Response to the NEON RFI

TITLE: Core Wildland Site for the Great Basin Domain (Domain 15)

1. Submitting Domain: **Great Basin Domain (Domain 15) (IRON)**

2. RFI Response: (i.e., Research Design Observational, Research Design Experimental, Core Wildland)

CORE WILDLAND SITE

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I. Abstract

This RFI was developed in coordination with integrated efforts at the national level led by the Consortium for Connectivity at Continental Scales (3CS) and the Consortium of Regional Ecological Observatories (COREO).

Our proposed wildland site is Onaqui-Benmore, 100 km southwest of Salt Lake City, UT. The Onaqui-Benmore site (BLM/USFS) offers extensive sagebrush steppe transitioning into juniper woodland. This recommendation is the consensus of the many university, federal, and state scientists in the Intermountain Region Observatory Network (IRON). Currently there are no established station facilities at the Onaqui-Benmore sagebrush steppe site. However, it is an active area of ecological research and is well representative of the sagebrush steppe vegetation in Domain 15. Ecological research at this specific location or immediately nearby includes the Joint Fire Science Project focusing on sagebrush restoration following cheatgrass invasion and fires; historical USFS grazing treatment studies; carbon, water and nutrient cycle studies as well as eddy covariance measurements; and studies on the dynamics of rodents and Sin Nombre hantavirus.

Location of the proposed wildland steppe vegetation site within Domain 15 Latitude: 40.20 Longitude: -112.45 Base elevation: 1680 m Ownership: BLM and USFS Access: currently open, currently grazed Size: 640-1280 acres Aquatic features: none	

Domain 15 is a region of ecological contrasts that is currently experiencing significant ecosystem-scale changes and undergoing rapid urbanization at its margins. We refer to this domain more broadly as the Intermountain Region, because regional climate is controlled to a large extent by surrounding mountain ranges- the Cascade and Sierra Nevada Mountains on the west and the Rocky Mountains on the east. This domain is characterized by combinations of lower-elevation, sagebrush steppe and higher-elevation montane forests (basin and range). This complex topography impacts climate, hydrology, and species distributions, with montane zones exerting a disproportionate influence. While, the basin and range could have posed a challenge for core wildland site selection, we can adequately characterize ecological processes within the domain through selection of both lower elevation basins described here in the wildland RFI response and higher elevation ranges described in the accompanying gradient RFI response.

Within the wildland site, we propose a modification of the tower types as specified in the ISEP, which will allow more effective analysis, and modeling of disturbance regimes in sagebrush steppe ecosystems.

II. Domain Characteristics

Domain 15, designated by NEON as the "Great Basin", is a region of broad ecological contrasts that is currently experiencing significant ecosystem-scale changes and undergoing rapid urbanization at its margins. We prefer to refer to this domain more broadly as the Intermountain Region, largely because its climate is controlled to a large extent by the mountains that surround most of the domain from the Cascade and Sierra Nevada Mountains on the west to the Rocky Mountains on the east.

The Intermountain Region is characterized by combinations of lower-elevation, sagebrush steppe and higher elevation montane forests (basin and range). The complex topography of basins and ranges impact the climate, hydrology, and species distributions. Higher elevation mountain ranges receive a disproportionate share of the region's precipitation, which in turn constrains the distribution of plant and animal species (e.g., Brown, 1971), as well as human settlement in the domain. Thus, the basin and range presents a profound challenge for site location within the domain: no single site can characterize such a spatially heterogeneous region. A single high elevation site cannot characterize the ecological processes occurring at lower elevation, and *vice versa*. Characterizing ecological processes within the domain will require the study of both lower elevation basins and higher elevation ranges using wildland and gradient sites.

Our proposed wildland 'basin' site is Onaqui-Benmore, 100 km southwest of Salt Lake City, UT. The Onaqui-Benmore site (BLM/USFS) offers extensive sagebrush steppe transitioning into juniper woodland. Ecological research at this specific location or immediately nearby includes the Joint Fire Science Project focusing on sagebrush restoration following cheatgrass invasion and woodland expansion; historical USFS contrasting grazing and re-vegetation treatment studies; USU carbon, water and nutrient cycle studies as well as eddy covariance measurements; and Utah studies on the dynamics of rodents and hantavirus. The complementary 'range' site proposed in the accompanying Gradient RFI is the Red Butte Canyon RNA, a fully protected USFS watershed with a history of ecological, aquatic, and climatic studies; this site contains both a stream and reservoir.

Figure 1. Location of the wildland steppe vegetation site within Domain 15 Latitude: 40.20 Longitude: -112.45 Base elevation: 1680 m Ownership: BLM and USFS Access: currently open, currently grazed Size: 640-1280 acres Aquatic features: none Proposed Wildland site: sagebrush steppe	

[We refer to the currently unofficial, all-encompassing consortium of universities and agencies in Domain 15 focusing on NEON activities as the Intermountain Region Observatory Network (IRON) (http://neon-iron.org).]

II.1 How is Onaqui-Benmore sagebrush characteristic of the steppes of the Great Basin?

The Onaqui-Benmore site is characteristic of the Intermountain Region in terms of 1) climate, 2) landforms, 3) vegetation, 4) disturbance regimes, and 5) fauna.

Climate: The Intermountain Region, located between the Sierra Nevada and Cascade ranges to the West and the Rocky Mountains to the east, is among the driest regions of the USA. In winter, western North American climate is dominated by a westerly flow of cool, moist air from the northern Pacific. However, the Sierras and Cascades cast a rain shadow across the Intermountain Region, leading to low precipitation in the basins. In summer, monsoonal flow from the subtropical eastern Pacific becomes more important, but most of the Intermountain Region is currently beyond the monsoon's typical northern limits although this moisture extends into the region during ENSO events. As a result, the climate of the Intermountain Region is arid to semiarid, with cool, moist winters and hot, dry summers. A gradient of precipitation seasonality occurs within the region, which we also describe in the Gradient RFI. To the extreme north and west, virtually all precipitation occurs in fall through spring, with very dry summers. In the southern and eastern extremes, equal amounts of precipitation may fall in winter and summer. Even in these locations, however, most of the effective precipitation for plant growth is received in winter, since summer rains rapidly evaporate due to high temperatures. The Onaqui-Benmore site provides a clear example of the regional climate (Figure 2). Mean annual precipitation is only 274 mm, and while it is distributed equitably throughout the year, soil moisture is recharged during the winter and spring when temperatures are low. Because the site is influenced by both Pacific winter storms and summer monsoon flow, this site will be sensitive to changes in either of these climate signals.

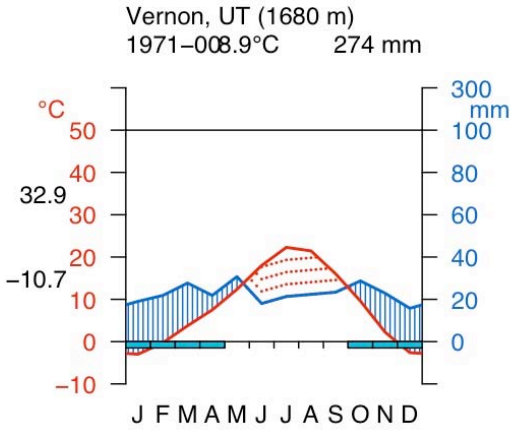


Figure 2. Climate diagram for Vernon, UT, approximately 8 km from the proposed Onaqui-Benmore site (1953-2005). Monthly average temperature data are shown in red; monthly average precipitation is shown in blue. Data are from the National Climate Data Center. Precipitation values differ from values for the Onaqui-Benmore site calculated using PRISM.

Vegetation: Big sagebrush (*Artemisia tridentata* subspecies) is the defining feature of Intermountain Region lower elevation vegetation. The two most widespread vegetation types in the region are "Sagebrush steppe" and "Great Basin sagebrush" (Küchler, 1970). In sagebrush steppe, which occurs in basins in the northern half of the region, and at higher elevations in the southern half, sagebrush is co-dominant with perennial bunchgrasses, primarily *Pseudoroegneria spicata*. In Great Basin sagebrush, which occurs in drier and hotter basins, sagebrush is the dominant overstory species, and the understory is composed of a small-statured perennial grass, *Poa secunda*, and a variety of forbs. A variety of shrub-dominated communities occur at lower elevations in saline soils, and tree species, especially juniper and pinyon pine, are found at higher elevations. Each of these vegetation types occurs within the Onaqui-Benmore area. The site lies on a gently sloping alluvial fan and provides a gradient from salt desert at the bottom up through healthy Wyoming big sagebrush-grassland and into Juniper woodland.

The following species, found at the proposed wildland site, are representative of steppe vegetation:

Grasses
bluebunch wheatgrass (*Pseudoroegneria spicata*), Sandberg bluegrass (*Poa secunda*), Indian ricegrass (*Achnatherum hymenoides*), squirreltail (*Elymus elymoides*), Great Basin wild rye (*Leymus cinereus*), western wheatgrass (*Pascopyrum smithii*).

Shrubs
Wyoming big sagebrush (*Artemisia tridentata wyomingensis*), mountain big sagebrush (*Artemisia tridentata vaseyana*), yellow rabbitbrush (*Chrysothamnus viscidiflorus*), spineless horsebrush (*Tetradymia canescens*), shortspine horsebrush (*Tetradymia spinosa*), shadscale (*Atriplex confertifolia*), fourwing saltbush (*Atriplex canescens*), spiny hopsage (*Grayia spinosa*), winterfat (*Krascheninnikovia arborescens*).

Trees
Utah juniper (*Juniperus osteosperma*), singleleaf pinyon (*Pinus monophylla*)

Forbs
Eureka milkvetch (*Astragalus eurekensis*), northwestern Indian paintbrush (*Castilleja angustifolia*), sego lily (*Calochortus nuttallii*), shortstem buckwheat (*Eriogonum brevicaule*), cushion buckwheat (*Eriogonum ovalifolium*), plains pricklypear (*Opuntia polyacantha*), spiny phlox (*Phlox hoodii*), gooseberryleaf globemallow (*Sphaeralcea grossulariifolia*), shaggyfruit pepperweed (*Lepidium lasiocarpum*)

Vast areas of the Intermountain Region have been invaded by exotic plant species, especially annual species. Onaqui-Benmore is no exception.

The following exotic plants are locally common at the proposed wildland site:

Cheatgrass (*Bromus tectorum*), tall tumblemustard (*Sisymbrium altissimum*), pinnate tansymustard (*Descurainia sophia*), clasping pepperweed (*Lepidium perfoliatum*), Canada thistle (*Cirsium arvense*), prickly lettuce (*Lactuca serriola*), curveseed butterwort (*Ceratocephala testiculata*).

Disturbance regimes: Three types of disturbance play important roles in Intermountain ecosystems: livestock grazing, fire, and land-use change or urbanization.

Grazing was introduced in the Intermountain west in the mid-1800's and by the early 1900's evidence of severe overgrazing led the U.S. Congress to pass legislation to

regulate grazing on public lands. Consistent with this regional history, the Onaqui-Benmore area has been grazed by domestic livestock since settlement. By the 1980's the Forest Service had instituted a light to moderate fall/winter grazing regime that continues today.

Although fire has always been a component of sagebrush steppe, invasions of exotic annuals, especially *Bromus tectorum*, have dramatically shortened fire return intervals. The invasion-fire feedback has resulted in the loss of native perennial species from extensive areas of the region. Heavily invaded and burned areas occur within the Onaqui site, especially at the lower elevation. In addition, at higher elevations, research treatments have been imposed to study the invasion-fire interaction.

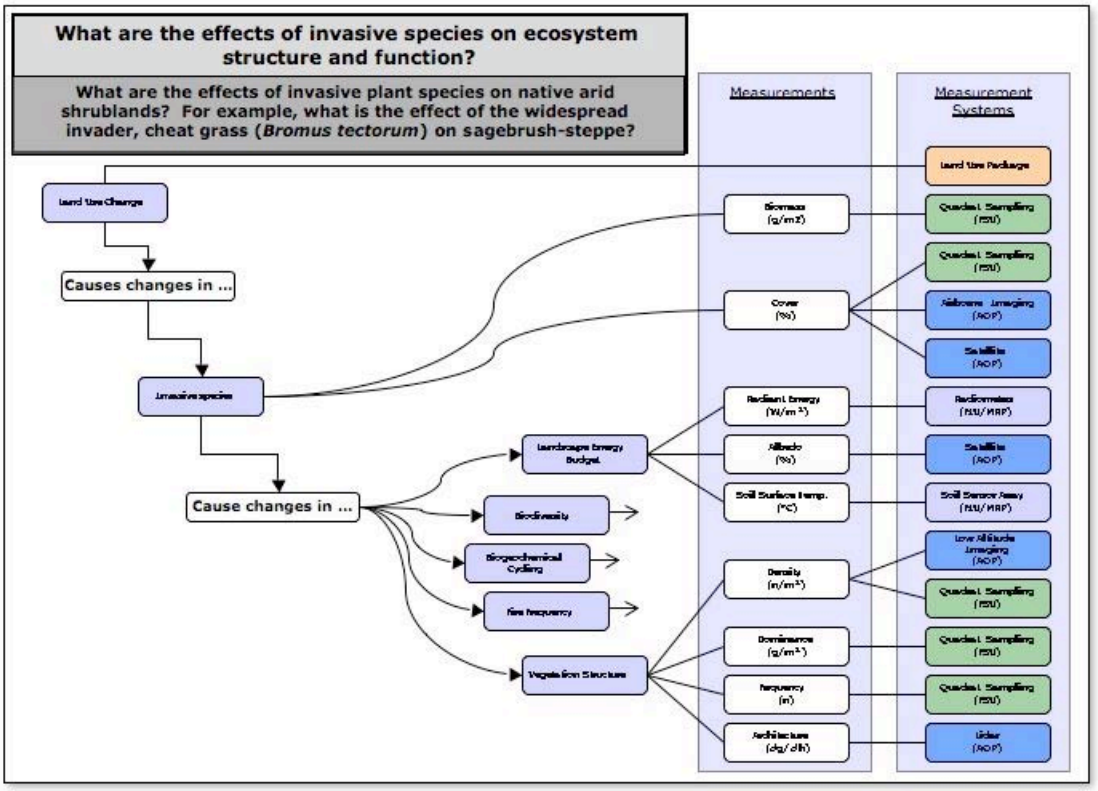


Figure 3. An example of how NEON equipment will be used to address domain and continental scale ecological questions at the core wildland site. This graphic is courtesy of James MacMahon.

Some of the most rapidly urbanizing areas of the United States occur along the edges of the Intermountain Region. Besides the direct impacts of wildland-urban conversion, public lands adjacent to growing population centers may experience indirect effect due to higher levels of pollution, traffic, and recreational use. The Onaqui-Benmore site is currently just 60 km from the explosive growth along the Wasatch Front, making it a reference that will allow us to detect direct effects of urbanization on closer sites. This aspect is discussed in the GRADIENT RFI response.

Fauna: The Onaqui-Benmore site appears to have a diverse and characteristic sagebrush-steppe fauna. It is known to have leks of the greater sage-grouse, a key sagebrush-steppe obligate bird that is characteristic of and dependent on healthy tracts of native sagebrush steppe, and wild horses range in the mountains of the area. Small and moderate-sized mammals that are verified present nearby and likely also at the Onaqui-Benmore site including *Microtus montanus, Lagurus curtatus, Dipodomys ordii, Neotoma lepida, Perognathus parvus, Reithrodonyomys megalotis, Onychomys leucogaster*, *Lepus californicus*, *Ammospermophilus leucurus*, and *Sylvilagus nuttalli*. *Peromyscus maniculatus*, a focal species for NEON, is also locally abundant (50% of the small-mammal fauna). Larger mammals include pronghorn, mule deer, badgers, coyotes, and possibly mountain lions. Sagebrush hosts a diverse invertebrate fauna, and we would expect also a diversity of ants and beetles. Sixty-eight species of birds are listed from the Vernon Breeding Bird Survey route, including the Northern Harrier, Sharp-shinned, Swainson's, Red-tailed and Ferruginous Hawks, Golden Eagle, American Kestrel, Prairie Falcon, Killdeer, Long-billed Curlew, Wilson's Snipe, Rock Pigeon, Mourning Dove, Great Horned, Burrowing and Short-eared Owls, Red-shafted Flicker, Western Kingbird, Loggerhead Shrike, Western Scrub-Jay and Pinyon Jay, Black-billed Magpie, Horned Lark, Mountain Bluebird, Northern Mockingbird, Sage Thrasher, Brewer's, Vesper, Lark and Savannah Sparrows, and Western Meadowlark. Both a diverse and characteristic sagebrush fauna and several non-native species are represented. Nearby streams (i.e., Red Butte Canyon) are populated with a large diversity of macroinvertebrates as well as a number of threatened fish species (Bonneville cutthroat trout, least chub, and leatherside chub).

II.2 Human impacts: extensive grazing and human expansion on the margins

Human populations in the Intermountain Region are growing at or near the highest rate in the nation. In 1990, the population of the Great Basin was 2.9 million and by 2004 had grown to 4.9 million. Most individuals, 2.6 million, live in urban areas that are located at the base of watersheds on the periphery of the region and that have populations greater than 50,000 (e.g., Salt Lake City, Ogden-Layton, Provo-Orem, Reno, Boise, Nampa, Logan, Idaho Falls, Pocatello, Carson City, and Bend). From 1973 to 2000, populations in these developed areas increased 43% and are expected to continue growing at an accelerated pace above the national average. The expanding human population is placing increasing pressure on the wildland/urban interface and native ecosystems already impacted by a legacy of livestock grazing, invasive species and altered fire regimes. In forested systems, a decrease in fire frequency due largely to fire exclusion has resulted in a shift in species composition from early-seral, shade intolerant species to late-seral shade tolerant species. Shade intolerant species like aspen that provide critical wildlife habitat are being out-competed, and increases in vertical stand structure (fuel ladders) and biomass (fuel loads) are resulting in more severe fires. In the pinyon-juniper woodland zone, decreased fire frequency due to fire exclusion, overgrazing through the mid-1900s and climate change has facilitated expansion of pinyon and juniper trees into mid-upper elevation sagebrush ecosystems. As stands mature and canopy closure occurs, understory sagebrush species are eliminated and the risk of higher-severity crown fires increases. In

arid and semi-arid shrublands and lower-elevation pinyon-juniper woodlands, an increase in annual invasive grasses such as cheatgrass coupled with higher fire frequencies is resulting in progressive conversion to homogenous grasslands dominated by non-native invasive species. In many low to mid-elevation sagebrush ecosystems an annual grass fire cycle now exists, and areas that historically burned every 30 to 60 years now burn as often as every 5 years. Nonnative forbs (e.g., knapweeds, rush skeletonweed, yellow star thistle) are beginning to spread through the region often with unknown consequences for native ecosystems and fire regimes. Populations of many sagebrush-associated species are in decline, and approximately 20% of the ecosystem's native flora and fauna are considered imperiled. In many areas there has been a loss of watershed functioning due to changes in erosion and sedimentation, biogeochemical cycling and thermal regimes (albedo, etc.). About 75% of the biodiversity of the Great Basin is associated with riparian areas and aquatic ecosystems. Changes within the watersheds coupled with water diversions, water extraction and point and nonpoint source pollutants are placing rivers, streams and springs and their associated flora and fauna at risk.

III Ownership, access, and use constraints

III.1 Land ownership and current use

The Onaqui site is under the ownership predominantly of the USDI Bureau of Land Management (BLM) with some inclusion of State of Utah land. The adjacent Benmore alternative site is managed by the USDA Forest Service (USFS). Both the Onaqui and Benmore sites are currently part of long term grazing allotments that will continue under light winter grazing. Since grazing is a dominant part of the past and current land management practice across a majority of the domain, it could be argued that light grazing should continue at the site. On the other hand, NEON needs and management requirements could require that grazing be eliminated. This is an issue that requires input from NEON Inc. and direct involvement of the federal land agencies and current grazing permitees.

Presently, land for the Joint Fire Sciences-funded SageSTEP project has been approved for research; this includes 300 acres of sagebrush steppe and several thousand acres of juniper woodland. Approval by the SageSTEP scientific committee is required for any additional research in these plots in order to guarantee the integrity of the ongoing research. These research areas are fenced, but otherwise open to public access. Note, however, that extensive land is still available.

The site has open access to the public; although access is through a small amount of private land, gates are not locked and by law access is required. The major access constraint at the moment is that the current dirt roads are impassable by vehicles during wet and winter snow conditions.

III.2 Entity owning the property

Onaqui parcels are owned by BLM; Benmore parcels are owned by USFS.

III.3 Restrictions on use of or access to the site

None, assuming that the arrangements with current grazing permitees are satisfactorily addressed.

III.4 Existing easements

None known.

III.5 Accessibility and availability

The Onaqui-Benmore region is on public lands managed by the BLM (Onaqui) and the USFS (Benmore). These are currently multiple use lands, but arrangements to make the land accessible for 30+ years are possible. Access is off a public highway.

Driving time to the Onaqui-Benmore region from the University of Utah in the Salt Lake Valley along the Tooele Highway is 70-90 minutes.

Limited land-use changes are anticipated in the region, which currently supports only ranching. The urban growth is expected to be in the Provo – Salt Lake Valley regions along the Wasatch 60 km to the east. Growth is occurring about 40 km to the north in the town of Tooele (population ~30,000). The closest development is the small community of Vernon, UT, a ranching community with a population of ~ 100.

Airplane access is excellent. There is a BLM landing strip in Vernon, 6-8 km from the Onaqui-Benmore sites. Long-distance airport access to the Onaqui-Benmore region is excellent with the Salt Lake International Airport located approximately 90 km to the northeast.

III.6 Feasibility of running experiments on the site

Experiments on the site are possible; fire ecology experiments are already underway.

III.7 Environmental analysis

Any future research activities must be approved by the BLM or the USFS through the National Environmental Policy Act (NEPA) process; note, however, that clearances to

date suggest few problems (e.g., archaeological or major threatened/endangered species concerns). The area is currently managed so as to promote sage grouse populations.

III.8 Environmentally sensitive characteristics of the wildland site

None, other than all sagebrush steppe ecosystems are managed to promote sage grouse.

III.9 Airspace restrictions

There are no flight restrictions for this location.

III.10 Eddy covariance tower requirements are satisfied

Flat space with sufficient horizontal fetch for eddy covariance measurements is easily possible at most locations in the Onaqui-Benmore region. Laying line power to an advanced Biomesonet tower is possible and will depend on exactly where the tower is sited.

III.11 Stream site does not exist on the sagebrush steppe

There is no real possibility of low-order stream measurements at this wildland site, but these aquatic measurements are proposed to take place at the 'range' site Red Butte Canyon as described in the accompanying Gradient RFI response.

IV Existing Infrastructure

Currently there are no research, lab, or lodging facilities at the Onaqui-Benmore site.

IV.1 No existing housing facilities

The Onaqui-Benmore site is 100 km from Salt Lake City and the University of Utah, a relatively easy commute for maintenance of technical services. Very dependable lodging (dormitories) and laboratory space for NEON researchers are available on campus. On average we suspect that researchers will spend several days to a week at the field site, but conduct most of their sophisticated analyses at the University of Utah and not at the Onaqui-Benmore site.

The closest community to the Onaqui-Benmore site is Vernon, UT, a nearby ranching community with a population of less than 100 that is 6-8 km from the site. There is a BLM Fire Station in Vernon (houses fire fighters in the summer) and a landing strip on a

BLM section within the community. We are exploring opportunities to erect/lease a structure in the community or on the BLM land adjacent to the Fire Station.

IV.2 No existing laboratory facilities

We propose to build or lease a small structure in Vernon, UT, (community 6-10 km from field sites) for the Onaqui-Benmore site that would house a small laboratory for modest measurements and sample cleaning, contain space for storage and equipment maintenance, and contain storage and overnight lodging-eating capacities for several scientists. We prefer to approach NEON for funds for this small structure, but will also approach the University of Utah for funds if additional NEON funds are not available. One of the challenges in establishing a NEON site in Domain 15 is the lack of established ecological field research stations.

We do not propose to build the 3,000 sq. ft. building facility described in the NEON ISEP at the Onaqui-Benmore site, but instead we propose to build this larger facility at a more central NEON domain location - on campus at the University of Utah or nearby in the University's Research Park which is adjacent to key gradient sites (Red Butte Canyon and proposed urban sites) in the domain and closer to where technical staff are more likely to live.

IV.3 Available utilities

Electricity, LP tank gas, and well water are available in Vernon.

IV.4 Existing computer resources

We have not been able to learn details of the Internet and transmission capacities in the community of Vernon. There are repeater towers nearby on the peak of Vernon Hills (10 km east of Vernon), but details are unknown at this time.

Complete Internet and cyberstructure capacities are available at the University of Utah, which is one of the leading institutions in cyberstructure capacities.

IV.5 Road access to the site

Access to the Onaqui-Benmore sites is by dirt road off the north-south highway.

We anticipate that in the long term ATV access to the sites will work out best because the dirt roads can be challenging during the winter when snow covered and frequent 4-WD vehicle access during wet periods can cause excessive road damage.

IV.6 Security issues

Security measures to prevent unauthorized access to the site will need to be addressed once the requirements from NEON are more clear and the land agencies are more fully aware of the requirements.

IV.7 Existing meteorological infrastructure

Considerable existing meteorological infrastructure is already in place near the Onaqui-Benmore wildland site. Twenty-five observing stations are located within 35 km of Onaqui (Figure 4 left). These stations are maintained by several agencies and programs: Tooele County Department of Emergency Management (18 stations), Natural Resource Conservation Service (3 stations), Bureau of Land Management (3 stations), Dugway Army Proving Grounds (2 stations). Valley locations tend to focus on warm season precipitation, temperature, wind, and relative humidity, while the high elevation sites are used primarily for monitoring snowpack. Automated data collection for these stations is already in place as part of the MesoWest network of observing systems (Horel et al., 2002). One SNOTEL station is located in the region at Vernon Creek (id 12k01s, latitude 39.94, longitude -112.41, 2243 m elevation); another 12 SNOTEL stations are located near the 'range' site.

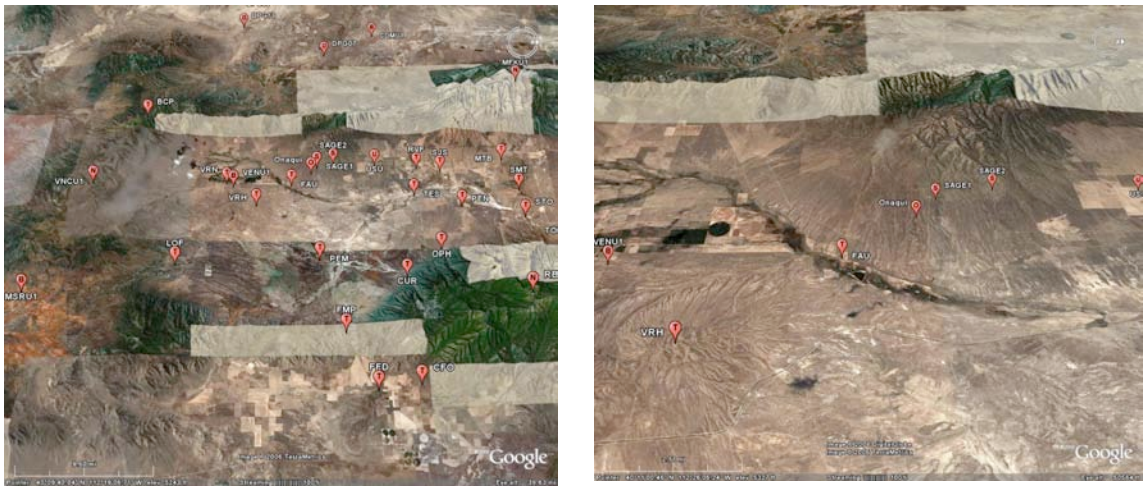


Figure 4. Left. Considerable meteorological infrastructure is already in place and maintained by agencies and universities in the vicinity of the Onaqui Wildland site (labeled by O). These include stations maintained by the Tooele County Department of Emergency Management (T), Natural Resource Conservation Service (N), Bureau of Land Management (B), Dugway Army Proving Grounds (D), SageSTEP program (S), and Utah State University (U). Automated data collection is already available for nearly all of these sites through MesoWest (http://www.met.utah.edu/mesowest). Right. A zoom to focus on the Onaqui slope.

Two additional stations in the vicinity of the Onaqui site were installed during October 2006 as part of SageSTEP (http://www.sagestep.org/), which is funded by the Joint Fire Science Program. One station is in sagebrush steppe and the other in woodland; they measure precipitation, temperature, relative humidity and soil moisture (with a TDR probe and at three depths with gypsum blocks). An additional eddy covariance site was maintained by Utah State University to investigate impacts of water vapor and CO_2 fluxes on ecological processes (Ivans et al., 2006).

IV.8 Proposed tower arrangements at the wildland site

We propose an alternative arrangement of tower types at the wildland site than is described in the ISEP. This requested variation in tower types is to take advantage of the heterogeneity at the wildland site associated with disturbance and the impacts of invasive species. We wish to be able to capture the flux, seasonality, and resource use differences associated with the vegetative mosaic that is increasingly dominating sagebrush steppe landscapes. Instead of 1 advanced Biomesonet tower and 4 additional basic towers as described in the ISEP, we propose the following:

Location in sagebrush steppe	**Tower type**	**Sensor arrays**
Sagebrush steppe	Advanced Biomesonet	Canopy and soil; no aquatic
Annual grassland dominated Bromus tectorum; result of ecosystem conversion	Relocatable tower	Canopy and soil; no aquatic
Sagebrush-juniper steppe; higher slopes where junipers are invading sagebrush steppe	Relocatable tower	Canopy and soil; no aquatic
Sagebrush steppe replicate site	Basic Biomesonet tower	Canopy and soil; no aquatic
Experimental set aside	Basic Biomesonet tower	Canopy and soil; no aquatic

The Basic Biomesonet towers not used at the wildland site will be deployed instead to gradient sites in the domain as described separately in the GRADIENT RFI response.

V Supplemental Information

V.1 Basin and Range – Red Butte Canyon as range site

The 'range' of the IRON basin and range is the Red Butte Canyon Research Natural Area (http://redbuttecanyon.net), a protected watershed with a history of ecological, aquatic, and climatic studies. This canyon is closed to the public and has never been grazed or settled. Red Butte Canyon contains both a stream and reservoir with a long record of aquatic studies.

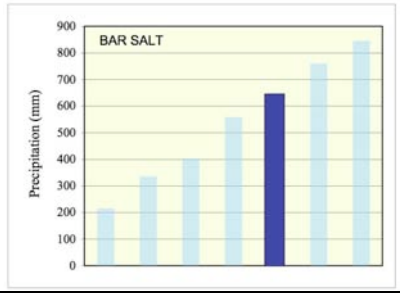
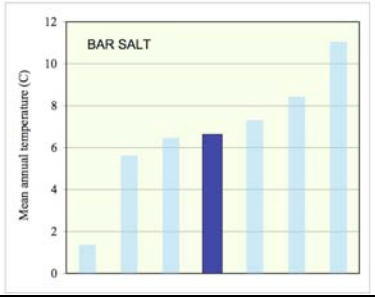
Red Butte Canyon is a closed and secure, pristine watershed of 2,500+ ha immediately east of the University of Utah. It spans 1600-2300 m elevation, and is characteristic of Great Basin watersheds. The lower canyon is dominated by *Bromus tectorum* and some *Artemisia tridentata*. The canyon transitions into a shrub woodland dominated by *Quercus gambelii* and *Acer grandidentatum*; the canyon is dominated by *Populus*

tremuloides and *Pseudotsuga menziesii*. The riparian zone is dominated by *A. grandidentatum, A. negundo,* and *Betula occidentalis*.

There is a network of 8 weather stations in the canyon with records going back to 1945; a USGS NAWQA stream monitoring site; and detailed maps of the geology, vegetation, and soils. A comprehensive biotic inventory has been updated continuously over the past 40 yrs. Utah State University, in conjunction with the Central Utah Water Conservancy District maintain two permanent gauging stations in the stream/reservoir that monitor all chemical, physical and limnological characteristics of the aquatic system. The Red Butte stream and reservoir system are also core sites for the lakes (GLEON) and streams (STREON) research designs.

There are laboratories and dormitories adjacent at the University of Utah, including a small laboratory and storage building at the mouth of the canyon. This lab facility includes 1 ha for experiments and two 60-m artificial stream systems where both stream water and nitrogen can mimic natural conditions.

Location within domain: Latitude: 40.80 Longitude: -111.78 Ownership: USFS Access: closed, protected, RNA Aquatic features: stream and reservoir Contributions to national gradient: Snowmelt, drought, aquatic, stream, land cover, invasives, infectious disease	

Climatic location of Red Butte Canyon within the BAR SALT gradient are shown in dark blue. Contributions to national gradients: drought, land cover, invasives, infectious disease		

V.2 Existing gradients at the sagebrush steppe site

The Onaqui site contains important gradients involving precipitation, plant communities and invasions, and fire. The site lies on a gently sloping alluvial fan and provides a gradient from salt desert at the bottom up through a healthy Wyoming big sagebrush-grassland which at the upper end grades into a woodland "invasion front" and on into a thick Juniper woodland dominated by Utah juniper (*Juniperus osteosperma*) with a small

component of singleleaf pinyon (*Pinus monophylla*). Precipitation increases from approximately 275 mm in the low elevation salt desert to over 400 mm in the woodlands at higher elevations. Along with this gradient there is a trend from more weedy conditions lower down to very healthy native herbaceous understory at the higher levels of the sagebrush with few weeds. At lower elevations, invasive annuals have degraded some native salt desert and sagebrush steppe communities, while at higher elevations expansion of woodland has reduced understory vegetation. In nearby areas scattered wildfires have occurred in both sagebrush and woodland habitats, providing a mosaic of past disturbances. The invasion and fire gradients have been further extended by the management activities being investigated with the SageSTEP project. In the sagebrush steppe habitat BLM has implemented a 75-acre fall burn, a 75-acre mowing treatment with blade height set to remove about 50% of the sagebrush, and a 75-acre tebuthiuron herbicide treatment applied at a rate set to kill approximately 50% of the sagebrush. These treatments were applied in Fall 2006. In the woodland, a roughly 1000-acre burn was conducted in Fall 2006. In addition a 50-acre plot was cut by chainsaw and a 50-acre plot had trees chipped with a bullhog.

V.3 Onaqui-Benmore site history

The Onaqui Mountains above the site are home to 125+ wild horses and are managed to maintain this wild horse population (Onaqui Wild Horse Management District).

Onaqui has been grazed continuously since settlement. There is no evidence of past cultivated agriculture and little in the way of extensive historical or prehistorical Native American use. For at least the last few decades the site has been under only light to moderate Fall/Winter grazing, thus the overall good ecological condition. The grazing allotment is still active and the site will continue to be grazed in the same manner for the foreseeable future.

Onaqui was incorporated into the multi-State SageSTEP experiment in 2006 (see above and below for details). This experiment will be maintained for a minimum of five years with expectations of one to two decades.

The Benmore Experimental Range was established near Vernon, Utah, in the mid-1930s. Research focused on the ecology and management of crested wheatgrass under various livestock production systems. Nearby stands of native sagebrush steppe were maintained as controls. Active research ended in 1984, when the pastures were returned to a Forest Service public grazing allotment under conservative management.

V.4 Ongoing research activities at the Onaqui-Benmore site

Fire ecology and invasive species. The Onaqui site is part of a multi-state network of research sites associated with the Joint Fire Sciences program. SageSTEP, or "Sagebrush Steppe Treatment Evaluation Project," is a multi-institutional, multi-disciplinary project

that is evaluating the effects of fire and fire surrogate treatments designed to reduce fuel and to restore healthy sagebrush communities under threat of conversion to woodland at higher elevations and to cheatgrass at lower elevations. At Onaqui there are both a woodland site and a sagebrush steppe site (see above for treatments applied). This long-term study will monitor vegetation, fuels, soils and wildlife responses. Although there are many objectives associated with this large project, the central objective is to quantify thresholds of ecological condition.

Infectious Diseases. Sin Nombre hantavirus (SN) is a recently discovered virus that causes disease, Hantavirus Cardio-Pulmonary Syndrome ("HCPS") with high mortality in humans. The primary reservoir for SN the deer mouse, *Peromyscus maniculatus*, (a focal species in NEON) attains high densities in sagebrush steppe habitats and up to 39% of the population can be infected with SN . The central focus of research initiated in 2002 is to determine how anthropogenic habitat disturbance by all-terrain vehicles affects SN prevalence in deer mice and secondary reservoirs. Results from 2002-2005 reveal several of the natural abiotic and biotic factors governing prevalence of SN in deermice. First, on average, the density of deer mice at a site and individual residence time explained a significant fraction of the variance in prevalence. Deer mouse density in turn, appears regulated by both abiotic and biotic factors. Drought (2002-2004) significantly reduced animal densities across all sites. Rodent diversity in the community also impacted deer mice densities; there were fewer deer mice in highly diverse rodent communities. ATV disturbance resulted in decreased population densities of deer mice and increased population turnover—two factors that decreased prevalence. However, population densities only differed at disturbed and undisturbed sites during years of below average precipitation. During average-above average precipitation (2006), there were no differences in densities of deer mice across disturbed and undisturbed sites. Ongoing work is focused on understanding the mechanisms behind these complex interactions.

Carbon, water, and nutrient cycles. At the north end of the Onaqui field site, monthly dynamics of carbon, water, and nutrient cycling have been studied on replicated plots dominated by sagebrush (native shrub), cheatgrass (invasive annual), or crested wheatgrass (perennial grass planted for cattle grazing). These included several years of eddy covariance observations on each of the three vegetation types (Ivans et al., 2006). Additionally, the carbon cycle studies included measures of net primary production, soil respiration, and decomposition. Completed nitrogen cycle research has focused on mineralization and immobilization rates, microbial biomass, and plant nitrogen uptake rates, as well as measures of standing stocks in deep soils.

Climate. Myrick et al. (2005) provided an analysis of surface climates in the Onaqui – Rush Valley area. Current meteorological information is obtained in real time as part of the MesoWest network of observing systems (Horel et al., 2002) and will help to provide a framework for examining the relationships in the atmospheric conditions near the wildland site and those in surrounding regions. As shown in Figure 5, surface weather observations are available at over a dozen stations within 10 km of the site.

Figure 5. Current meteorological stations within 10 km of the proposed wildland site.

V.5 Institutional Diversity in IRON

The Intermountain Region Observatory Network (IRON) is an affiliation of universities and agencies interested in NEON. The IRON group has met regularly in open and all-inclusive meetings for several years to discuss NEON site selection, as well as other collaboration. ***The IRON Domain submission is a consensus document for this group***, which includes representation of

- ***research universities*** - University of Utah, Utah State University, Idaho State University, Boise State University, Brigham Young University, Oregon State University, Washington State University, University of Wyoming, University of Idaho, University of Nevada at Reno, University of Nevada at Las Vegas, University of California at Irvine
- ***2- and 4-year teaching institutions*** - Weber State University, Westminster College, College of Southern Idaho, Albertson College of Idaho, Eastern Washington University, Utah Valley State College, Salt Lake Community College

- ***federal agencies*** - National Park Service, US Geological Survey, US Fish & Wildlife Service, Environmental Protection Agency, Bureau of Land Management, USDA-ARS, US Forest Service, Bureau of Reclamation, Pacific Northwest National Lab, US Army
- ***state agencies*** – Desert Research Institute, Utah Division of Wildlife Resources, Idaho Fish and Game, Oregon Department of Fish and Wildlife, Washington Department of Fish and Wildlife, Nevada Division of Wildlife, Wyoming Game and Fish

V.6 Educational opportunities

Multiple education and outreach facilities serving K-12 and public outreach have expressed a serious interest in participating in NEON, including

- Bean Museum, Brigham Young University, Provo (UT)
- Children's Museum, Salt Lake City (UT)
- Great Basin National Park (NV)
- Idaho State Museum of Natural History (ISU, Pocatello, ID)
- National Park Service, Upper Columbia Basin Network Sagebrush Steppe Parks Craters of the Moon National Monument and Preserve (ID), City of Rocks National Reserve (ID), Hagerman Fossil Beds National Monument (ID), John Day Fossil Beds National Monument (OR), Lake Roosevelt National Recreation Area (WA)
- Natural History Museum, University of Utah, Salt Lake City (UT)
- Sawtooth Science Institute, Sun Valley (ID)
- Snake River Birds of Prey National Conservation Area, BLM Boise (ID)
- The Leonardo, Salt Lake City (UT)
- The Peregrine Fund, World Center for Birds of Prey, Boise (ID)
- Western Governors Association, Salt Lake City (UT)

In addition, there are several active programs that link University researchers with primary and secondary schools (e.g., NSF-funded K-12 Programs at ISU, USU, and UU).

VI Literature Cited

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VII Budget and Justification

The proposed budget is designed to cover the maintenance and data acquisition needs for **both** the CORE WILDLAND SITE AND THE DOMAIN 15 GRADIENT SITES.

We describe broad budgetary categories associated with maintaining and operating the NEON infrastructure and collection/analyses of baseline FSU components within the domain. We briefly describe six broad categories: building construction, science support, technical support, education support, secretarial support, travel to NEON field sites, basic field and laboratory supplies, and analytical support. We presume that a separate NEON budget is available for equipment maintenance and replacements.

Building construction. The ISEP describes a 3,000 sq. ft. building requirement. At a current construction cost of $325 per sq. ft., the estimated building cost is $975,000.

Chief scientist support. We anticipate that one Ph.D.-level scientist will be required to oversee all NEON operations within the domain. The 2007 estimate 1.0 FTE base salary for the site scientist is $75,000.

Faculty science support. We anticipate that a NEON operations committee of 8 faculty-level Ph.D.s will share responsibility and also co-supervise key components of the NEON activities. The NEON operations committee would consist of faculty at different universities, representing key focal interests of NEON FIU and FSU activities, including (a) meteorology and climate, (b) biosphere-atmosphere fluxes and trace gases, (c) aquatic components, (d) infectious diseases, (e) invasive species and disturbance, (f) nutrient cycles, (g) land-use intensification and scaling, and (h) urbanization. For each faculty member of the operations committee, they would receive 2 months of summer salary, which is estimated to be $20,000 each.

FIU sensor technical support. We anticipate that 4 sensor technicians will be required to maintain the FIU needs for this domain. These will be B.S.-M.S.-level technicians with proven skills to oversee the following FIU needs: (a) 2 senior technicians responsible for maintenance of tower equipment, including flux and stable isotope sensors and (b) 2 senior technicians for maintenance and calibration of sensor arrays. The 2007 estimate base salary for each of these individuals is $45,000.

FSU senior biological technical support. We anticipate that 2 senior biological technicians will be required to maintain the FSU needs for this domain and to supervise

the junior FSU technicians. These will be M.S.-level technicians with proven skills to oversee the FSU needs. The 2007 estimate base salary for these individuals is $45,000.

FSU junior biological technical support. We anticipate that a team of 3 junior technicians will be required to maintain FSU needs for this domain. The 2007 estimate base salary for these individuals is $30,000.

Cyberinfrastructure support. We anticipate that 2 cyberinfrastructure technicians will be required to maintain cyberinfrastructure needs for this domain (domain network, transfers data to NEON archive, supports systems administration, database and metadata management implementation). The 2007 estimate base salary for these individuals is $65,000.

Education support. We anticipate need for 1 FTE M.S.-E.D. level individual to lead the effort at K-12, public outreach, and university-related outreach. The 2007 estimate base salary for this individual is $55,000.

Secretarial support. We anticipate the need for a 1.0 FTE secretary to support of the domain office, support for the science and technical staff, and provide logical coordination. The 2007 estimate base salary for this individual is $35,000.

Web-based support. We anticipate the need for a 0.5 FTE web-design technician to support the domain office. The 2007 estimate 0.5 FTE salary for this individual is $23,000.

Benefits. The employee benefits package for all of the staff, scientist, and faculty positions described above is an additional 40% to the base salaries of each employee.

Travel to NEON field sites. We anticipate that a fleet of 5 4-WD vehicles will be necessary for the routine servicing of the field sites, acquiring FSU samples, and providing support for NEON scientists working at NEON sites. We use Toyota 4-runners as an example to establish a price basis for cost estimates (internet listed price of $39,000 each). In addition, we anticipate that a fleet of 6 ATV internet listed price of $7,500 each) will be required for minimum impact driving at the field sites (Onaqui-Benmore and Red Butte Canyon). Maintenance, gas, and servicing costs for the vehicles are estimated at 15% of their original costs. This category totals an estimated $240,000 in MFERC equipment funds and $36,000 in annual maintenance costs.

Basic field and laboratory supplies. A basic budget will be required for the normal office and field supplies associated with NEON data collection, sample preservation, onsite analyses, and sample archiving. An initial estimate for this staff is $96,000 per year.