is also reported to contain this species, however, it has not been possible to confirm this.

B. Maintain the necessary habitat needed to provide a migration stopover between the wildlife refuges of the Pahranagat Valley and Ruby Marshes.

Rationale

Railroad Valley WMA is approximately halfway between these major waterfowl areas. Railroad Valley is heavily used by migrating waterfowl. Counts of over 10,000 ducks and geese have been made here during migration.

Lockes Pond can be reached with 2 wheel drive about 2 months out of the year. A 4 wheel drive can reach it 4 or 5 months. The road into Big Well Pond is passible in part in all but the wettest weather by most pick-up trucks. Since the road is not graveled there is always an element of risk of becoming stuck. The short road into Blue Eagle Pond is only drivable 2 or 3 months of the year. The road to Chimney Springs is drivable yearlong. Overall, the very poor condition of the road system has contributed heavily to the lack of maintenance of the Wildlife Management Area's facilities.

C. Redevelop the Railroad Valley Wildlife Management Area into a waterfowl production area.

Rationale

Waterfowl populations are declining all over North America, as nesting habitat continues to be lost to other uses. In addition, Nevada's population is growing rapidly. Many of these people are interested in hunting and would enjoy waterfowl hunting if they were reasonably assured of a reward for their efforts.

D. Provide a warm-water fishery for the inhabitants of western Nye County.

Rationale

There are very few opportunities to fish for warm water species in central Nevada, particularly Largemouth bass. Even though the Railroad Valley Wildlife Management Area is a two hour drive from Tonopah, it is the closest bass fishery on public lands. Many residents would welcome the opportunity to fish for warm water species were an opportunity really available.

V. Planned Actions and Costs

This section provides detailed management prescriptions which are planned to achieve objectives described under Section III of this HMP. The planned actions listed are those necessary to restore the Railroad Valley Wildlife Management Area to its condition approximately 10 years ago. No truly new actions are planned.

General

Use the new USGS 7½ maps to develop two large scale sets of maps showing the location of all facilities. One set is to be kept at the Battle Mountain District Office and the other at the Tonopah Resource Area Office. The maps are to be updated annually. Approximate cost would be $300.00.

A. Protect the Railroad Valley Springfish and its Habitat

1. High Priority

a. Maintain springfish exclosures at Lockes. Estimated cost annually -	$ 100.00
b. Continue photographic study of springfish habitat fenced. Estimated cost annually (initiated 1987) -	$ 100.00.
c. Continue springfish population study. Estimated cost annually (initiated 1987) -	$ 200.00
Annual cost	$ 400.00

2. Medium Priority

a. Clean Chimney Springs ponds and ditches annually to remove algae buildup. -	$ 500.00
b. Maintain the fence surrounding Chimney Springs. Estimated cost annually -	$ 150.00
Annual cost -	$ 650.00

B. Continue to provide a migration stopover between the wildlife refuges of the Pahranagat Valley and Ruby Marshes.

1. High Priority

Rebuild, gravel and maintain road to Lockes Pond No. 1	
(Maintain every 3 years)	$ 1,000.00
(One time rebuilding cost)	$70,000.00
Build, gravel and maintain road to Lockes Pond No. 2	
(Maintain every 3 years)	$ 200.00
(One time rebuilding cost)	$20,000.00

Raise, gravel and maintain road to Big Well Pond Flowing Well	
(Maintain every 3 years)	$ 1,500.00
(One time rebuilding cost)	$ 3,000.00
Road construction and maintenance -	$95,700.00
Burn excessive vegetation (5 ac.) by Big Well	$ 500.00
Replace 2 overflow and water control structures at Big Well Ponds (ten year life) -	$ 8,000.00
Replace 2 existing water control structures at Lockes Pond (ten year life) -	$ 4,400.00
Construct spillway between Lockes No. 1 and Lockes No. 2 Ponds -	$ 1,500.00
Water Control structures -	$14,400.00

2. Medium Priority

Build, gravel and maintain road to Big Well Pond dikes	
(Maintain every 3 years)	$ 500.00
(One time construction cost)	$15,000.00
Total -	$15,500.00
Install 2 overflow spillways at Lockes Meadow (ten year life) -	$ 3,500.00
Maintain dike height by 2 feet in Lockes Meadow area (five year life)	
Annual cost -	$15,000.00
	$18,500.00
Lockes Meadow ditch	

3. Low Priority

Clean and maintain well at Blue Eagle Pond -	$ 5,000.00
Clean and maintain 2 wells at Big Well Pond -	$10,000.00
Clean and maintain well at Chimney Spring -	$ 5,000.00
Well maintenance -	$20,000.00
Gravel and maintain road to Well No. 4	
(Maintain every 3 years)	$ 300.00
(One time graveling cost)	$ 7,000.00
Total	$ 7,300.00
Dredge 5 ac. hole at Well No. 2 Pond. (five year life) -	$ 1,500.00
Dredge 5 ac. hole at North Well Pond (five year life) -	$ 1,500.00
Dredge 5 ac. hole at Well No. 4 Pond (five year life) -	$ 1,500.00
Total dredging -	$ 4,5000.00

C. Develop the Railroad Valley Wildlife Management Area into a waterfowl production area.

1. High Priority

Maintain Blue Eagle Ponds fence (5 year life) -	$ 1,000.00
Maintain Lockes Ponds fence (5 year life) -	$ 2,000.00
Total -	$ 3,000.00

2. Medium Priority

Maintain 2 goose nesting platforms at Big Well Ponds (5 year life) -	$ 150.00
Maintain 12 goose nesting platforms at Lockes Ponds (5 year life) -	$ 900.00
Total -	$ 1,050.00

3. Low Priority

Construct 3 nesting islands at Blue Eagle Ponds (10 year life) -	$ 1,500.00
Construct 22 nesting islands at Big Well Ponds (10 year life) -	$11,000.00
Construct 16 nesting islands at Lockes Ponds (10 year life) -	$ 8,000.00
Develop 5 one-acre ponds in Lockes Meadow (10 year life) -	$10,000.00
Develop 3 nesting islands in Lockes Meadow (10 year life) -	$ 3,000.00
Total -	$33,500.00

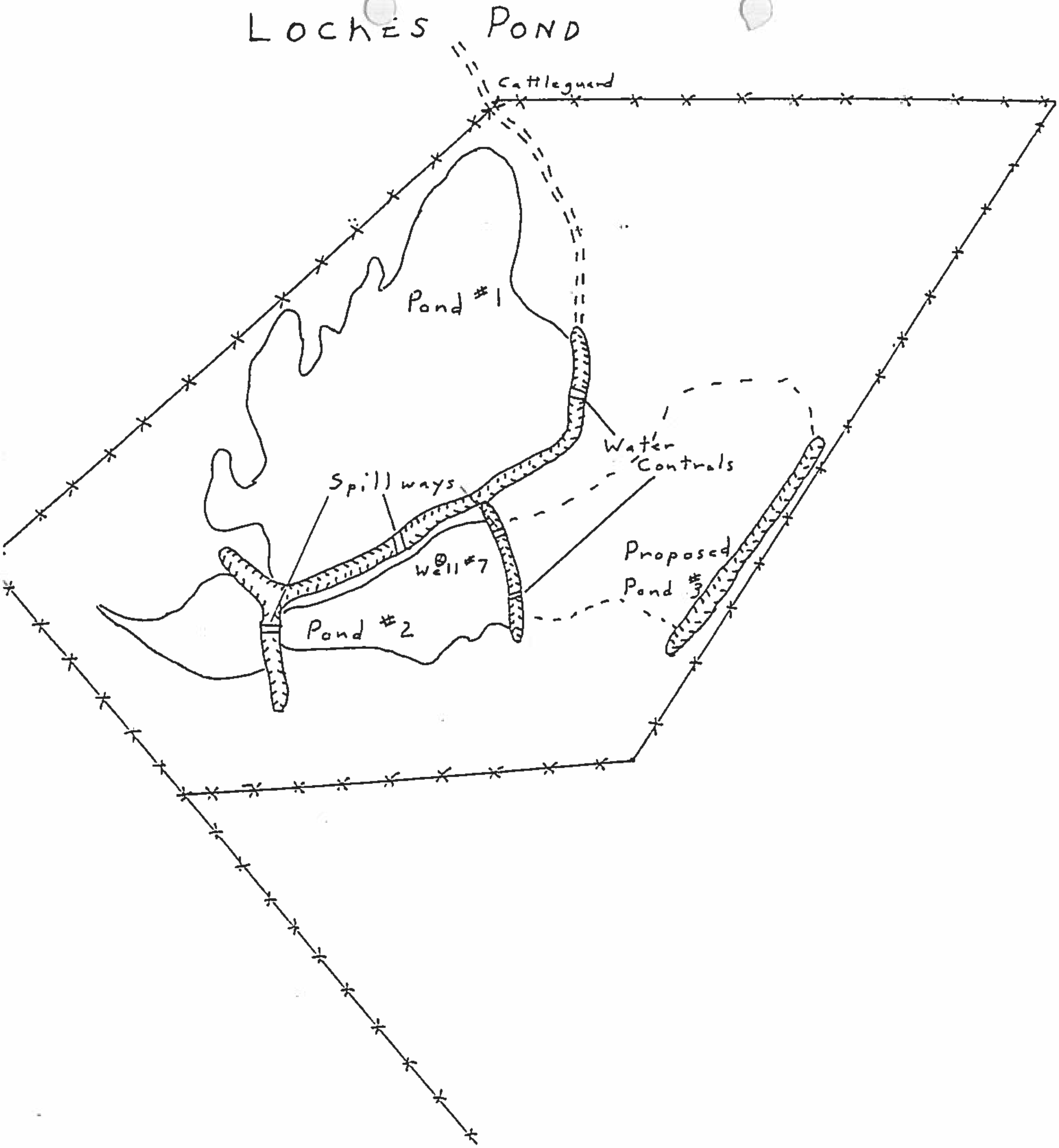
D. Provide a warm-water fishery for the inhabitants of western Nye County

1. High Priority

Construct gravel spawning beds in Lockes Pond No. 2 and Big Well Pond (5 year life) -	$ 5,000.00
Stock largemouth bass and a forage fish (one time cost) -	$ 5,000.00
Total	$10,000.00

E. Totals

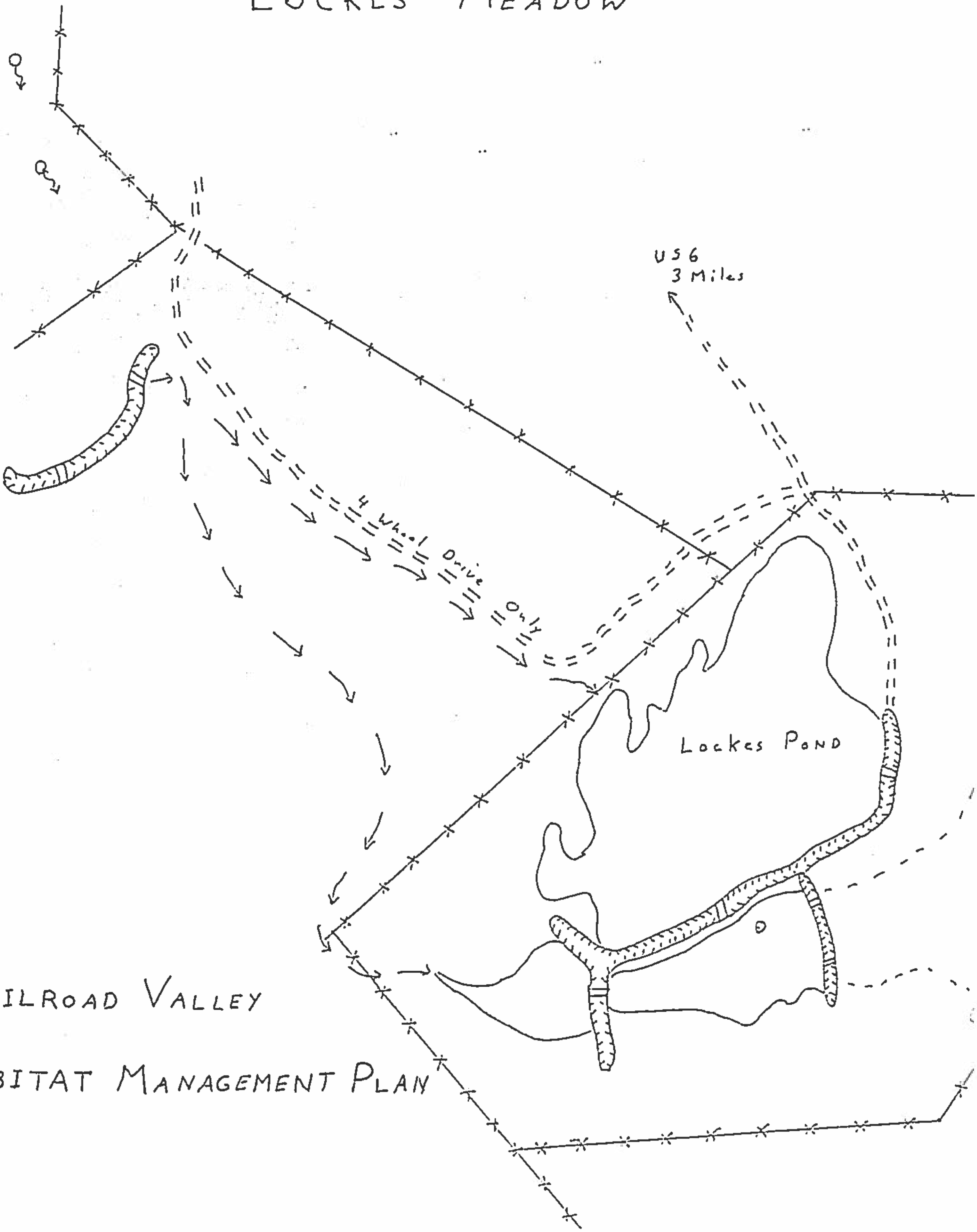
Road construction -	$118,000.00
Bass stocking -	$ 5,000.00
High priority cost -	$123,500.00
Medium priority cost -	$ 20,200.00
Low priority cost -	$ 65,300.00



Railroad Valley

Habitat Management Plan

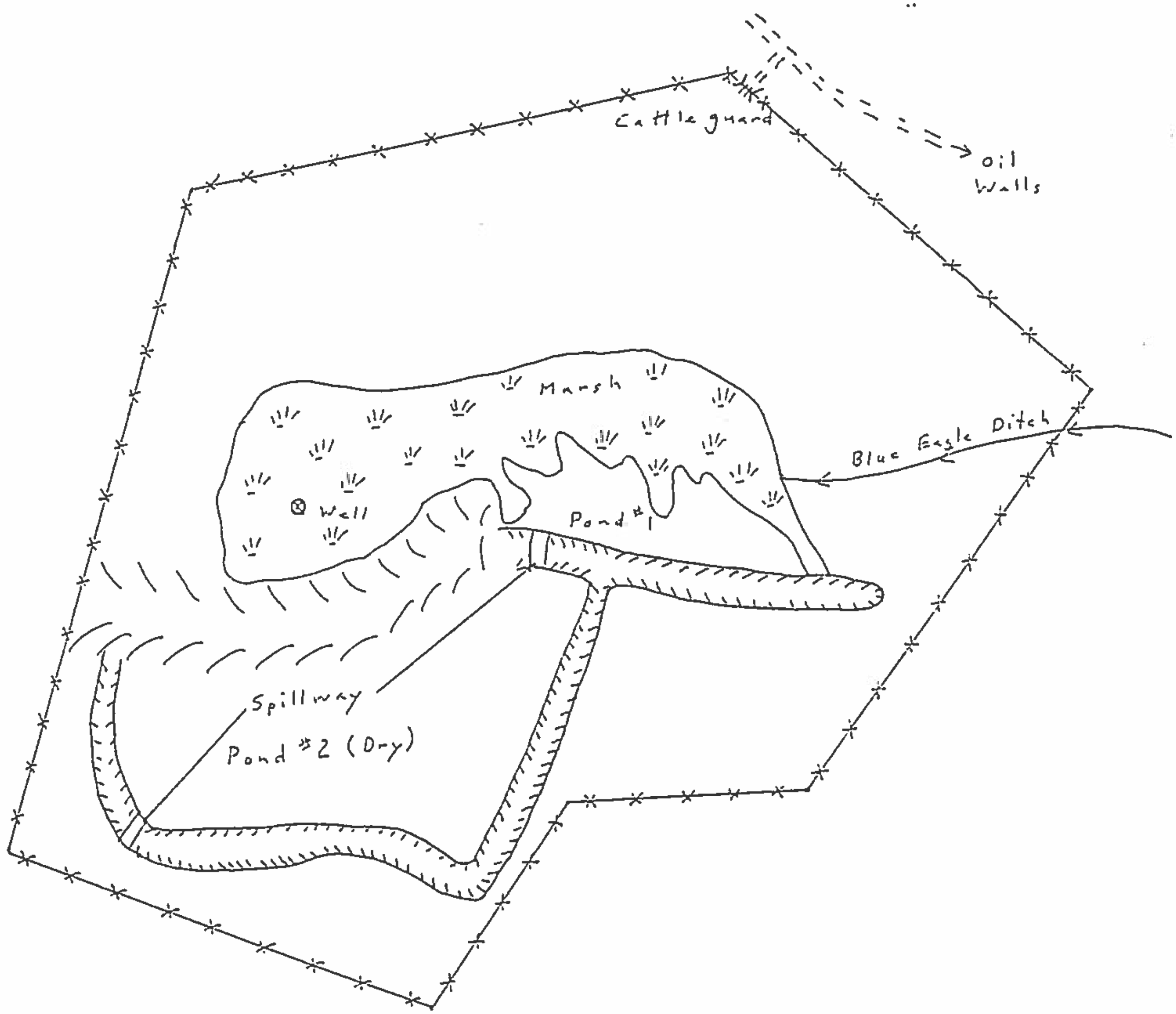
Lockes Meadow



Railroad Valley

Habitat Management Plan

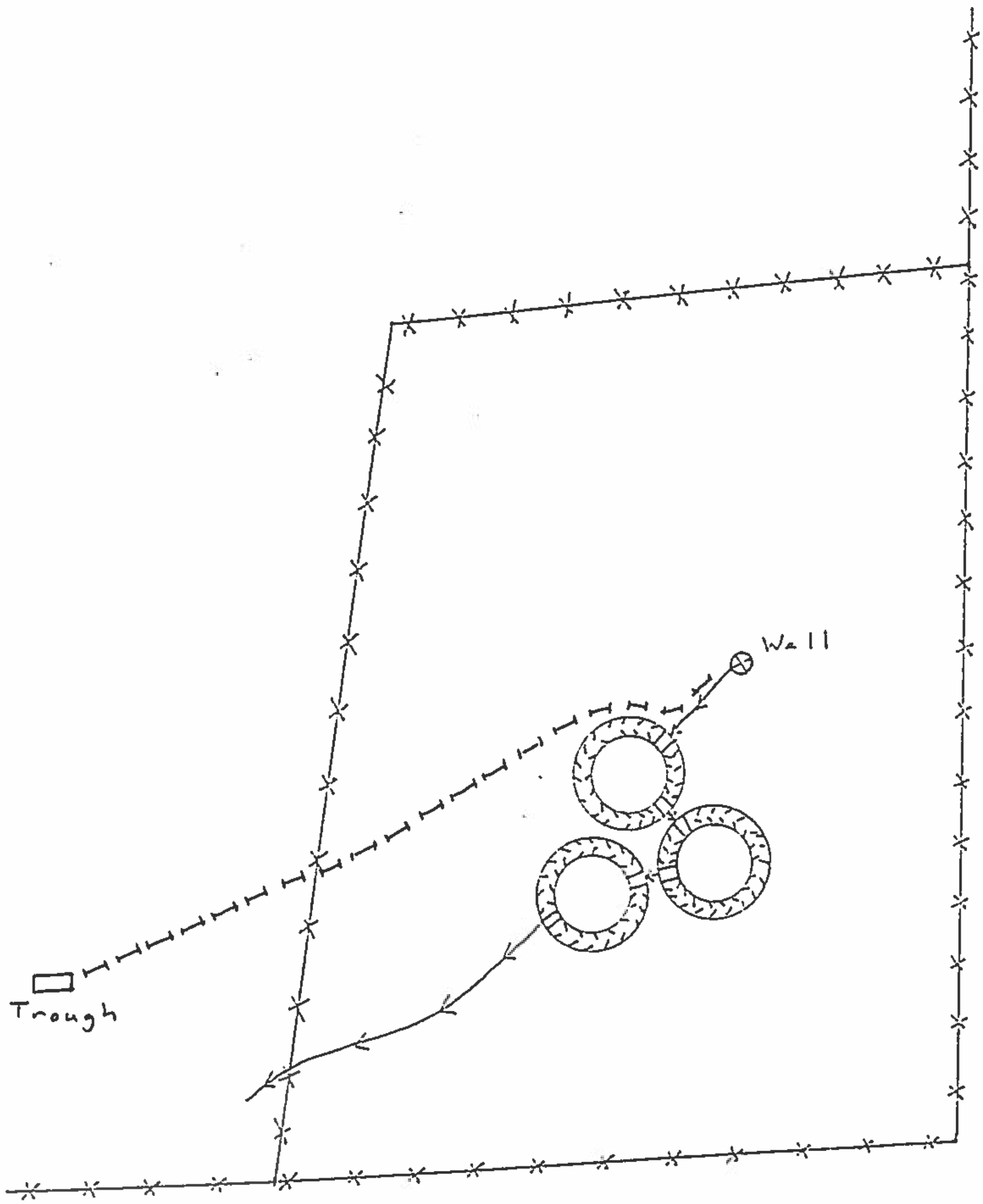
Blue Eagle Pond



Railroad Valley

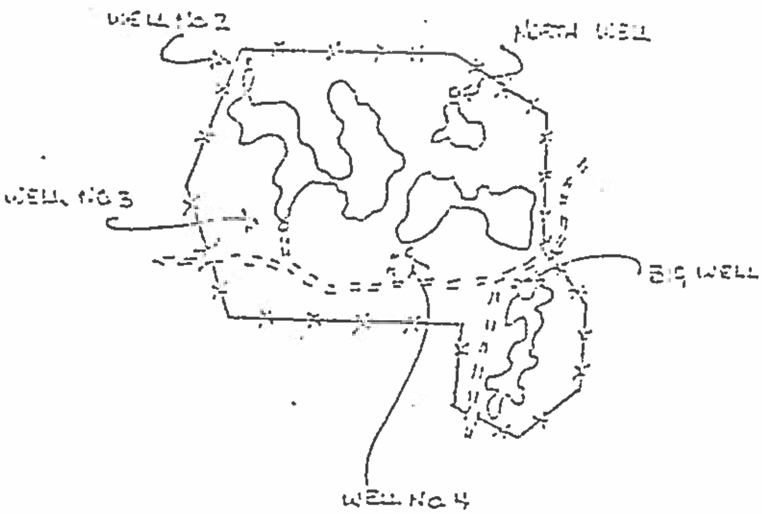
Habitat Management Plan

CHIMNEY SPRINGS



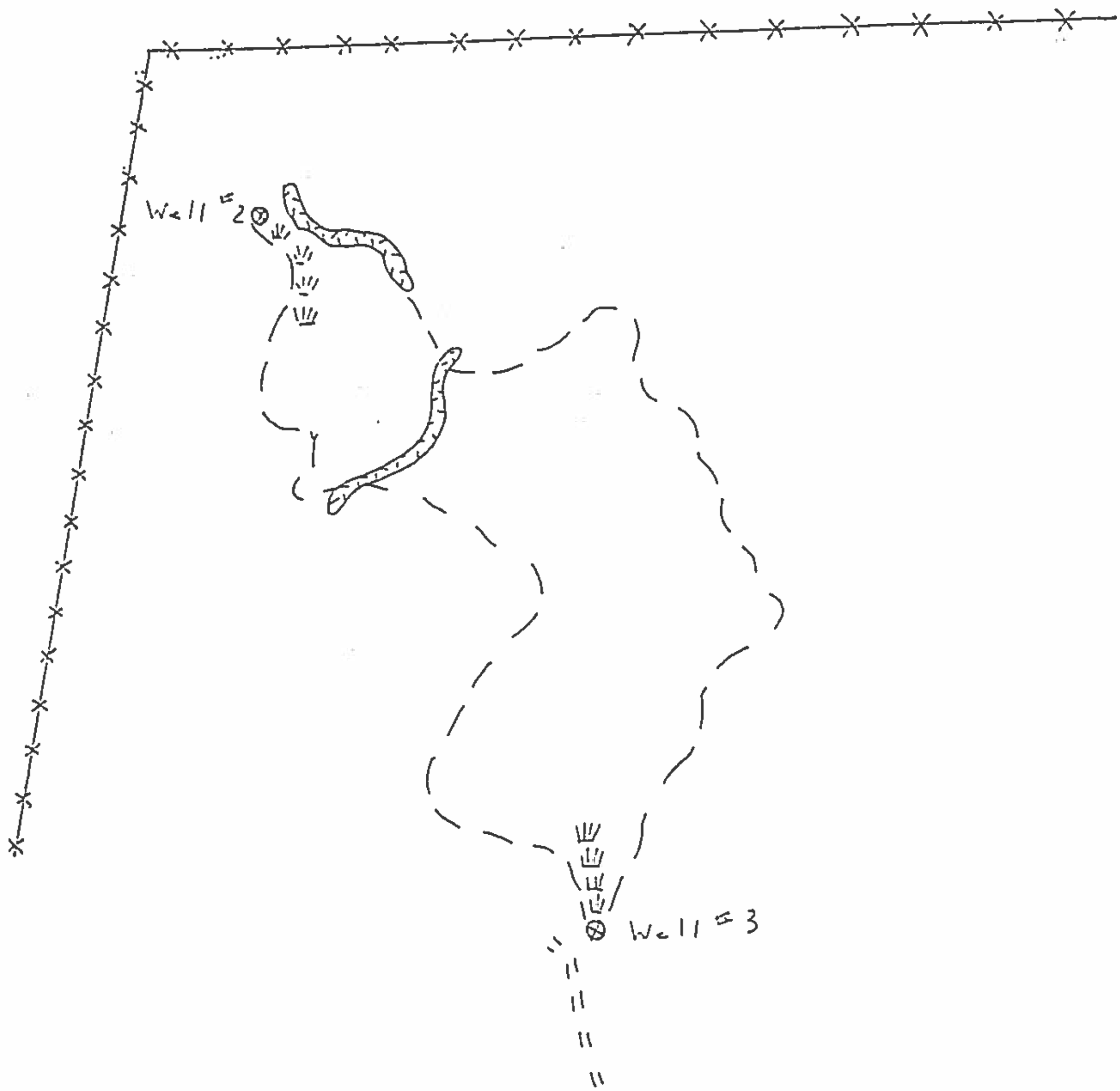
RAILROAD VALLEY
HABITAT MANAGEMENT PLAN

BIG WELL AREA



RAILROAD VALLEY
HABITAT MANAGEMENT PLAN

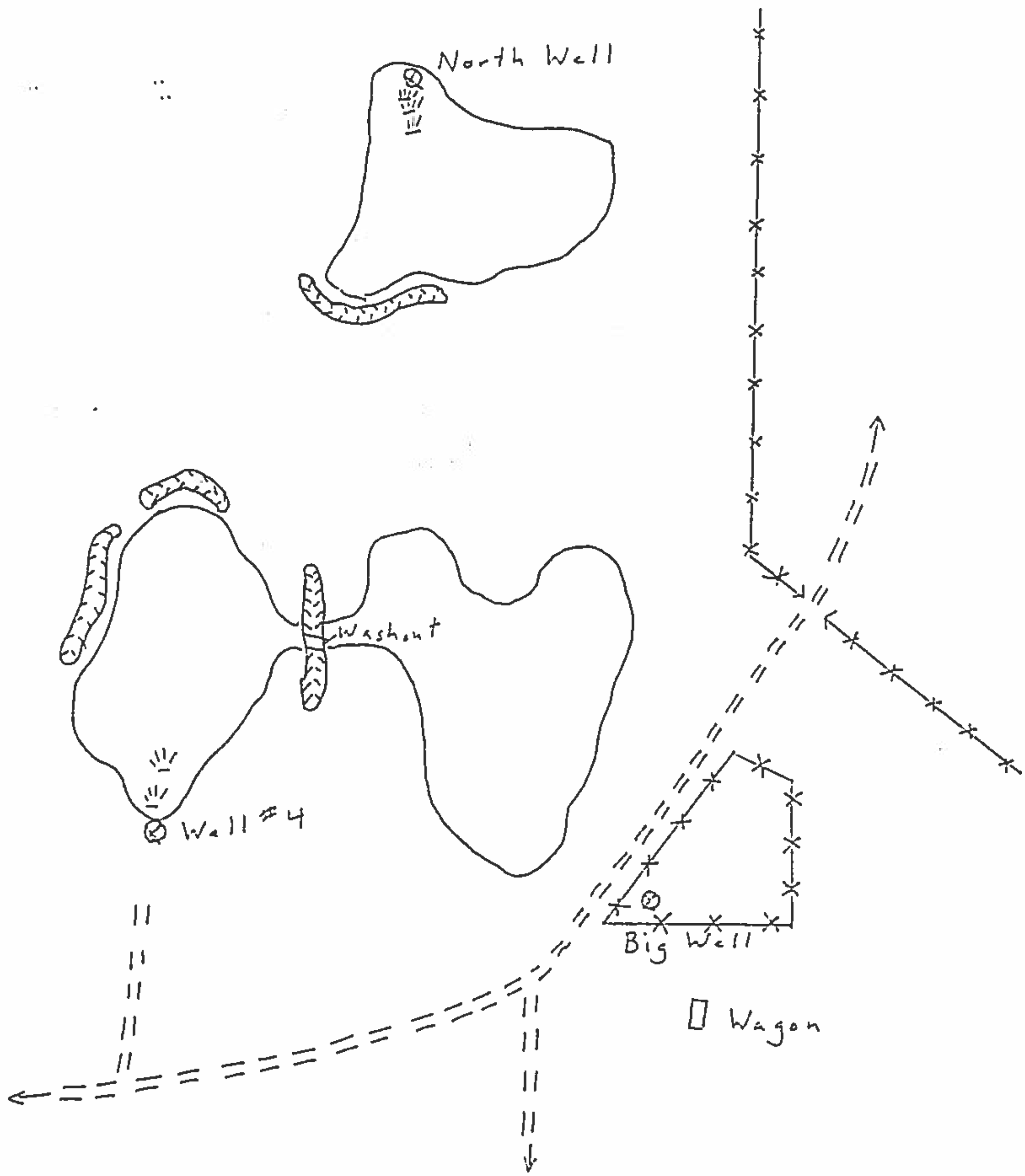
WELL No. 2 & 3 PONDS



RAILROAD VALLEY

HABITAT MANAGEMENT PLAN

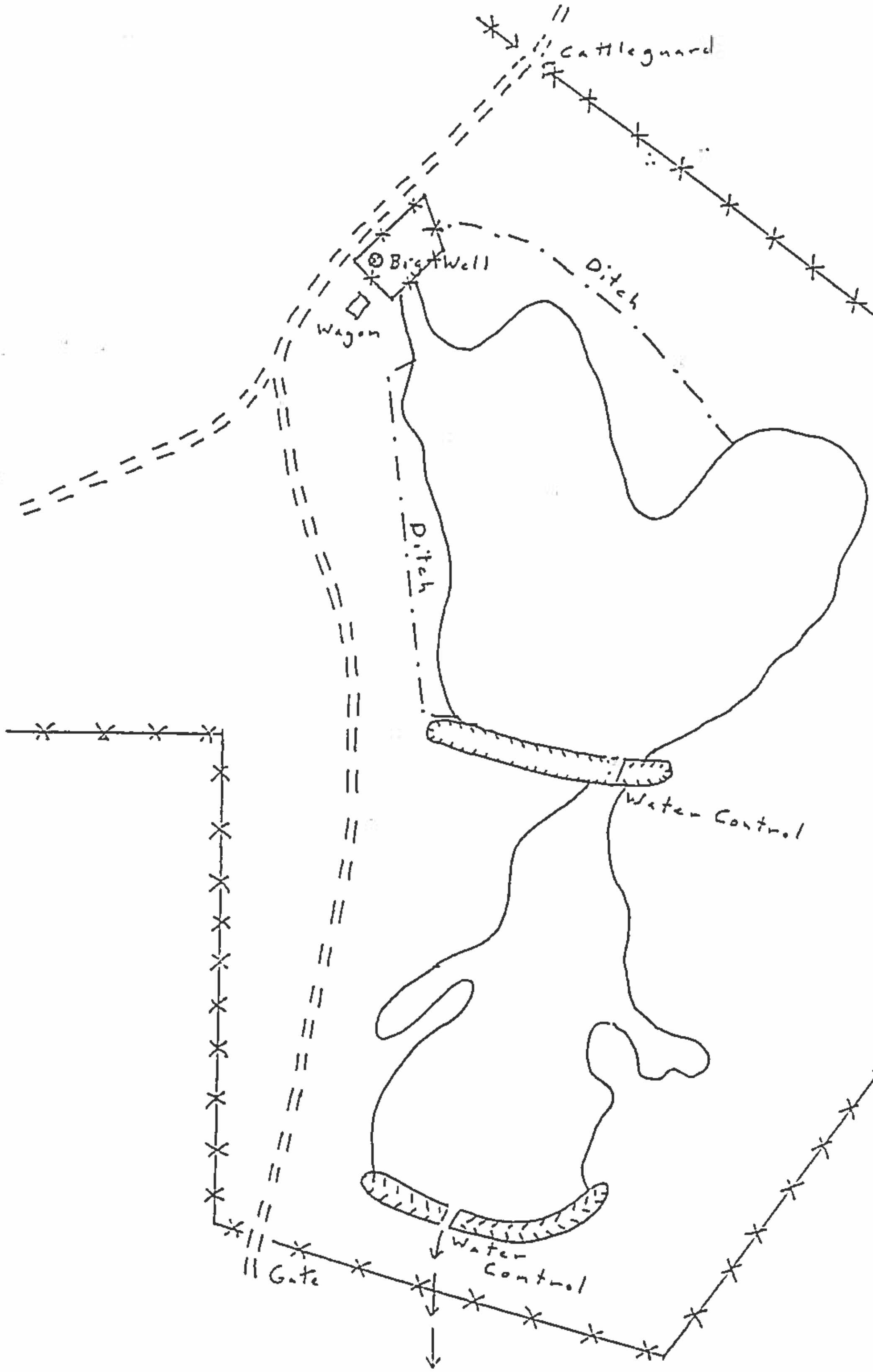
North Well & Well #4



Railroad Valley

Habitat Management Plan

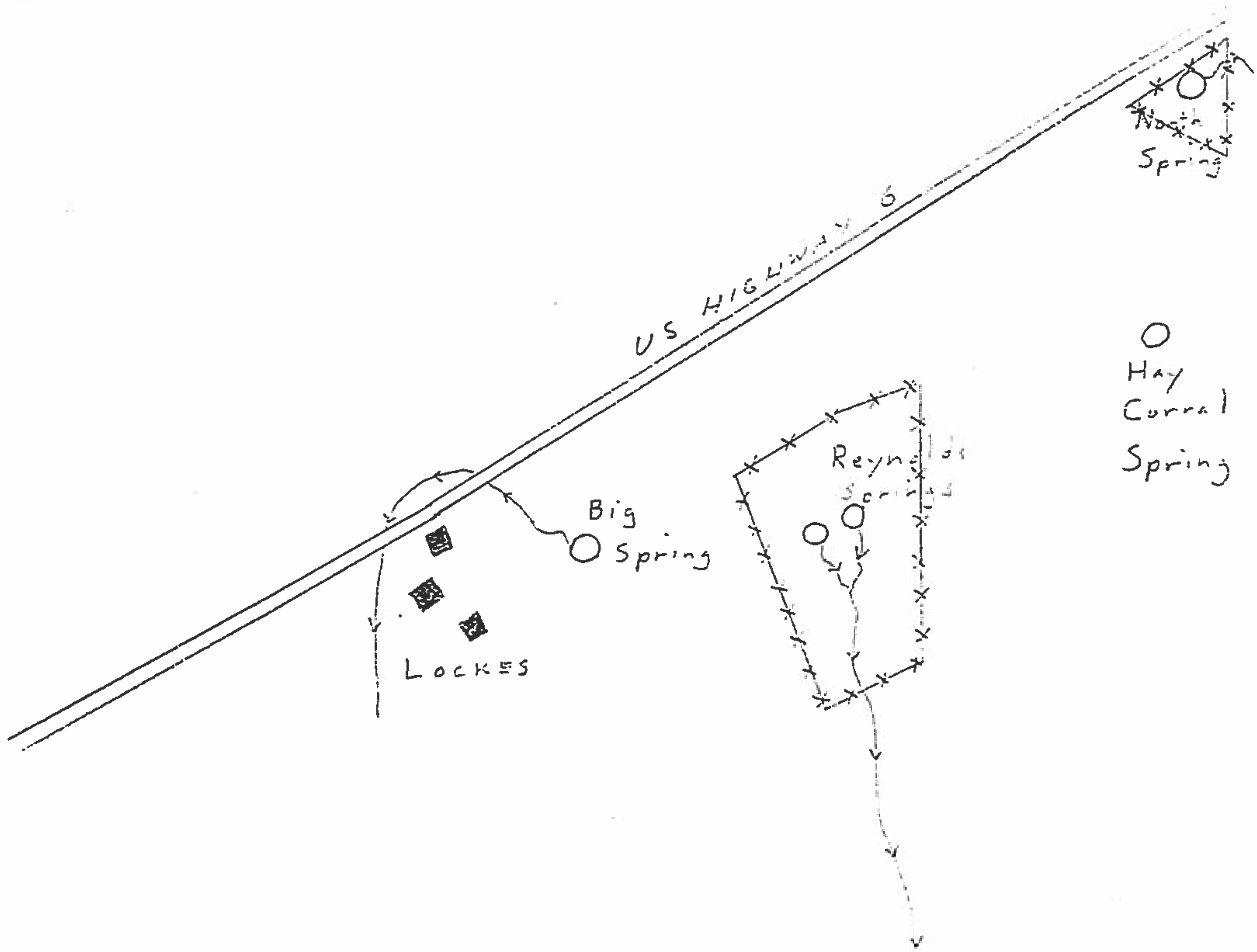
Big Well Pond



Railroad Valley

Habitat Management Plan

SPRINGFISH EXCLOSURES



RAILROAD VALLEY

HABITAT MANAGEMENT PLAN

Periodically, oil field roads within 1 mile of the Wildlife Management Area will be evaluated for possible value to the Wildlife Management Area's operations.

Periodically, oil field water wells within 2 miles of the Wildlife Management Area will be evaluated for possible value to the Wildlife Management Area's operations.

VI. Support Actions

1. Maps

   a) Cartography assistance needed to draft maps.

2. Roads

   a) Engineering needed to draft contract for all road construction.

3. Lands

   a) Do not entertain any surface disturbing actions within 3 miles of the Wildlife Management Area that could cause difficulties in expanding current Wildlife Management Area.

   b) Consider exchange with Lockes Ranch, Inc. for Hay Corral and Big Springs.

   c) Consider exchange with Larry Sharp Estate and Carl Hanks for Tom Spring, Blue Eagle Springs and Kate Springs.

4. Oil and Gas

   a) Stipulations have been developed protecting the Wildlife Management Area and its wildlife from oil and produced water spills, standing oil in pits (emergency, sump, mud, depressions, etc.), salvage or cleanup of standing oil and utilization, for the Wildlife Management Area of oil field roads and oil field water wells (not produced water).

   b) These stipulations are used routinely in all appropriate oil field actions.

   c) These stipulations will be added to the Oil and Gas sections of the ongoing Tonopah Resource Management PLan, due date April 1993.

   d) The current leasing stipulations (surface, no occupancy) are sufficient for leases in the W.M.A. We recommend these stipulations be added to leases in lands to be added to HMP (see maps). No surface occupancy would be full time in meadow situations and part time (nesting season) in others.

5. Range

Should any livestock grazing be permitted in closed areas, it will be contingent upon the livestock operator taking over maintenance of the existing fences and cattleguards.

VII. Coordination with Other Programs, Agencies and Organizations

1. Range Management

The HMP area is within 4 grazing allotments - all grazed by cattle. The Nyala, Butterfield, and Blue Eagle Allotments have stewardship AMP's on them. An AMP is being prepared for the remaining allotment, the Crater Black Rock, in conjunction with the Sand Springs Allotment. While all of the allotments on the HMP area are cattle allotments, the Sand Springs, only a short distance from the warm springs, is a cattle/sheep allotment.

The main conflicts with the Wildlife Management Area are riparian vegetation grazing and trampling around North and South Reynolds Springs and North Spring. Both these problems are being dealt with, more or less successfully, by exclosures.

If it is determined that livestock use would be beneficial to the habitat, a grazing plan will be developed specifying objectives to be met and establishing, among other parameters deemed appropriate, time, length, and amount of grazing to be allowed. Grazing will only be allowed in the closed areas on a temporary non-renewable basis to meet wildlife objectives.

2. Wild Horses and Burros

There are no wild horse or burro herd areas on the HMP area. The Sand Spring HMA is located just north of U.S. Highway 6. The management objectives for the horse population in the Sand Springs HMA is to establish an optimal number of wild horses that will be compatible with the multiple use objectives outlined in the Tonopah Management Framework Plan and in concert with the concept of a thriving ecological balance.

3. Oil and Gas Development

Oil development is fairly heavy in and around the HMP area. If there are no accidents, the presence of oil development is an asset to the Wildlife Management Area. The production roads and water wells are potentially valuable to the Wildlife Management Area. Since oil related mortality can be very high, this is a mixed blessing.

The entire HMP area is leased for oil and gas, and a large portion of it is in actual production. There are surface occupancy stipulations covering the entire wildlife management area, however, surface occupancy has been permitted in areas away from the ponds.

4. Geothermal Development

Geothermal leases are scattered through the area. North and South Reynolds Springs and North Spring are included in leases. Other areas include areas just north of Chimney Springs and southwest of Blue Eagle Springs areas. No geothermal development has occurred.

5. Other Mineral Development

Very little other mineral development has occurred near the HMP area other than mineral materials sites along U.S. Highway 6.

7. Recreation Management

Railroad Valley recreational use is largely hunting in the wildlife management area. Some incidental sightseeing and photography would be expected to occur.

Off-road vehicle use would be expected to be minimal. Railroad Valley is an old playa and the potential for getting stuck in the mud is very high, especially in the winter. During dry spells when the playa surface is hard, no challenge exists to attract ORV enthusiasts. Vehicles are limited to existing roads in the Railroad Valley Wildlife Management Area.

7. Fire Management

Fires in the HMP area are rare. The vegetation over most of the area is sparse and fire will not readily spread. The sedges and rushes in and around the ponds, springs and streams are usually green, with water often present.

Initial attack would be by the Currant Volunteer Fire Department should any ranch or oil field installations be threatened. Otherwise the Ely District of BLM would respond.

Occasionally, controlled burns might be of value should vegetation become too thick. Most likely, however, this would be controlled by livestock.

8. Lands

Lockes is being considered for acquisition through the land and water conservation fund. Other areas might be considered in the future (see map, page 7).

Wildlife mortality will be considered in planning all rights-of-way in and around the HMP area.

9. Water Resources

Railroad Valley Wildlife Management Area gets its water from two basic sources, ground water and runoff. The ground water is of good quality and comes from springs and flowing wells. The runoff is highly alkaline. The goal is to keep the water quality in the ponds high enough to support plant and inverebrate life, thus attracting waterfowl.

The hydrologic data available has been placed in Appendix 3.

VIII. Environmental Assessment

An environmental assessment has been completed for the Railroad Springfish Exclosure. An environmental assessment will be completed for all construction projects listed in this HMP. Any projects not listed in this HMP (except maintenance) will have a separate environmental assessment written on them.

IX. Evaluation, Monitoring and Revision

The Railroad Valley Springfish population is being monitored by NDOW, primarily using fish traps. Its habitat is being monitored photographically by BLM. Both studies will continue.

Waterfowl populations have not been monitored in recent years. NDOW should monitor the populations periodically, perhaps in conjunction with other monitoring in the area.

If largemouth bass are restocked, NDOW should monitor their population periodically.

X. Public Affairs

This HMP must receive the written concurrence of NDOW prior to approval by the Tonopah Area Manager. Ducks Unlimted, Sacramento, CA has expressed interest in this document. They will be sent a copy. Advertisments will be placed in the local newspapers and the HMP will be made available for inspection at the Tonopah Resource Area office.

XI. Recreation Value Data

In 1979 the Tonopah MFP estimated 100 angler days and 400 hunter days use at the Wildlife Management Area. It also estimates 600 maximum angler days and 700 maximum hunter days. Due to the poor condition of the roads, this has declined considerably. An estimate for 1989 usage would be under 10 angler days and 250 hunter days plus 10 days watching wildlife.

The Idaho State Office of the BLM, in "Methodology for Computing Wildlife Economic Value for Use in Activity Plan Benefit/Cost Analysis" (dated September 1981) estimates the value of a day warm water fishing as $21.00 waterfowl hunting as $32.00 and non-game use as $29.00.

Present use would then calculate as $210.00 fishing and $8,000.00 hunting and $290.00 non-game use. Potential use would calculate as $12,600 for fishing, $22,400 for hunting and $870.00 (3x) for non-game use. That give an estimate of $27,310 annually for consumptive use. The high and medium priority items would be paid for in approximately 5 years.

Other values, such as the value of a duck produced or wetland acre values were not available.

XII. Literature Cited

Ballantyne, K.J., 1979. "Habitat Management Plan for the Railroad Valley Wildlife Management Area", Bureau of Land Management, Tonopah, NV, 61 pp.

Bureau of Land Management. "Railroad Valley Wildlife Management Area", Bureau of Land Management, Reno, NV, 8 pp.

Bureau of Land Management, 1981. "Tonopah Management Framework Plan", Bureau of Land Management, Tonopah, NV, pp WL-1.1.

Candland, D.M., 1980. "Soil Survey of Big Smoky Valley Area", Nevada. Soil Conservation Service, Washington, DC, pp 42-46.

Carpenter, E., 1915. "Ground Water in Southeastern Nevada", United States Geological Survey, Water-Supply Paper 365, Washington, DC, pp 75-79.

Chinook Research Laboratories, Inc., 1982. "Water Quality Analysis" (YA-553-CT2-1018). Bureau of Land Management, Reno, NV, 23 pp.

Harlow, W.M. and Harrar, E.S., 1950. "Textbook of Dendrology", McGraw-Hill Book Company, Inc., New York, NY, 555 pp.

Magistad, O.C., 1945. "Plant Growth Relations on Saline and Alkali Soils", Botanical Review XI, 4, pp 181-230.

Mozingo, H.N. and Williams, M., 1980. "Threatened and Endangered Plants of Nevada", U.S. Fish and Wildlife Service, BLM, Reno, NV, 268 pp.

Nevada Department of Minerals, 1987. "Oil and Gas Report", State of Nevada, Carson City, NV, 4 pp

Pinzl, A., 1986. "Threatened and Endangered Plant Map Bood of Nevada", Nevada State Museum, Carson City, NV, pp 7-4.

Soil Conservation Service, 1978. "National Soils Handbook Notice 30", Soil Conservation Service, Washington, DC, 95 pp.

Williams, C.D. and J.E., 1981. "Distribution and Status of Native Fishes of the Railroad Valley System, Nevada", Cal-Neva Wildlife Transactions 1981. The Wildlife Society, Sacramento, CA, pp 48-51.