Categorical
Use Attainability Analysis
for Recreation

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1.0 SUMMARY

The State of Wyoming has two designations for recreational use of surface waters: primary contact recreation and secondary contact recreation. Primary contact recreation waters are those where recreational activities are expected to result in immersion in or ingestion of the water. Secondary contact recreation waters are those where contact with water is expected to be either incidental or accidental and not result in either immersion in or ingestion of the water. During the 2007 revision of Wyoming's Surface Water Quality Standards, waters not listed in Table A of the Wyoming Surface Water Classification List were designated for secondary contact recreation. These designations were disapproved by the United States Environmental Protection Agency (EPA) because a use attainability analysis (UAA) had not been completed to show that primary contact recreation was not an existing or attainable use.

Wyoming is the third driest and least populous state in the U.S. As a result, Wyoming has thousands of miles of streams where primary contact recreation is not an attainable or existing use because there is not enough water to support immersion (full body contact) activities and there is little potential for children or other members of the public to ingest small quantities of water because the stream is not located near recreation sites or areas frequented by children or the public. The Wyoming Department of Environmental Quality, Water Quality Division (WDEQ/WQD) developed a categorical UAA using Geographic Information Systems (GIS), over 850 field surveys and public feedback to determine which streams in the state do not support and are not used for primary contact recreation. Due to insufficient data on water availability to support primary contact recreation in lakes, reservoirs and ponds, still water bodies are not addressed in this UAA.

Streams that lack sufficient flow to support primary contact recreation (i.e, ephemeral, small intermittent and small perennial streams), were identified as those with mean annual flows less than 6 cfs. Streams with estimated mean annual flows less than 6 cfs, including flow from point source discharges, were designated for secondary contact recreation. Data layers representing populated places, schools, campgrounds, recreation sites, natural areas, rest areas, National Parks and Recreation Areas, and State Parks and Historic Sites were then used to identify low flow streams that may be used for primary contact recreation. Other primary contact recreation streams were identified as those within 0.5 miles of trailheads or dispersed campsites that were within 0.25 miles of a road and located on public land. When two stream segments designated for primary contact recreation were separated by a secondary contact recreation segment, the primary contact recreation segment was extended to minimize the occurrence of short, isolated reaches. The results were validated with 151 field surveys conducted by WDEQ/WQD and 720 field surveys conducted by Wyoming's Conservation Districts. There was 93.4% agreement between the primary surveys before extensions and 94.9% agreement after extensions; there was 80.4% agreement between all the surveys and the UAA before extensions and 79.7% agreement after extensions. Of Wyoming's 115,373 stream miles depicted in the 1:100,000 National Hydrologic Dataset (NHD) that were addressed in this UAA, primary contact recreation is not an attainable or existing use on 87,775 miles, or 76.1% of the stream miles.

Primary and secondary contact recreational use designations for 100k streams can be viewed on the Recreation Designated Uses Web Map: http://159.238.120.99/recreation/index.html. Recreational use designations of streams not present in the 100k NHD can be determined from the "Primary Areas" layer present in the web map. Streams not present in the 100k NHD that are located in the Primary Area layer are designated for primary contact recreation. Streams not present in the 100k NHD or in the Primary Areas layer are designated for secondary contact recreation.

2.0 BACKGROUND

As outlined in Wyoming's Surface Water Quality Standards (Water Quality Rules and Regulations, Chapter 1), Wyoming has two designated uses for recreation, primary and secondary contact recreation, and a summer recreation season (May 1 through September 30). Primary contact recreation is defined as "any recreational or other surface water that could be expected to result in ingestion of the water or immersion (full body contact)." Full body contact water recreation is defined as "any recreational or other surface water use in which there is contact with the water sufficient to pose a significant health hazard (i.e., water skiing, swimming)." Secondary contact recreation is defined as "any recreational or other surface water use in which contact with the water is either incidental or accidental and that would not be expected to result in ingestion of the water or immersion."

During the 2007 revision of Chapter 1, WDEQ/WQD designated all "waters not specifically listed in Table A of the Wyoming Surface Water Classification List" for secondary contact recreation. EPA disapproved this portion of Wyoming's water quality standards because the designations had been made without conducting a use attainability analysis. A use attainability analysis is required when removing the primary contact recreational use because Section 101(a)(2) of the Clean Water Act outlines that "it is the national goal that wherever attainable, an interim goal of water quality which provides for the protection and propagation of fish, shellfish, and wildlife and provides for recreation in and on the water be achieved by July 1, 1983." Section 101(a)(2) has been interpreted to establish a rebuttable presumption that the 101(a)(2) uses, the fishable/swimmable uses, are attainable on all water bodies and must be protected, unless a state or tribe demonstrates that the uses are not attainable through a use attainability analysis.

EPA outlined that in order to resolve the disapproval, "the State will need to delete the language in Section 27(a)" and "for waters where the State believes that further review of the appropriate recreation use is warranted, the best option would be to utilize the Wyoming DEQ's Recreational Use Designations Use Attainability Analysis (UAA) Worksheet on a site-specific basis"…. or "another option……would be to work with the Region to develop a categorical UAA" (EPA 2008).

After receiving a large number of site-specific recreation UAAs and recognizing the overwhelming public interest in appropriately designating recreational uses for waters of the state, WDEQ/WQD determined that a statewide categorical UAA would be the most effective and efficient method to identify primary and secondary contact recreational uses for waters in Wyoming. In 2009, WDEQ/WQD began compiling datasets that could be used for the UAA. In 2010, WDEQ/WQD and Wyoming's Conservation Districts conducted field visits and completed surveys at almost 900 sites.

In February 2012, WDEQ/WQD submitted a preliminary draft of the Categorical UAA to EPA Region 8 for feedback. In a May 2012 comment letter, EPA Region 8 outlined that their main concern with the draft categorical UAA was the lack of connection to the use removal factors outlined in Chapter 1, Section 33(b) and the Code of Federal Regulations, 40 CFR § 131.10(g). To address EPA's concerns, WDEQ/WQD developed an approach to identify waters which do not support primary contact recreation based on factor 2 (Chapter 1, Section 33(b)(ii) and 40 CFR § 131.10(g)(2)), the "low flow" factor. WDEQ/WQD then submitted an *Identification of Low Flow Streams* analysis to EPA in October 2012. EPA provided feedback in January 2013 indicating that their "preliminary thinking is that WDEQ's draft approach for identifying streams with insufficient flow to support primary contact recreation, with some modification, would be consistent with 40 CFR § 131.10(g)(2)."

WDEQ/WQD considered EPA Region 8 feedback on both the February 2012 *Draft Categorical Use Attainability Analysis for Recreation* and the October 2012 *Identification of Low Flow Streams* analysis and released the *Draft Categorical Use Attainability Analysis for Recreation* for public comment on August 6, 2013. The public notice identified that the state needed assistance from the public to identify streams in Wyoming that are used for primary contact recreation that were not identified as primary in the draft UAA. The public notice specifically identified areas such as pools or other deep water areas that may occur on low flow streams that may be used for primary contact recreation. WDEQ/WQD also requested assistance in identifying any potential issues with the datasets used in the draft UAA.

WDEQ/WQD did not receive any comments indicating that there are pools or other deep water areas on "low flow" streams that are used for primary contact recreation. WDEQ/WQD did receive comments indicating that the access datasets were designating too many dry draws and gullies for primary contact recreation that were not used for, nor have the potential to be used for, primary contact recreation (see Categorical Use Attainability Analysis for Recreation Response to Comments for Comment Period Ending September 30, 2013 for the full text of the comments and responses). Based on these and other comments received during the August 6 – September 30, 2013 public comment period, WDEQ/WQD released a revised *Categorical Use Attainability Analysis for Recreation* for a 45-day public comment period on January 28, 2014 (see Categorical Use Attainability Analysis for Recreation Response to Comments for Comment Period Ending March 14, 2014 for the full text of comments and responses). This document describes the analysis that was used to identify streams in the state where primary contact recreation is not an existing or attainable use and therefore can be designated for secondary contact recreation. Individual stream designations and the GIS datasets used in the analysis can be accessed from the Recreation Designated Uses Web Map: http://159.238.120.99/recreation/index.html.

2.1 Use Attainability Analysis Process

Chapter 1, Section 4 describes the classes and designated uses for surface waters in Wyoming and Section 33 outlines the process to modify designated uses and develop site-specific criteria. Section 33 specifies that "the administrator may lower a classification, remove a designated use which is not an existing nor attainable use, establish ambient-based criteria on effluent dependent waters, make a recommendation to the council to establish sub-categories of a use or establish site-specific criteria if

it can be demonstrated through a use attainability analysis (UAA) that the original classification, designated use or water quality criteria are not feasible because:

(i) Naturally occurring pollutant concentrations prevent the attainment of the classification or use; or

(ii) Natural, ephemeral, intermittent or low flow conditions or water levels prevent the attainment of the use, unless these conditions may be compensated for by the discharge of sufficient volume of effluent discharges without violating state water conservation requirements to enable uses to be met; or

(iii) Human caused conditions or sources of pollution prevent the attainment of the use and cannot be remedied or would cause more environmental damage to correct than to leave in place; or

(iv) Dams, diversions, or other types of hydrologic modifications preclude the attainment of the classification or use, and it is not feasible to restore the water body to its original condition or to operate such modification in such a way that would result in the attainment of the classification or use; or

(v) Physical conditions related to the natural features of the water body such as the lack of a proper substrate, cover, flow, depth, pools, riffles, and the like, unrelated to water quality, preclude the attainment of an aquatic life use; or

(vi) Controls more stringent than those required in Section 301(b) and 306 of the Federal Act would result in substantial and widespread economic and social impact. This subsection shall not apply to the derivation of site-specific criteria" (WDEQ/WQD 2013a).

The six removal factors outlined above are derived from the Code of Federal Regulations (CFR) § 131.10(g), which outline that "states may remove a designated use which is *not* an existing use, as defined in CFR § 131.3, or establish sub-categories of a use if the State can demonstrate that attaining the use is not feasible…." As outlined in both state and federal regulations, a UAA must utilize these six factors to demonstrate that a use is not attainable and therefore can be removed. Chapter 1 and federal regulations define UAAs similarly; Chapter 1 Section 2(b)(li) defines a UAA as "a structured scientific assessment of the factors affecting the attainment of the use. The factors include physical, chemical, biological, and economic factors as described in Section 33 of these regulations" (WDEQ/WQD 2013a).

Section 2.9 of the EPA's *Water Quality Standards Handbook*[1] discusses the ability of states to conduct UAAs for groups of waters, referred to here as a categorical UAA. The handbook outlines that "States may also conduct a generic use attainability analysis for groups of water body segments provided that the circumstances relating to the segments in question are sufficiently similar to make the results of the generic analyses reasonably applicable to each segment."

[1] http://water.epa.gov/scitech/swguidance/standards/handbook/chapter02.cfm#section9

2.2 Wyoming Guidance on Recreation Use Attainability Analyses

Additional guidance for UAAs in Wyoming is provided in the *Use Attainability Analysis Implementation Policy* (WDEQ/WQD 2013b). Section 7 of the policy outlines the UAA process for Recreation Designations; the policy also includes a Recreational Use Designations Use Attainability Analysis (UAA) Worksheet. The policy outlines that "The decision as to whether a water body is most appropriately designated for primary or secondary recreation protection is not intended to be a difficult one. There are only a few factors relating to water availability, access and recreational opportunity that need to be considered." The policy also outlines that waters "located within federal, state or local parks and recreation areas;" waters "known to be used for primary contact recreation activities such as swimming, rafting, floating, canoeing or kayaking;" "all lakes and reservoirs located in the state already used or have the potential to be used for primary contact recreation;" "waters located within or flow through municipalities or high density housing areas;" and "larger perennial streams and game fisheries" will generally be designated for primary contact recreation.

2.3 EPA Guidance on Recreation Use Attainability Analyses

EPA has published at least two guidance documents that address recreation UAAs. The first was published in 1992 by EPA Region 8 and titled *Recreation Standards and the CWA Section 101(a)(2) 'Swimmable' Goal*. The second was published in 2004 by EPA and titled *Implementation Guidance for Ambient Water Quality Criteria for Bacteria* (EPA 2004). These guidance documents outline that protection for primary contact recreation is not necessary on every water and address when it is appropriate to assign less than swimmable uses to waters.

The 1992 Region 8 guidance outlines that "although assigning swimmable goal standards to all waters would clearly satisfy all requirements pertaining to recreation and fully protect public health, Region VIII recognizes that there may be some waterbodies where application of such standards may be unnecessary. For example, in situations where an evaluation of the relevant factors indicates that existing and potential primary contact recreation uses cannot reasonably be presumed to exist, it may not be necessary or appropriate to set standards in support of the swimmable goal" (EPA 1992). Similarly, the 2004 EPA guidance outlines that "where a state or authorized tribe has determined that primary contact recreation is not an existing use as defined by federal and state (or tribal) regulations, nor attainable for one of the reasons identified in the federal and state (or tribal) regulations, states and authorized tribes may adopt other categories of recreation such as intermittent primary contact recreation, wildlife impact recreation, or secondary contact recreation" (EPA 2004).

The 1992 Region 8 guidance outlines four options to achieve compliance with the requirements associated with the swimmable goal, one of which is to "conduct and submit to EPA for review use attainability analyses (UAAs) for all waters where recreation standards are not consistent with the CWA Section 101(a)(2) goal." Similarly, Section 3.5.1 of EPA's 2004 guidance identifies that "states and authorized tribes may assign less than 'swimmable' standards where adoption of such a standard is adequately justified by a use attainability analysis (UAA)" (EPA 2004). The 1992 guidance outlines that "In the case of potential uses, the decision must be based on consideration of a variety of factors

affecting potential (e.g., access, flow, depth)" (EPA 1992). The 2004 guidance states that "less than 'swimmable' standards may be considered, for example, where flowing or pooled water is not present within a waterbody during the months when primary contact recreation would otherwise take place and the waterbody is not in close proximity to residential areas, thereby indicating that primary contact uses are not likely to occur. Also, if a state or authorized tribe can demonstrate that natural, ephemeral, intermittent, or low flow condition or water levels prevent attainment of the primary contact recreation use, a secondary contact recreation use may be appropriate" (EPA 2004).

2.4 Wyoming's Categorical Use Attainability Analysis for Recreation

As articulated in federal and state regulations and guidance, removal of the primary contact recreational use where it is not an attainable or existing use through a categorical UAA is consistent with the Clean Water Act. To comply with federal and state regulations and guidance on recreation UAAs, this UAA combines an evaluation of: water availability (low flow conditions – factor 2), outlined in Chapter 1, Section 33(b)(ii) and 40 CFR § 131.10(g)(2); access, mentioned in Wyoming's *Use Attainability Implementation Policy* (WDEQ/WQD 2013b) and EPA guidance documents (EPA 1992; EPA 2004); and whether primary contact recreation is an existing use, as outlined in Chapter 1, Section 33(b) and 40 CFR § 131.10(g).

As a first step, the UAA uses GIS datasets to identify streams that do not support primary contact recreation because "natural, ephemeral, intermittent or low flow conditions or water levels prevent the attainment of the use, unless these conditions may be compensated for by the discharge of sufficient volume of effluent discharges without violating state water conservation requirements to enable uses to be met" (40 CFR § 131.10(g)(2)). Because there is little information available in GIS to identify whether a still water body (lake, reservoir, pond, etc.) has sufficient water to support primary contact recreation, still water bodies are not addressed in this UAA.

As a second step, the UAA uses additional GIS datasets to identify any "low flow" streams that may be used for primary contact recreation or where primary contact recreation may be an existing use because the stream is located in an area where children and/or the public have easy access to the stream. These include those areas identified in Wyoming's Recreational Use Designations Use Attainability Analysis (UAA) Worksheet such as parks, recreation areas, high density housing areas, schools, etc. (WDEQ/WQD 2013b). Although these streams will generally not support full body immersion since they are "low flow", the water in these streams might be ingested by children and/or other members of the public and therefore should be protected for primary contact recreation.

In the third step, the UAA incorporates public feedback received during an August 6 to September 30, 2013 public comment period. Public feedback focused on whether primary contact recreation is an existing use in areas other than those identified in steps one and two. These areas included any pools, deep water areas, or other sites located on "low flow" streams not identified in one of the GIS datasets. Based on the feedback received during the August 6 to September 30, 2013 public comment period, there are not any pools or deep waters areas located on "low flow" streams that are used for primary contact recreation that are not designated for primary contact recreation in the UAA.

For streams where the UAA indicates that there is not sufficient water availability (low flow conditions) to support primary contact recreation, not sufficient access or recreational opportunity to support primary contact recreation, and public feedback has not indicated that the stream is used for primary contact recreation, primary contact recreation is presumed not to be an existing or attainable use and can be removed. The remaining low flow streams that are not proximate to areas frequented by children and/or the public can be grouped together categorically since the conditions that most influence the recreational use of the streams are sufficiently similar. These streams will be designated for secondary contact recreation.

The designation of streams for secondary contact recreation through this UAA has been applied to all waters within the exterior boundary of the State of Wyoming. However, it should be noted that the EPA or authorized tribes administer the Clean Water Act in Indian Country, as defined at 18 U.S.C. Section 1151.

3.0 LOW FLOW STREAMS

Streams in which "natural, ephemeral, intermittent or low flow conditions or water levels prevent the attainment of the" primary contact recreation use were identified to fulfill the regulatory requirements in Chapter 1, Section 33(b)(ii) and 40 CFR § 131.10(g)(2) and to maintain consistency with Wyoming's *Use Attainability Analysis Implementation Policy* and EPA's 1992 and 2004 guidance on recreation UAAs.

3.1 Recreation UAAs Based on 131.10(g)(2)

EPA Regions 6 and 7 have approved recreation UAAs based on 40 CFR § 131.10(g) factor 2. Documentation that was previously located on the EPA Region 6 website regarding recreation UAAs identified that "Region 6 has allowed factor 2 to be used whenever this lack of flow results in water depths of less than 18 inches (1.5 feet). Arkansas, in their ecoregion analysis, found that waterbodies with watersheds of less than 10 sq. mi. also did not support a swimming use and the region has approved this approach too." The section of EPA Region 8's Recreation UAA Worksheet on physical conditions asks whether "any portions of the segment ever provide sufficient flow and/or depth for total body immersion (in a prone position)" (EPA 1994).

EPA Region 7 has used a similar approach to Region 6, where states such as Iowa, Kansas, and Missouri have used stream depth to show that primary contact recreation is not attainable based on 131.10(g) factor 2. An EPA action letter to Iowa dated June 29, 2010 describes that the Iowa Department of Natural Resources (IDNR) "assigned a secondary contact recreational use to water bodies where the maximum depth measurements were less than one meter or the average depth was less than 0.5 meters and no other information indicated that primary contact recreation was attainable" (EPA 2010). Missouri's 2007 Recreational Use Attainability Analysis protocol[2] describes that a maximum depth of at least one meter (3.28 ft) or a median depth of at least one-half meter

[2] Missouri Recreation UAA Protocol: http://www.dnr.mo.gov/env/wpp/wqstandards/uaa/pdf/wpp_wqs_uaa.pdf

(1.64 feet) must be maintained during base flow conditions in the survey area in order to support whole body contact recreation. Therefore, waters designated for secondary contact recreation will have a median depth of less than 0.5 meters (1.64 ft) and a maximum depth less than one meter (3.28 ft). Missouri's protocol defines base flow conditions as the "portion of stream flow contributed by sources of water other than precipitation runoff. This refers to a fair weather flow sustained primarily by springs or groundwater seepage, wastewater discharges, irrigation return flows, releases from reservoirs, or some combination of these sources." Median depth is calculated by measuring depth at cross-sections spaced equidistantly throughout a segment (MDNR 2007).

3.2 Wyoming Climate

From 1971 to 2000, Wyoming was the third driest state in the U.S.; only Nevada and Utah were drier. Mean annual precipitation was 12.97 inches[3]; 30% of the state received less than 12 inches of precipitation per year and 67% of the state received less than 16 inches of precipitation per year (USDA/NRCS 2006; Figure 1). Precipitation ranged from 5 inches per year in the central basin areas to 93 inches per year in the mountainous areas of northwestern Wyoming. As a result of the dry climate in large portions of Wyoming, most streams in the state do not have sufficient flow to support primary contact recreation. These are ephemeral, intermittent or small perennial streams, the majority of which are located in the basin areas of the state. Ephemeral, intermittent or small perennial streams may also occur in mountainous areas of the state where streams have small watershed areas and/or surface water moves rapidly to groundwater. Streams with larger watershed areas that originate in mountainous areas with high mean annual precipitation, where water does not move rapidly to groundwater, will generally be larger perennial streams that may have sufficient flow to support primary contact recreation.

3.3 Identification of Low Flow Streams in Wyoming

Based on EPA-approved recreation UAAs, both depth and watershed area have been used to identify "low flow" streams. Because WDEQ/WQD is using a Geographic Information Systems (GIS) based approach to identify streams where primary contact recreation is not an attainable use, the UAA is limited to attributes represented in the GIS.

3.3.1 National Hydrography Dataset

The National Hydrography Dataset[4] (NHD) is a comprehensive set of digital spatial data that represents the surface water of the United States using common features such as lakes, ponds, streams, rivers, canals, and ditches. The NHD is available in two seamless datasets; one based on 1:24,000-scale (24k) topographic mapping, known as the high-resolution NHD, and the other based on 1:100,000-scale (100k) topographic mapping, known as the medium resolution NHD (Simley and Carswell 2009). The 100k and 24k NHD stream datasets contain one attribute associated with flow,

[3] Earth Systems Research Laboratories: http://www.esrl.noaa.gov/psd/data/usclimate/pcp.state.19712000.climo

[4] National Hydrography Dataset: http://nhd.usgs.gov/index.html

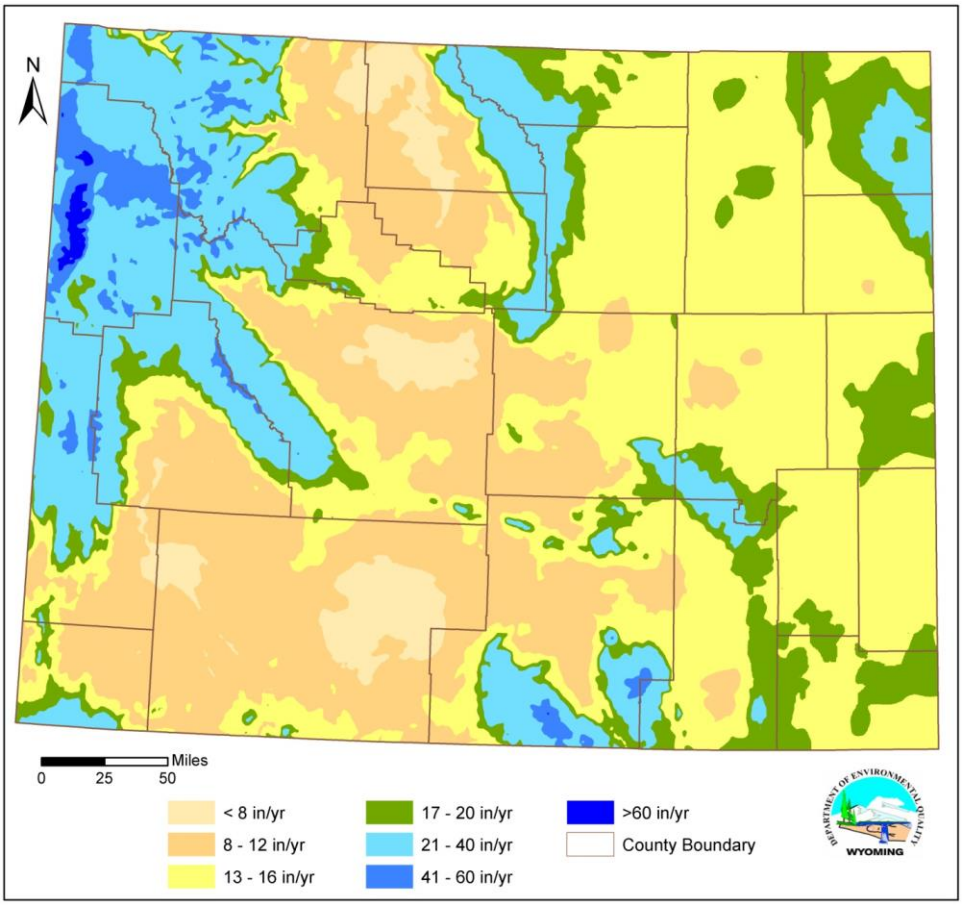

Figure 1. Mean annual precipitation for Wyoming 1971-2000.

hydrologic classifications of perennial, intermittent and ephemeral, but these are general classifications that lack sufficient accuracy to determine whether the stream is capable of supporting primary contact recreation.

Additional attributes contained in NHDPlus[5] that are more direct estimates of flow can be joined to the 100k NHD dataset. NHDPlus is "an integrated suite of application-ready geospatial data products, incorporating many of the best features of the National Hydrography Dataset (NHD), the National Elevation Dataset (NED), and the National Watershed Boundary Dataset (WBD)" (McKay et al. 2013). Version 1 of NHDPlus was first released in 2006 and Version 2 (V2) of NHDPlus was released in 2012. NHDPlus V2 includes one direct measure of flow for stream segments in the 100k NHD, mean annual flow estimates (MAF), and two indirect measures of flow, watershed area and stream order.

Stream Order

Stream order is a classic method for ranking streams according to size. NHDPlus V2 stream order is based on a modification of the Strahler Method. The Strahler Method was developed by Arthur Strahler to characterize the relative size of streams (McKay et al. 2013). The NHDPlus V1 Strahler order calculation metadata (NHDPlus 2005) describes stream order as "stream order follows dendritic networks from headwaters to the river outflow. At headwaters, stream/rivers are assigned a Strahler

[5] NHDPlus: http://www.horizon-systems.com/NHDPlus/index.php

order of one (1st order). When two 1st order streams flow together, the downstream feature is assigned a Strahler order of two (2nd order). Only when two features of the same order flow together does the Strahler order increment to the next larger order." The concept is applied similarly in NHD V2. Pierson et al. (2008) describes that perennial and intermittent streams are included in determining Strahler order. The stream order NHDPlus V1 metadata (NHDPlus 2005) also describes that "Strahler order is used in water-related research to represent relative flow." Strahler stream order therefore generally identifies streams smallest in cross sectional area and mean annual flow as 1st order, streams with slightly larger cross sectional area and mean annual flow as 2nd order, and so on. Approximately 9,400 of the 115,000 100k stream miles addressed in this UAA have a stream order of zero. These stream segments are generally isolated reaches; canals and ditches; or tributaries to canals and ditches. Because stream segments with a zero order are not part of the cumulative flow path used to estimate mean annual flows, these segments also have mean annual flow estimates of zero.

Watershed Area

Watershed area, known as total upstream cumulative drainage area in NHDPlus V2, is the cumulative drainage area at the downstream end of a flowline (McKay et al. 2013). WDEQ/WQD compared the drainage area estimates within NHDPlus V2 to watershed areas of 257 USGS gage sites in Wyoming. NHDPlus estimated the drainage area of gaged sites extremely well ($R^2 = 0.99$; Figure 2).

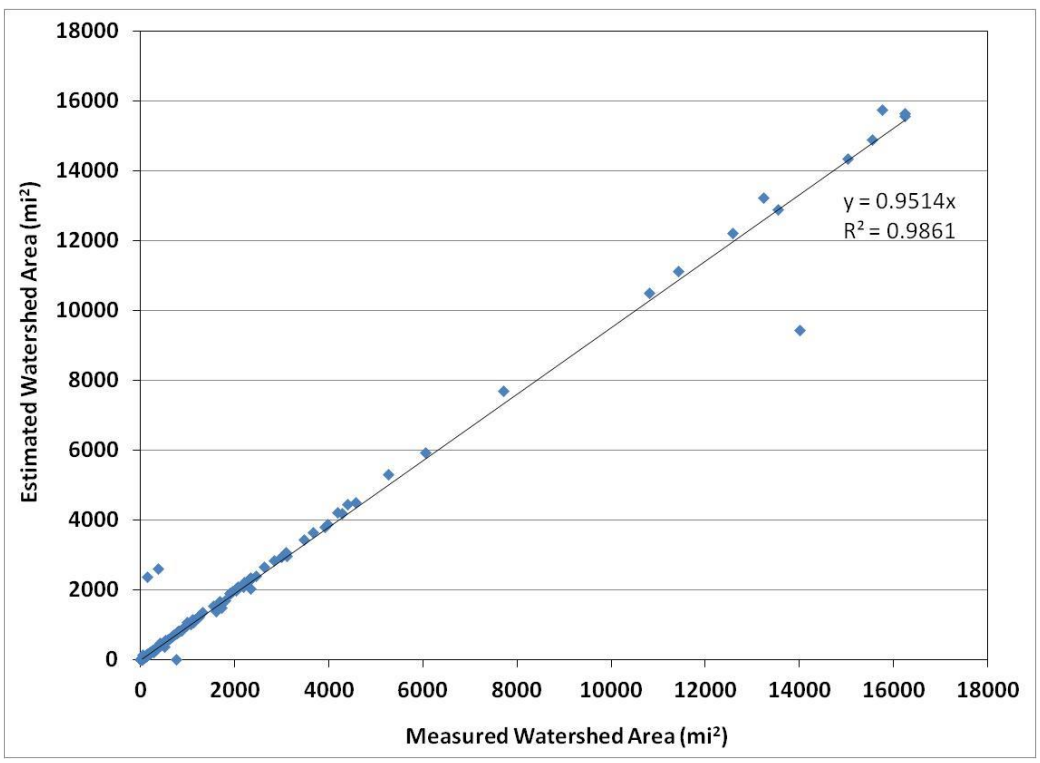

Figure 2. Watershed area at 257 USGS gage sites and watershed area at these same sites estimated by NHD*Plus* Version 2.

Mean Annual Flow

Mean annual flow is the arithmetic mean of all of the individual daily mean flows for a given water year at a specific site on a river. NHDPlus V2 uses two methods to estimate mean annual flow (MAF)

for each stream segment in the 100k NHD, Enhanced Unit Runoff Method (EROM) and Vogel. EROM uses a 6-step flow estimation process. In step one, unit runoff is computed from a 900 m runoff grid produced from a flow balance model. In step two, a "losing stream methodology is incorporated that estimates stream flow losses that can occur due to excessive evapotranspiration in the stream channels." In step three, Falcone reference gages are used to adjust the flow estimates. In step four, flow transfers, withdrawals and augmentation are accounted for. In step five, flows upstream of a gage are adjusted to the observed flow at gage sites; only gages that meet certain criteria are used to perform the adjustment. In step six, a proportion of the gages are randomly removed from the gage adjustment process, which then provides a basis for an estimate of the accuracy of the flow estimates created in step 5 (McKay et al. 2013).

The Vogel method estimates mean annual flow using a log-log regression approach based on drainage area, precipitation, temperature data and mean annual flow values from the Hydro-Climatic Data Network (HCDN) of gages. The HCDN gages are minimally affected by human activities such as reservoirs, intakes and irrigation withdrawals, so the Vogel estimates are most representative of "natural" flow conditions. With the Vogel method, flow estimates are only valid within the ranges of the original data used for computing the regressions. Therefore, no Vogel estimates are available for drainage areas that fall outside these ranges (McKay et al. 2013). In Wyoming, approximately 58% of 100k stream miles do not have Vogel mean annual flow estimates in NHDPlus V2.

257 USGS gage sites in Wyoming were used to evaluate whether the Vogel or EROM mean annual flow estimates were more accurate (Figure 3). The period of record for these gages ranged from 10 to 100 years. EROM estimates were used at gage sites without Vogel estimates for the EROM and Vogel comparison. Because EROM MAF estimates were calibrated using some USGS gage sites, 68 calibration gages were removed from the analysis to avoid bias in the results. Based on the remaining 189 gages, EROM mean annual flow estimates were more accurate than the combined EROM and Vogel mean annual flow estimates (Figures 4 and 5; $R^2 = 0.86$ versus $R^2 = 0.84$). Using the entire 257 gage set, the EROM method estimated mean annual flows relatively well (Figure 6; $R^2 = 0.94$). EROM generally overestimated measured mean annual flows at USGS gages; EROM mean annual flow estimates were 1.2 times the mean annual flows measured at USGS gages.

3.3.2 Mean Annual Flows of Streams Not Supporting Primary Contact Recreation

WDEQ/WQD evaluated each of the three attributes available in NHDPlus (stream order, watershed area, and mean annual flow) and determined that due to the large variability in precipitation from one region of the state to another and corresponding variability in hydrologic regimes, mean annual flow estimates were the most accurate attribute to identify streams with insufficient flow to support primary contact recreation. Because NHDPlus is only available for the 100k NHD, the other surrogates for flow, stream order and watershed area, were used to evaluate the flow conditions of streams not present in the 100k NHD.

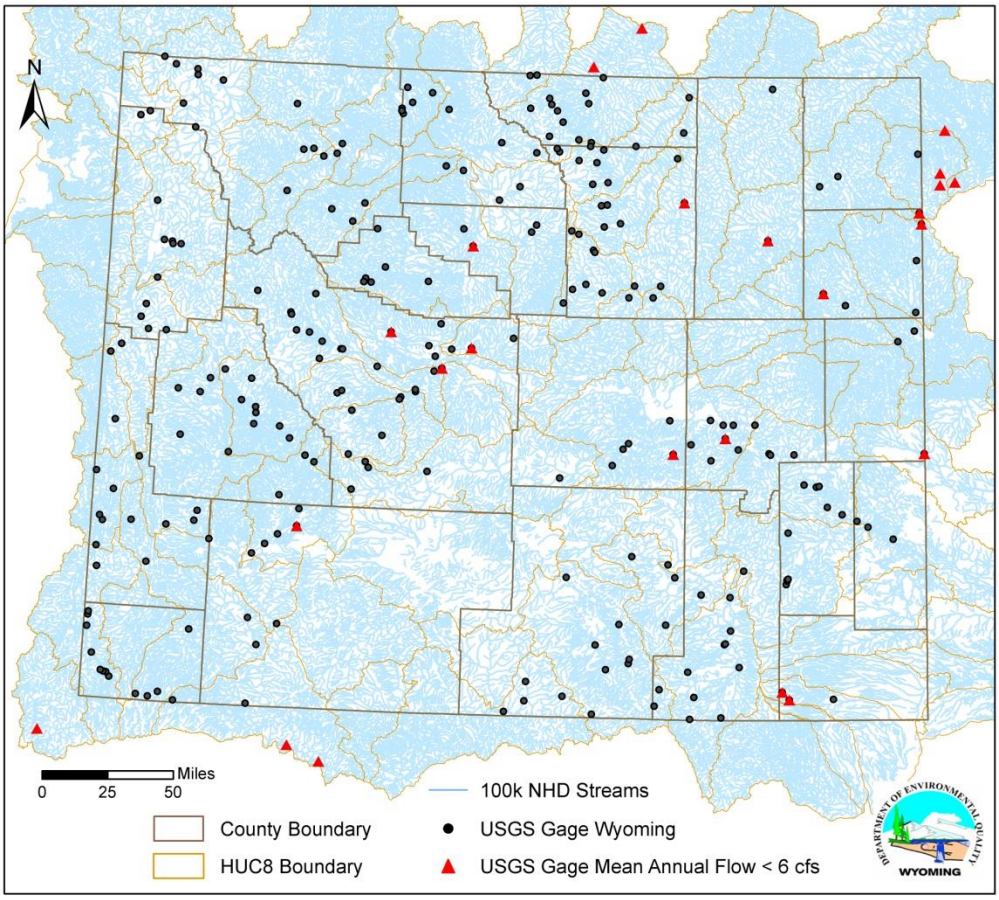

Figure 3. USGS gage sites in Wyoming (257 gages) and adjacent states (9 gages) used in flow analysis.

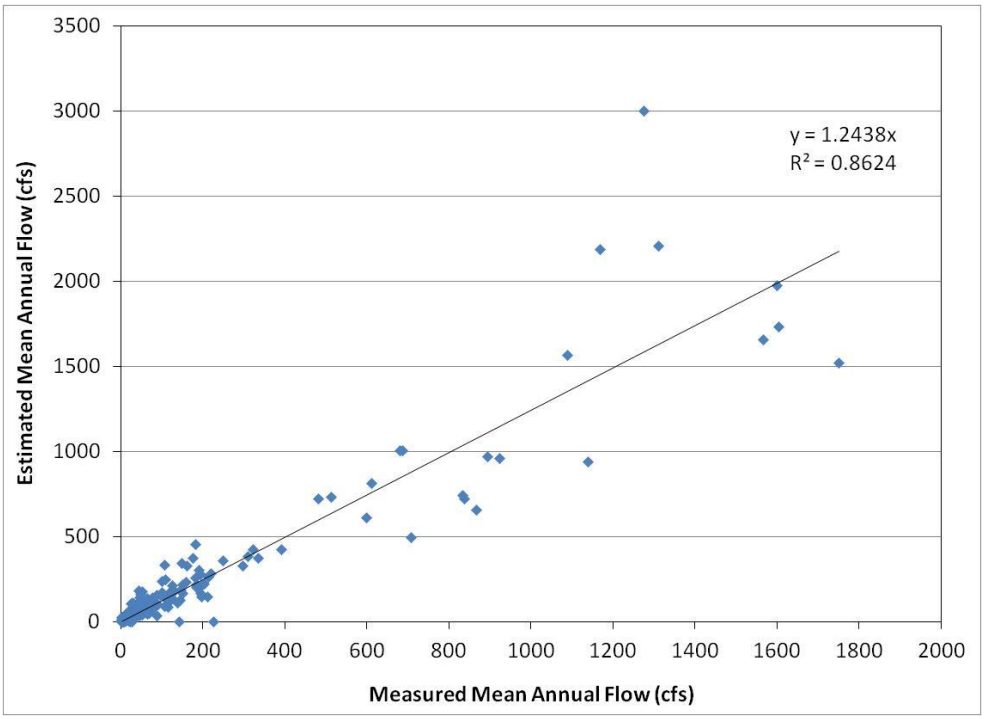

Figure 4. Relationship between measured mean annual flow and NHD*Plus* V2 EROM estimated mean annual flow at 189 USGS gage sites in Wyoming.

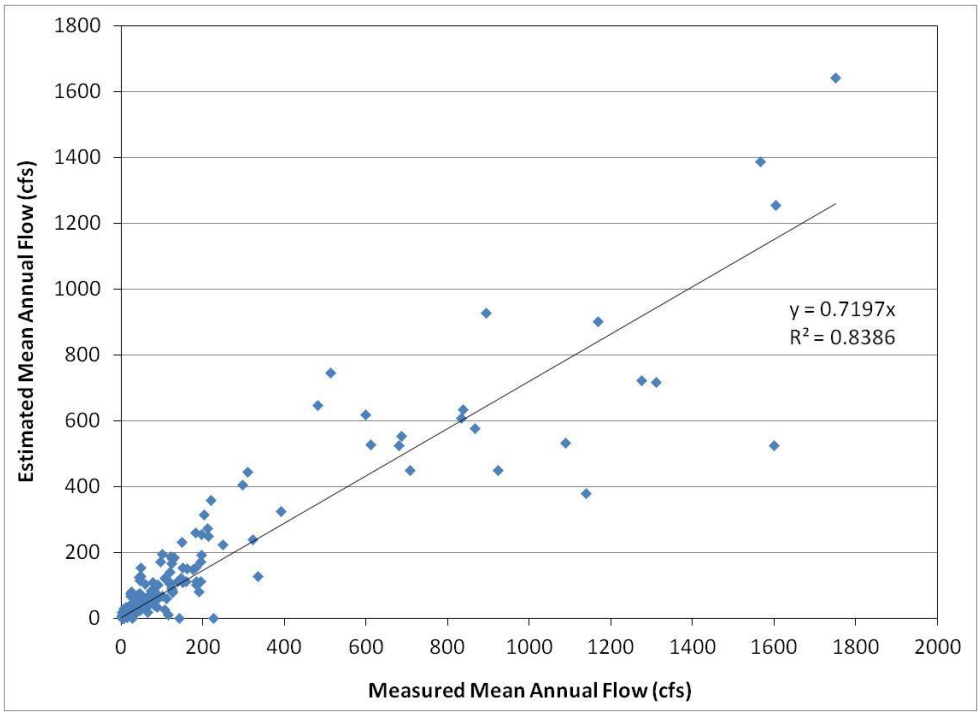

Figure 5. Relationship between measured mean annual flow and NHDPlus V2 Vogel and EROM estimated mean annual flow at 189 USGS gage sites in Wyoming.

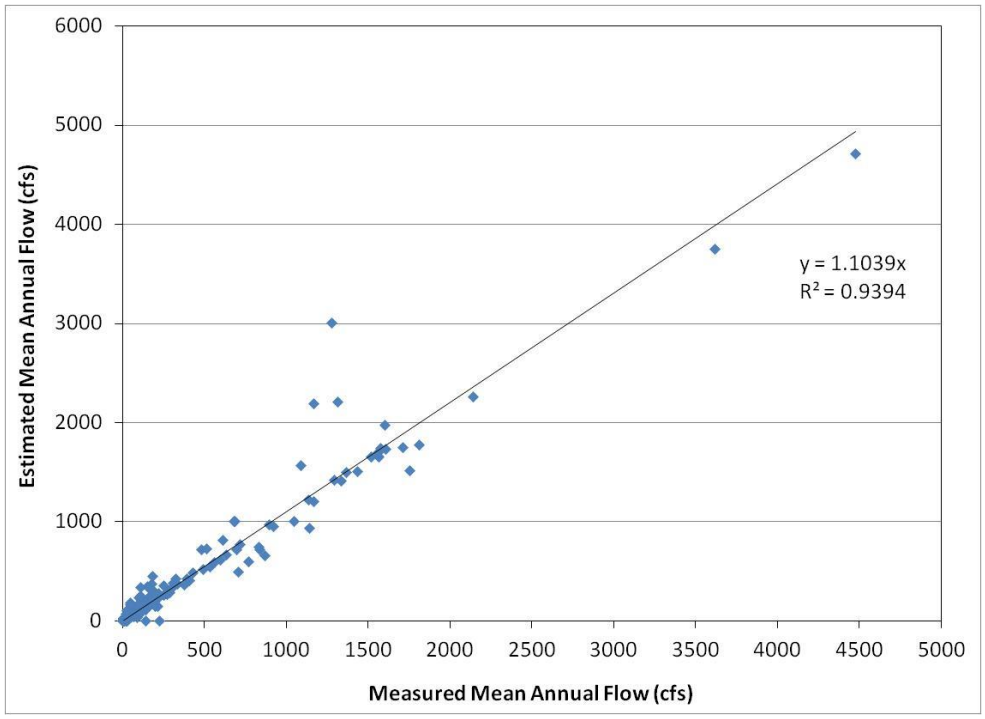

Figure 6. Relationship between measured mean annual flow and NHD*Plus* V2 EROM estimated mean annual flow at 257 USGS gage sites in Wyoming.

Streams that lack sufficient flow to support full body contact or immersion will generally fall into one of three categories in Wyoming: ephemeral streams; small intermittent streams (i.e., those with small watersheds, those that are dewatered during the primary recreation season, or those that are naturally dry during portions of the primary recreation season); or small perennial streams (i.e., those that are spring fed, those with very small watersheds, or those that are dewatered during the recreation season). Ephemeral streams are those that "flow only in direct response to a single precipitation event in the immediate watershed or in response to a single snow melt event, and which the channel bottom is always above the prevailing water table" (WDEQ/WQD 2013a).

Ephemeral streams typically do not support primary contact recreation because they only have water for very short periods immediately following precipitation events. An intermittent stream is a "stream or parts of stream where the channel bottom is above the local water table for some part of the year, but is not a perennial stream" (WDEQ/WQD 2013a). Smaller intermittent streams will generally not have enough flow to support primary contact recreation because they lack sufficient flow and/or depth to allow for immersion and may dry up for portions of the primary recreation season. A perennial stream is "a stream or part of a stream that flows continually during all of the calendar year as the result of a groundwater discharge or surface runoff" (WDEQ/WQD 2013a). Very small perennial streams do not support primary contact recreation because they lack sufficient flow and/or depth for immersion.

To identify streams that do not support primary contact recreation, WDEQ/WQD evaluated the relationship between mean annual flow and mean summer recreation season flow. More than 75% of the total annual streamflow at 257 USGS gage sites in Wyoming occurs during the primary recreation season (May 1 – September 30; Figure 7). Since the majority of the 257 gages are located on larger perennial streams (i.e., streams that are not ephemeral, small intermittent streams or small perennial streams), mean recreation season flows will generally be much higher than mean annual flows for streams that support primary contact recreation ($Q_{REC} > Q_{MAF}$). Conversely, the mean annual flow and mean recreation season flow of streams that do not support primary contact recreation will be more similar ($Q_{REC} \approx Q_{MAF}$) since small perennial streams do not have large enough watersheds to contribute significant runoff during the recreation season, ephemeral streams only flow in response to precipitation events throughout the year, and smaller intermittent streams do not have large enough watersheds to contribute runoff during the recreation season or may be dry for portions of the recreation season.

Annual hydrographs in a non-drought year, 1996[6], from three USGS gages located in northeast Wyoming show the relationship between mean annual flow and mean recreation season flow for a small perennial stream with a watershed area of 10.0 mi^2 (USGS gage 06392900); an ephemeral stream with a watershed area of 234 mi^2 (USGS gage 06375600); and a perennial stream with a watershed area of 204 mi^2 (USGS gage 06298000) (Figure 8). These gages were identified as perennial and ephemeral in an assessment of low flows in streams in northeast Wyoming (Armentrout and Wilson 1987). As identified in the hydrographs, mean recreation season flow is similar to mean annual flow for the small perennial stream and the ephemeral stream, while mean recreation season

[6] Palmer Drought Severity Index for 1996 was 3.38. http://www.ncdc.noaa.gov/temp-and-precip/ranks.php

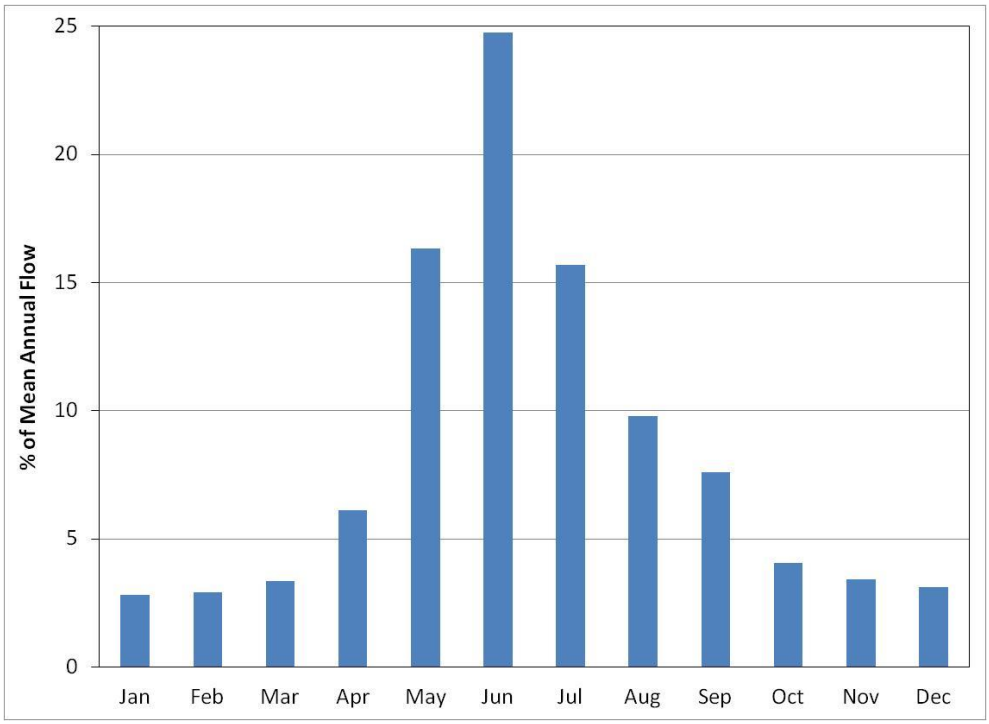

Figure 7. Percentage of mean annual flow by month for 257 USGS gage sites in Wyoming.

flow is much greater than mean annual flow for the larger perennial stream.

At the 257 USGS gages in Wyoming, mean recreation season flow was approximately 1.7 times mean annual flow (Figure 9; $R^2 = 0.98$). For gage sites with the lowest 20% of mean annual flows (51 gages), the relationship was similar; mean recreation season flow was approximately 1.7 times mean annual flow (Figure 10; $R^2 = 0.84$). However, for the 15 gage sites with mean annual flows less than 6 cfs, the relationship between mean annual flow and mean recreation season flow is closer to 1:1. Mean recreation season flow was 1.2 times mean annual flow (Figure 10). The period of record for the 15 gages was 10 to 39 years.

To confirm the relationship between mean annual flow and mean recreation season flow for USGS gage sites with mean annual flows less than 6 cfs, WDEQ/WQD determined mean recreation season flow for an additional 9 USGS gages located within adjacent states in HUC8 watersheds that either originate or terminate in Wyoming (Figure 3). The period of record for these gages ranged from 10 to 43 years. For the combined 24 gages, mean recreation season flow was approximately 1.3 times mean annual flow (Figure 11).

Based on this analysis, streams with mean annual flows less than 6 cfs have similar mean recreation season and mean annual flows. Streams with similar mean recreation season and mean annual flows have flow regimes that are typical of streams with insufficient flow to support primary contact recreation (i.e., ephemeral streams, small intermittent streams and small perennial streams). Therefore, streams with mean annual flows less than 6 cfs do not have sufficient flow to support primary contact recreation unless they occur in areas that are easily accessible to children and/or the public.

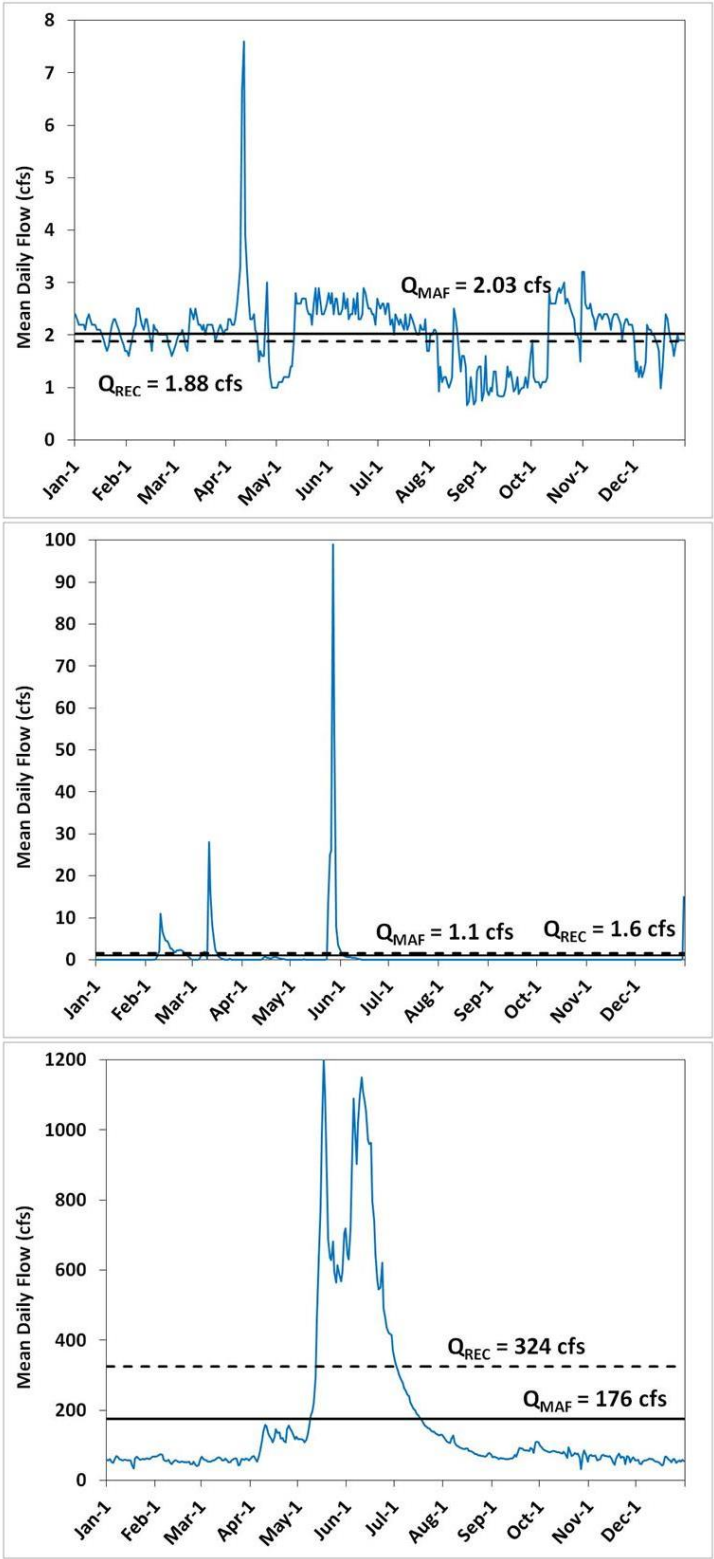

Figure 8. Mean daily flow (blue line), mean annual flow (black line), and mean recreation season flow (dotted line) during 1996 for, from top to bottom, a perennial stream (USGS gage 06392900, watershed area 10 mi^2); an ephemeral stream (USGS gage 06375600, watershed area 234 mi^2); and a perennial stream (USGS gage 06298000, watershed area 204 mi^2).

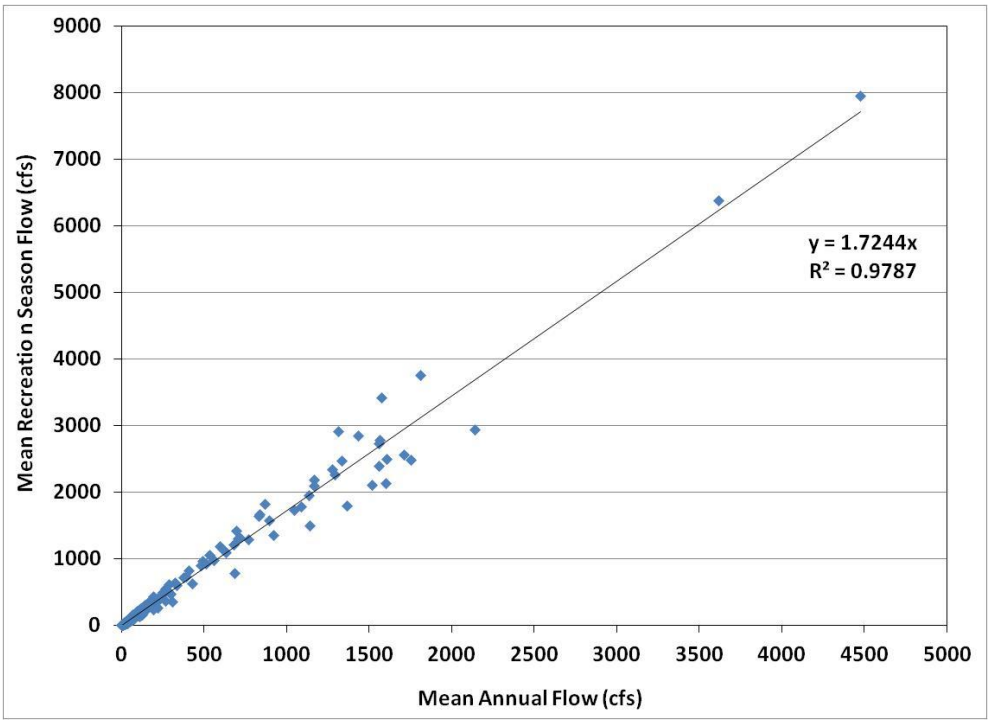

Figure 9. Relationship between mean annual flow and mean recreation season flow for 257 UGSG gages located in Wyoming.

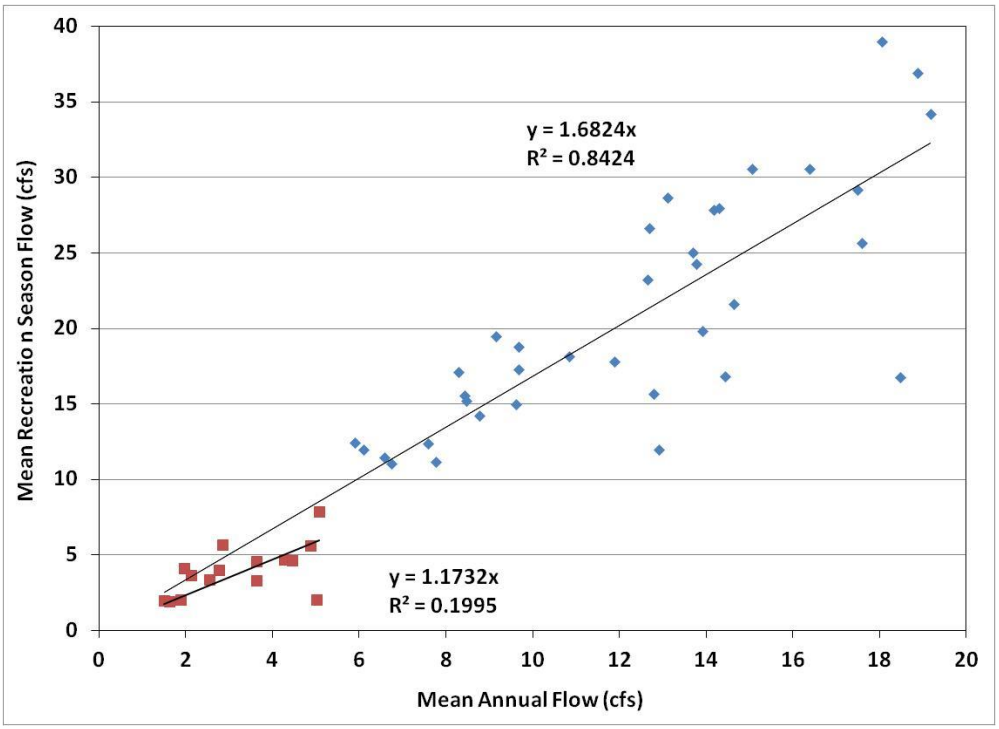

Figure 10. Relationship between mean annual flow and mean recreation season flow for 51 USGS gages located in Wyoming with the lowest 20% of mean annual flows (all points) and the 15 USGS gages with mean annual flows less than 6 cfs (red points).

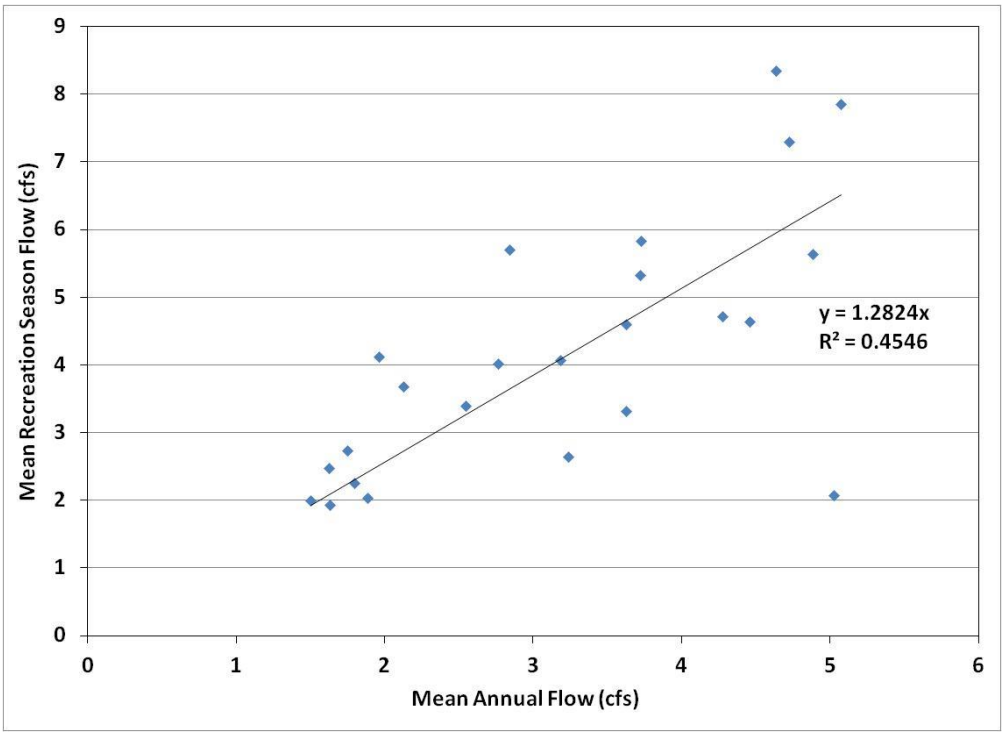

Figure 11. Relationship between mean annual flow and mean recreation season flow for 24 USGS gages located in Wyoming and adjacent HUC8 watersheds with mean annual flows less than 6 cfs.

It is important to note, however, that while using EROM mean annual flows is appropriate for identifying streams that do not have sufficient flow to support primary contact recreation at a statewide scale, there are likely streams with mean annual flows of 6 cfs or greater that also do not have sufficient flow to support primary contact recreation. For these streams, site-specific information should be collected to demonstrate that there is not sufficient flow and/or depth to support primary contact recreation, even though the EROM mean annual flow is 6 cfs or greater. In addition to demonstrating that there is not sufficient flow and/or depth to support primary contact recreation, a site-specific UAA would also need to show that the stream is not used for or likely to be used for primary contact recreation.

Furthermore, the EROM mean annual flow values are modeled estimates. In situations where actual flow measurements indicate that the mean annual flow of a stream is less than 6 cfs, these data can be used to demonstrate that the stream does not have sufficient flow to support primary contact recreation. In circumstances where actual flow measurements were available, either from a USGS gage or from other entities, and showed that the mean annual flow of the stream was less than 6 cfs, the measured mean annual flow was used in the flow analysis. The measured mean annual flow was applied to the stream segment where the gage was located and also used to extrapolate mean annual flow upstream and downstream of the gaged segment using the proportional EROM mean annual flow estimates. Where a site-specific UAA had been submitted to WDEQ and sufficiently demonstrated that there was insufficient flow to support primary contact recreation, WDEQ/WQD used the qualitative flow information submitted in the UAA to identify those streams as low flow. Site-specific UAAs used to identify a stream as “low flow” in the *Categorical UAA for Recreation* were submitted for portions of Poison Creek, Nowater Creek, East Fork Nowater Creek, Fifteenmile Creek,

and Kirby Creek. Portions of the site-specific UAAs used in the analysis are included in Appendix B of the *Categorical Use Attainability Analysis for Recreation Response to Comments for the Comment Period Ending September 30, 2013*.

3.3.3 Validation: Mean Recreation Season Depth of Low Flow Streams

As an additional line of evidence to show that streams with mean annual flows less than 6 cfs do not support primary contact recreation, WDEQ/WQD evaluated the relationship between mean annual flow and mean recreation season depth at USGS gage sites with mean annual flows less than 6 cfs. Of the 24 gages with mean annual flows less than 6 cfs, 17 gages had USGS field measurement data that could be used to calculate mean cross-sectional depth. USGS field data consists of cross sectional area, stream width, and velocity measurements for some or all of the field discharge values. Mean depth of the stream channel was calculated using the cross sectional area and stream width for each data point. Flow was plotted with mean depth for each field measurement and a best fit relationship identified (see Figure 12 as an example).

Mean recreation season depth was then calculated using the best fit relationship and mean recreation season flow at each gage site. For the 17 USGS gage sites with mean annual flows less than 6 cfs, the average mean recreation season depth was 0.5 feet and ranged from 0.4 feet to 0.8 feet (Figure 13). Based on the best fit relationship for all 17 gages, a stream site with a MAF of 6 cfs will have a mean recreation season depth of approximately 0.6 feet. Although the mean recreational season depth information presented here is not representative of an entire stream reach, the depth information does indicate that streams with mean annual flows less than 6 cfs will rarely have median depths at base flow conditions that exceed 1.5 feet. Moreover, based on the shallow depths of the cross sections, it is also unlikely that these streams will have isolated pools with depths greater than 3 feet.

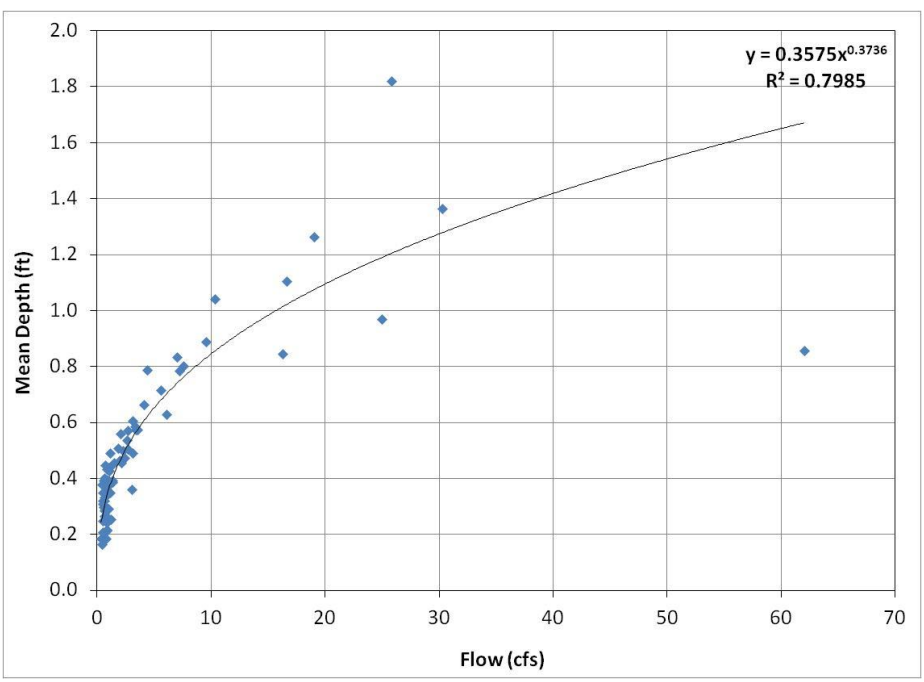

Figure 12. Relationship between flow and mean depth for USGS gage site 06647890 based on field measurement data. Mean depth calculated by dividing cross sectional area by width.

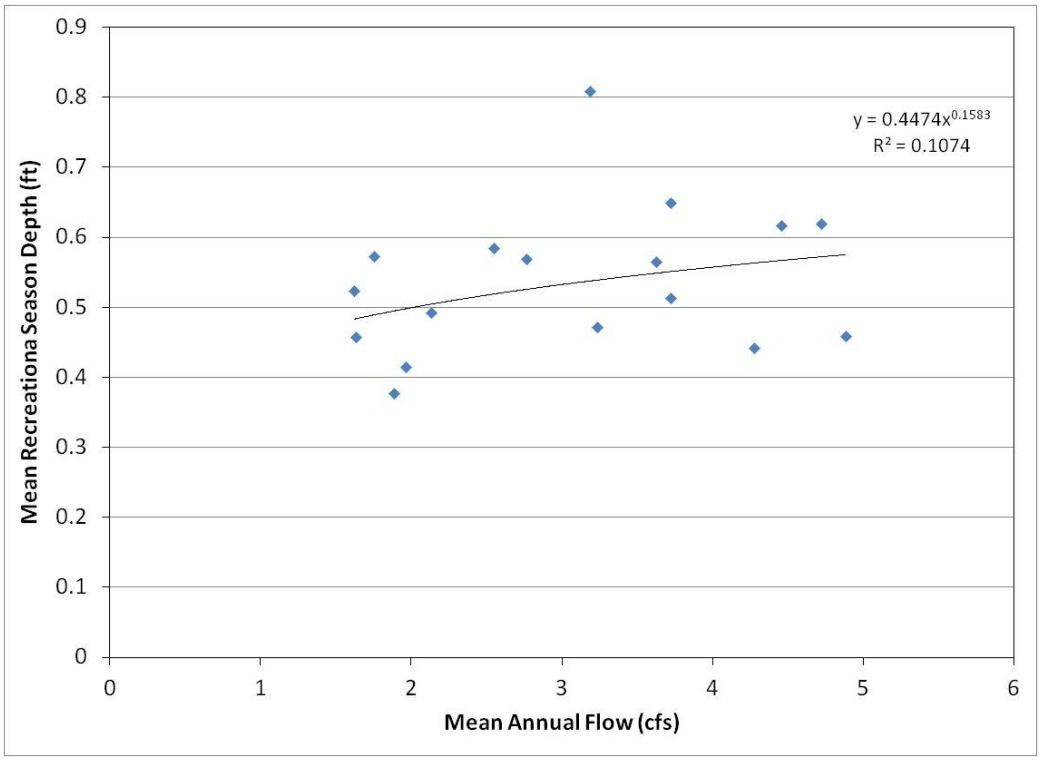

Figure 13. Relationship between mean annual flow and mean recreation season depth at 17 USGS gages with mean annual flows less than 6 cfs.

3.3.4 Validation: WDEQ Field Survey Photos

In July 2010, WDEQ staff visited 151 sites to evaluate an early version of the UAA. In September, October and November of 2010, staff from Wyoming's Conservation Districts visited over 700 sites to help validate the UAA. During site visits, field forms were completed and photographs were taken. Photographs of streams of varying orders, mean annual precipitation bands (USDA/NRCS 2006), and mean annual flows are shown below to depict typical channel characteristics of streams with mean annual flows less than 6 cfs (Figures 14-26) and greater than or equal to 6 cfs (Figures 27-34). The photographs are shown only to depict channel and flow characteristics; streams with mean annual flows less than 6 cfs shown here may be designated as primary based on the access datasets.

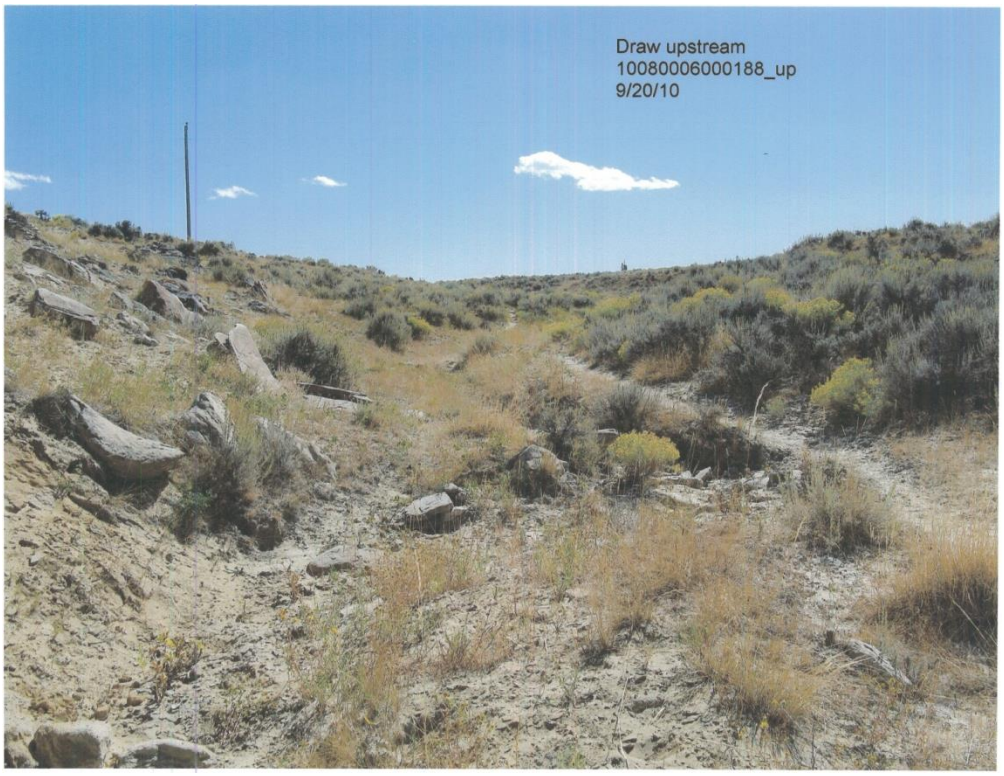

Figure 14. Lower Wind River Conservation District survey point, Unnamed Stream, September 20, 2010. EROM mean annual flow 0.1 cfs, 1st order. Mean annual precipitation 9 inches.

Figure 15. Campbell County Conservation District survey point, tributary to Wild Horse Creek, September 1, 2010. EROM mean annual flow 0.1 cfs, 1st order. Mean annual precipitation 15 inches.

Figure 16. WDEQ site survey site 17, Cottonwood Creek, July 14, 2010. EROM mean annual flow 0.1 cfs, 1st order. Mean annual precipitation 17 inches.

Figure 17. Campbell County Conservation District survey point, Road Creek, September 22, 2010. EROM mean annual flow 0.2 cfs, 1st order. Mean annual precipitation 15 inches.

Figure 18. WDEQ survey site 13, Unnamed Creek, July 14, 2010. EROM mean annual flow 0.5 cfs, 2nd order. Mean annual precipitation 19 inches.

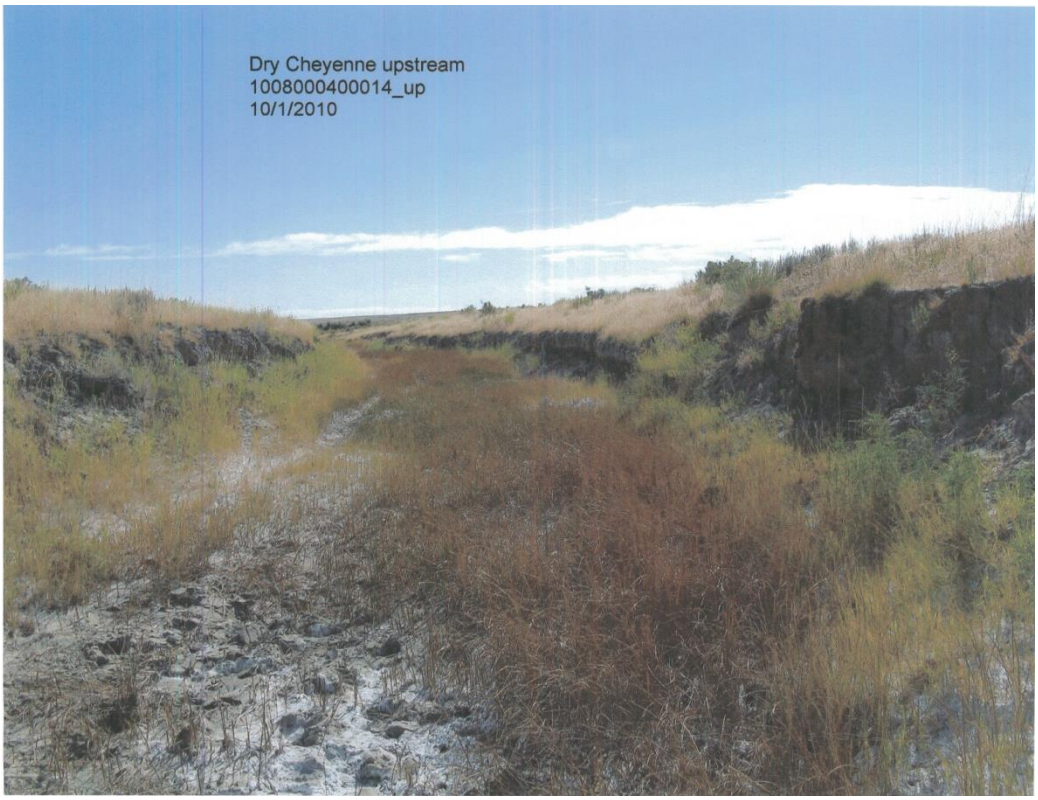

Figure 19. Lower Wind River Conservation District survey site, Dry Cheyenne, October 1, 2010. EROM mean annual flow 1.5 cfs, 3rd order. Mean annual precipitation 7 inches.

Figure 20. Lower Wind River Conservation District survey site, Dry Cheyenne, October 1, 2010. EROM mean annual flow 2.0 cfs, 3rd order. Mean annual precipitation 7 inches.

Figure 21. Goshen County Conservation District survey site, Sheep Creek, September 30, 2010. EROM mean annual flow 2.6 cfs, 3rd order. Mean annual precipitation 15 inches.

Figure 22. WDEQ survey site 118, Corduroy Creek, July 27, 2010. EROM mean annual flow 2.8 cfs, 1st order. Mean annual precipitation 21 inches.

Figure 23. WDEQ survey site 115, Grouse Creek, July 26, 2010. EROM mean annual flow 2.8 cfs, 1st order. Mean annual precipitation 21 inches.

Figure 24. WDEQ survey site 30, Little Willow Creek, July 15, 2010. EROM mean annual flow 2.8 cfs, 1st order. Mean annual precipitation 25 inches.

Figure 25. WDEQ survey site 66, Red Creek, July 17, 2010. EROM mean annual flow 3.9 cfs, 1st order. Mean annual precipitation 25 inches.

Figure 26. WDEQ survey site 117, Indian Creek, July 27, 2010. EROM mean annual flow 4.8 cfs, 2nd order. Mean annual precipitation 21 inches.

Figure 27. WDEQ survey site 93, Beaver Creek, July 19, 2010. EROM mean annual flow 6.0 cfs, 1st order. Mean annual precipitation 17 inches.

Figure 28. WDEQ survey site 151, South Lodgepole Creek, July 29, 2010. EROM mean annual flow 6.1 cfs, 1st order. Mean annual precipitation 21 inches.

Figure 29. Dubois-Crowheart Conservation District survey site, Tappan Creek, September 17, 2010. EROM mean annual flow 8.5 cfs, 2nd order. Mean annual precipitation 11 inches.

Figure 30. Dubois-Crowheart Conservation District survey site, Whiskey Creek, September 2, 2010. EROM mean annual flow 9.9 cfs, 3rd order. Mean annual precipitation 11 inches.

Figure 31. WDEQ survey site 10, Beaver Creek, July 13, 2010. EROM mean annual flow 12.5 cfs, 3rd order. Mean annual precipitation 25 inches.

Figure 32. WDEQ survey site 46, Elk Park Creek, July 16, 2010. EROM mean annual flow 13.6 cfs, 3rd order. Mean annual precipitation 17 inches.

Figure 33. WDEQ survey site 99, Sawmill Creek, July 19, 2010. EROM mean annual flow 14.0 cfs, 1st order. Mean annual precipitation 25 inches.

Figure 34. WDEQ survey site 116, La Bonte Creek, July 26, 2010. EROM mean annual flow 14.5 cfs, 3rd order. Mean annual precipitation 21 inches.

3.4 Point Source Discharges

WDEQ/WQD used point source discharge volumes to complete the flow analysis, as Chapter 1, Section 33(b)(ii) and 40 CFR 131.10(g)(2) identify that "natural, ephemeral, intermittent or low flow conditions or water levels prevent the attainment of the use, *unless these conditions may be compensated for by the discharge of sufficient volume of effluent discharges*…". WDEQ/WQD identified streams where primary contact recreation may be attainable due to point source discharges by adding measured discharge volumes reported by permittees during the 2012 calendar year to the EROM mean annual flow estimates provided in NHDPlus V2 if the discharge point was located within 300 feet of a stream segment. WDEQ/WQD considered 2012 data representative of current discharge conditions rather than a longer period of record due to reduced production from coal bed methane in recent years. Discharges from coal bed methane are not expected to return in the near future due to low natural gas prices. For outfalls that had multiple measured discharge rates, the reported discharge values were averaged. The addition of WYPDES flow resulted in the addition of approximately 12 stream miles, although some of these segments would have been identified as primary due to access.

3.5 Mean Annual Flow of Streams Not Present in the 100k NHD

NHDPlus V2 mean annual flow information is only available for streams in the 100k NHD. Even though the 100k NHD includes most streams of interest in the state, to avoid situations where a stream has not been designated for primary or secondary contact recreation, streams not present in the 100k

NHD were also evaluated as part of this UAA. The 100k NHD includes approximately 116,000 stream miles in Wyoming. The 24k NHD, on the other hand, includes approximately 281,000 stream miles in Wyoming. The 165,000 additional stream miles in the 24k NHD are a more detailed representation of streams present in the 100k NHD as well as thousands of miles of ephemeral tributaries to streams present at the 100k (see Figure 35 for differences between the 24k and 100k NHD). WDEQ/WQD is also aware of other streams and ditches not depicted in either the 100k or 24k NHD.

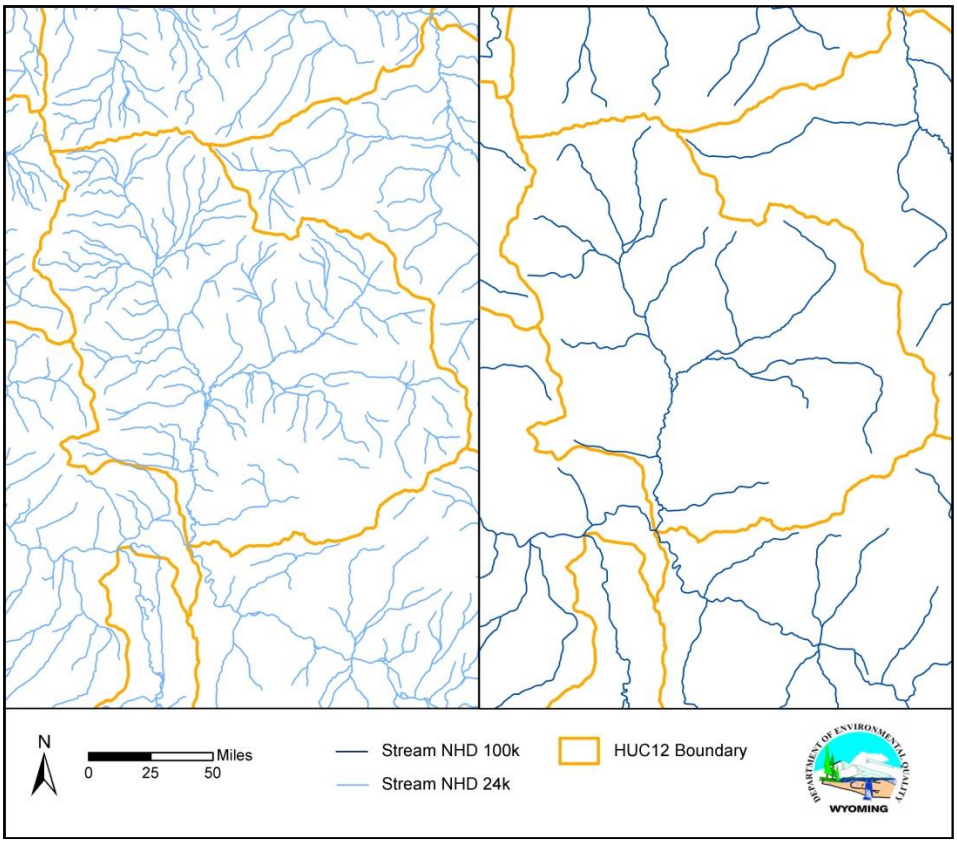

Figure 35. 100k and 24k NHD streams present in HUC12 170501020301. Mean annual precipitation 35-41 inches per year (USDA/NRCS 2006).

Watershed area and mean annual flow data from 100k NHD headwater (1st order) streams were used to extrapolate watershed area and mean annual flows for streams not present in the 100k NHD. First order streams in the 100k NHD have a mean watershed area of 8.6 mi^2, a median watershed area of 1.5 mi^2, and 95th percentile of 7.1 mi^2. First order streams in the 100k NHD have an average mean annual flow of 1.1 cfs, a median of 0.2 cfs, and 95th percentile of 4.8 cfs. Since streams not present in the 100k NHD are generally tributaries to 1st order 100k NHD streams and because flow and stream size generally increase as you move downstream, streams not present in the 100k NHD will have mean annual flows less than the 6 cfs threshold of streams that do not support primary contact recreation. As a result, streams not present in the 100k NHD do not have sufficient flow to support primary contact recreation and will be designated for secondary contact, unless they are located in areas that are easily accessible to children and/or the public.

4.0 ACCESS AND RECREATION AREAS

Additional data layers were used to identify streams with mean annual flows less than 6 cfs that may be used for primary contact recreation because the stream is easily accessed by children and/or the public or is located near a recreation area frequented by children and/or the public. Although streams in these areas lack sufficient flow for immersion, they are protected for primary contact recreation because water from these streams may be ingested. Streams that do not support primary contact recreation due to low flow conditions that are not located near population centers, schools or recreation sites are designated for secondary contact recreation, as outlined below.

4.1 Demographics of Wyoming

With a population of 563,626 persons based on the April 1, 2010 demographic data from the US Census Bureau, Wyoming is the least populous state in the United States[7] (USCB 2013). This translates to approximately 5.8 persons per square mile, compared to the average U.S. population density of 87.4 persons per square mile. Moreover, since approximately 70% of Wyoming's population lives in towns, large areas of the state are uninhabited. As a result, the majority of ephemeral, small intermittent and small perennial streams with insufficient flow to support primary contact recreation do not attract children and/or the public for recreation because they are not located near population centers, schools or recreation sites.

4.2 Data Layers and Buffers

Access and recreational opportunity data layers used in the categorical UAA were derived from multiple sources (Table A-1, Appendix A). Data were downloaded and used directly from a given source, obtained from multiple data sources and combined into one dataset, or generated by WDEQ. Since various entities frequently update their datasets, the specific datasets used in the UAA should be obtained directly from WDEQ/WQD (see Appendix B for a step by step process of how the UAA was developed).

Datasets and 1.0 mile and 0.5 mile buffers were used to identify primary areas and 100k NHD streams for primary contact recreation based on the likelihood that streams will be used for primary contact recreation (Table 1). Primary areas are used to identify the recreation designated use of streams not present in the 100k NHD. Distances were based on a general understanding of how far children and/or members of the public walk from their homes, schools and recreation sites.

4.2.1 Populated Places and Schools

Populated places and schools were treated similarly because both are frequented by children and/or the public. Primary areas and 100k streams located within and 1.0 mile from the boundary of census blocks with 55 person per square mile or greater and within 1.0 mile from a school were designated for primary contact recreation. A buffer distance of 1.0 mile was selected based on the distance

[7] United States Census Bureau: http://quickfacts.census.gov/qfd/states/56000.html

Table 1. Datasets and buffer distances used to identify low flow streams that may be used for primary contact recreation in the Categorical UAA for Recreation.

Category	Dataset	Buffer Distances
Populated Places and Schools	Census Blocks with Populations Greater than 55 Persons/square mile	1.0
	Schools	1.0
Established Recreation Areas	Campgrounds	0.5
	USFS and BLM Recreation Sites, Natural Areas, and WY DOT Rest Areas	0.5
	National Parks and Recreation Areas, State Parks and Historic Sites	Within Boundary
Other Accessible Recreation Areas	Trailheads (on public land and within 0.25 miles of a road)	0.5
	Dispersed Campsites (on public land and within 0.25 miles of a road)	0.5

elementary students are expected to walk to school; elementary schools students are bused if they live more than 1.0 mile from a school based on Wyoming Department of Education Policy (WDE 2002). Since elementary school children are expected to walk up to 1.0 miles to school, WDEQ/WQD anticipates that children and/or members of the public may travel up to 1.0 mile from populated places and potentially use streams within that distance for primary contact recreation.

The census block data set (Figure A-1) was derived from the United States Census Bureau 2010 dataset (11,272 polygons). Census blocks with a population density greater than 55 persons per square mile were derived from the 2010 census data by dividing the population by the area of the census block. Population densities greater than 55 persons per square mile were chosen because this density represented the lowest population density of Wyoming's 98 largest municipalities. School locations were derived from a combination of U.S. Department of Education and Wyoming Department of Education references (376 schools; Figure A-2).

4.2.2 Established Recreation Areas

Established recreation areas were identified as campgrounds, United States Forest Service (USFS) and Bureau of Land Management (BLM) recreation sites, natural areas, Wyoming Department of Transportation (WYDOT) Rest Areas, National Parks and Recreation Areas, and State Parks and Historic Sites. Streams within the boundaries of parks, monuments or historic sites, or within 0.5 miles of other types of established recreation areas were designated for primary contact recreation, as streams located within these areas may be used for primary contact recreation because they are easily accessible to children and/or members of the public.

Campground locations were derived from the Wyoming GeoLibrary (Campgrounds from the USGS Names Database for Wyoming at 1:24,000) and USFS and BLM datasets (397 campgrounds; Figure A-3). Recreation sites were obtained from the USFS and BLM (e.g., picnic areas and boat ramps), Natural Areas from the Wyoming GeoLibrary (Natural Area Tourist Visitation Places for Wyoming at 1:100,000), and Rest Areas from the WYDOT (280 sites; Figure A-4). National Parks and Recreation Areas and State Parks and Historic Sites (Figure A-5) were derived from the National Parks Service

data store (8 areas; 2.5 million acres), and the State Parks, Historical Sites and Trails Department (49 areas; 119,000 acres).

4.2.3 Other Accessible Recreation Areas

Trailheads and dispersed campsites located on public land and in close proximity to roads were identified as other recreation areas where nearby streams may be used for primary contact recreation. Trailheads and dispersed campsites located on public land and within the 0.25 mile buffer for roads were selected and streams within 0.5 miles of these dispersed campsite or trailheads were designated for primary contact recreation (Table 1).

Trailhead locations were derived from USFS and BLM datasets (186 trailheads; Figure A-6). Other trailhead locations within the state (i.e. trailheads within national parks, state parks, historic sites, etc.) were not included in the dataset, as streams within these areas were already designated for primary contact recreation.

Dispersed campsite data were received from Bighorn, Black Hills, Bridger-Teton, Caribou-Targhee, Medicine Bow, Shoshone, and Uinta-Wasatch-Cache National Forests. In portions of Bighorn, Bridger-Teton, and Shoshone National Forests where data were lacking, WDEQ personnel collected data directly using GPS surveys (Figure A-7).

Two sources were used to obtain a sufficient roads layer for the state, WYDOT and USFS (Figure A-8). WYDOT highways and county road datasets were combined with USFS roads suitable for passenger cars (USFS categories 3-5), resulting in an approximately 29,000 mile dataset. USFS roads suitable for passenger cars were based on a USFS roads scale of 1-5: basic custodial care (1), high clearance vehicles (2), suitable for passenger cars (3), moderate degree of user comfort (4), and high degree of user comfort (5).

The public lands layer was derived from the BLM GIS data server for Wyoming (Figure A-9). Public land included all lands managed by the National Park Service, National Grasslands, Bureau of Indian Affairs, Fish and Wildlife Service, USFS, State, BLM, Department of Energy, Bureau of Reclamation, Department of Defense, and Corps of Engineers. All other lands were considered private and not included in the analysis.

4.3 Recreation Use Designations

The primary areas and 100k streams identified for primary contact recreation were those: within or one mile from census blocks with population densities of 55 persons per square mile or greater; within one mile of a school; within 0.5 miles of established campgrounds, United States Forest Service (USFS) recreation sites, Natural Areas, and Wyoming Department of Transportation (WYDOT) Rest Areas; within National Parks and Recreation Areas, State Parks and Historic Sites. Additional streams that may be used for primary contact recreation were identified by overlaying trailheads and dispersed campsites located on public land with the 0.25 mile buffer for roads; primary areas and 100k streams within 0.5 miles of these trailheads and dispersed campsites were designated for primary contact recreation (Figure 36).

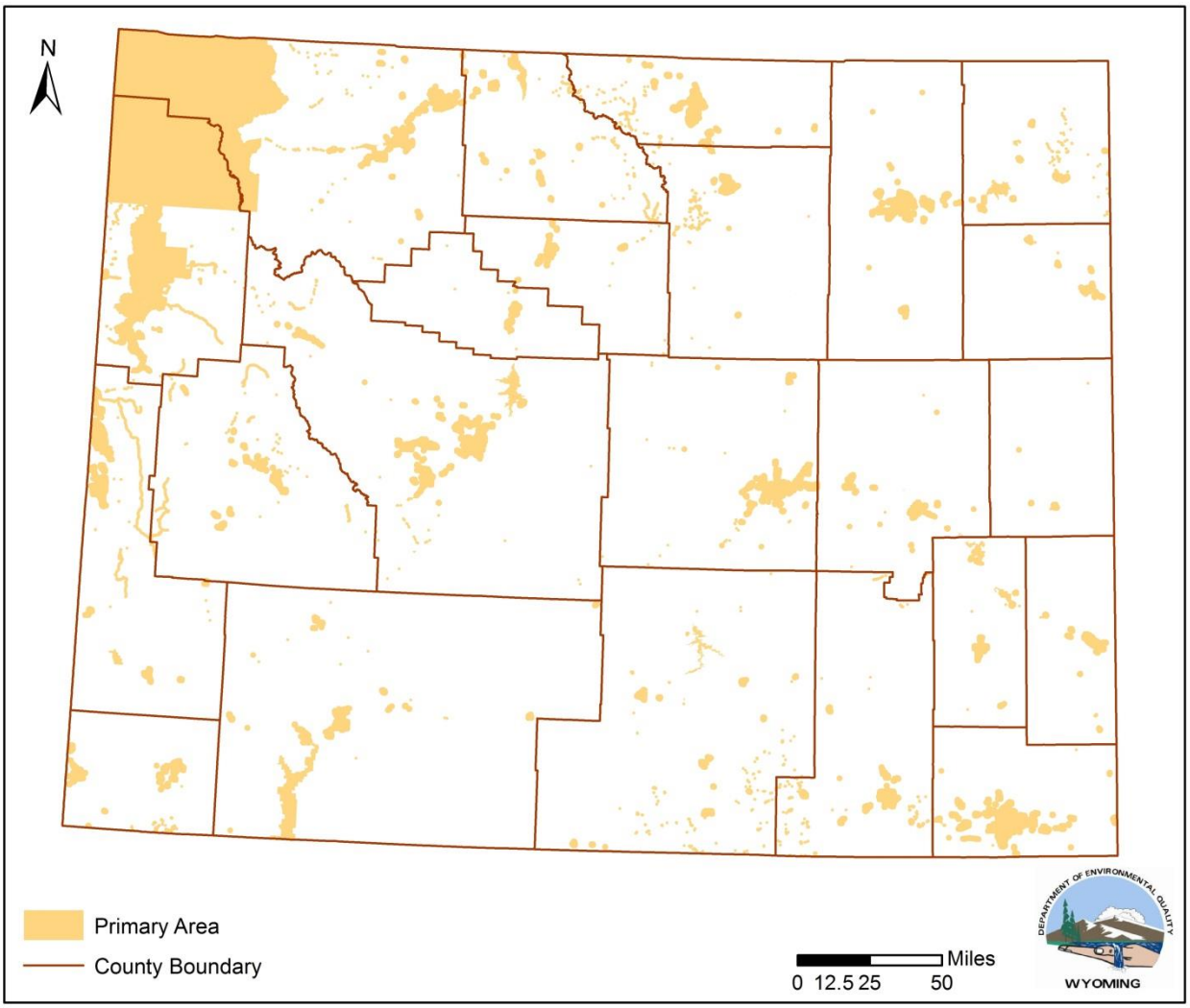

Figure 36. Areas of Wyoming where streams not present in the 100k NHD are designated for primary contact recreation.

5.0 EXTENSIONS

To help eliminate isolated primary streams, two primary segments separated by an isolated secondary segment were extended to include the isolated secondary segment. Side channels of braided primary streams were also designated as primary.

6.0 RESULTS

Based on this analysis, approximately 94,855 of the 115,373 100k NHD miles of streams addressed in this UAA do not have sufficient flow to support full body contact water recreation activities such a swimming (Table 2, Figure 37). Of these 94,855 stream miles, approximately 5,837 stream miles occur in areas frequented by the public and/or children due to their proximity to schools, towns and recreation areas. Although these streams do not support full body contact water recreation, because water from these streams may be ingested, they have been designated for primary contact

recreation. An additional 1,243 stream miles were designated as primary through the extension process to eliminate isolated primary or secondary stream segments. When combined, approximately 87,775 of the 115,373 100k NHD streams addressed in this UAA, 76.1%, of Wyoming's streams, do not have sufficient flow to support primary contact recreation and are not located in areas that are frequented by children and/or the public. These 87,775 stream miles represent streams where primary contact recreation is not an existing or attainable use (Figure 38). Because primary contact recreation is not an existing or attainable use on these 87,775 stream miles, the primary contact recreation use can be removed and these streams can be designated for secondary contact recreation.

Table 2. Stream miles and percentage of stream miles of UAA datasets and results.

UAA Datasets	Stream Miles	Percent of Stream Miles
Total 100k NHD Streams	115,373	100.0
Mean Annual Flow ≥ 6 cfs	20,507	17.8
Mean Annual Flow + WYDES ≥ 6 cfs	12	0.0
Mean Annual Flow < 6 cfs	94,855	82.2
Primary Due to Access	5,837	5.1
Primary Due to Extensions	1,243	1.1
Total Primary Streams	27,598	23.9
Total Secondary Streams	87,775	76.1

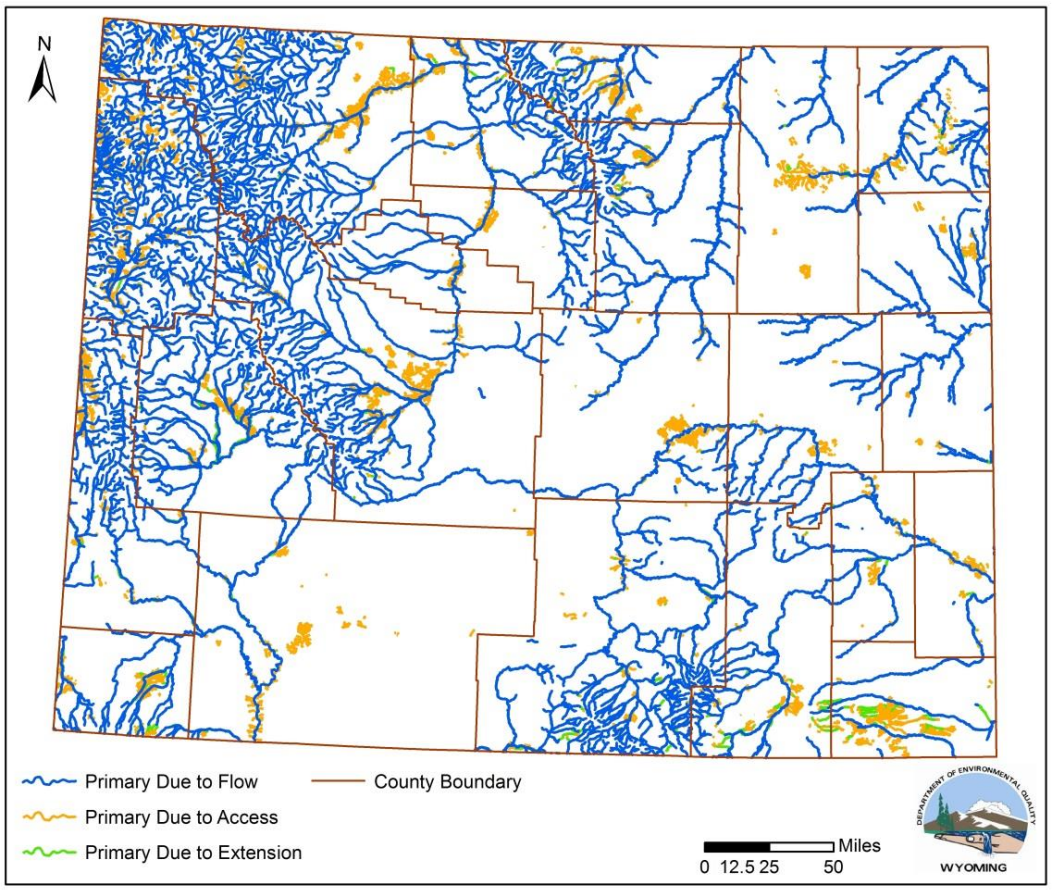

Figure 37. Primary recreation streams based on flow, access, and extensions.

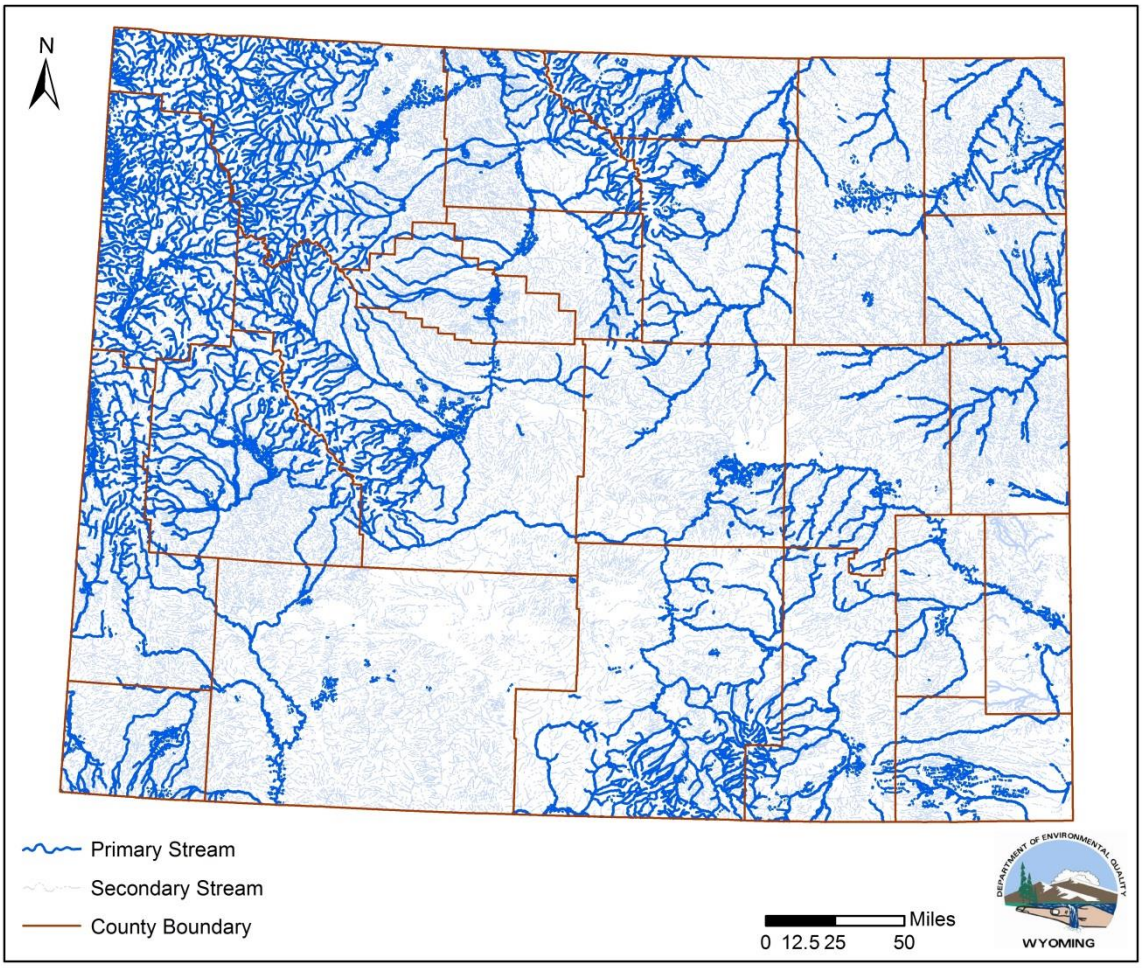

Figure 38. Primary and secondary contact recreation designations based on the Categorical UAA for Recreation.

6.1 Surveys

More than 850 field sites were surveyed by WDEQ/WQD and Wyoming's Conservation Districts during 2010 to validate the *Categorical UAA for Recreation* (Figure 39). WDEQ/WQD conducted a total of 151 surveys in July 2010 on stream segments expected to be on the threshold between primary and secondary contact recreation (See Appendix C, Figure C-1 for survey). The Wyoming Association of Conservation Districts (WACD) facilitated the collection of 720 surveys during the fall of 2010 from 1,000 randomly generated stream survey points (see Figure C-2 for survey). WDEQ/WQD identified 101 of the 151 sites as primary and 50 sites as secondary. Prior to and after the extension process, 5 of the 101 sites identified as primary in the field were designated as secondary by the UAA, resulting in 95% agreement between the UAA and the WDEQ primary surveys.

The WACD surveys identified 250 of 720 sites as primary and 470 as secondary. Prior to the extension process, 18 of the 250 sites identified as primary in the field were designated as secondary by the UAA, resulting in 92.8% agreement between the UAA and the primary surveys. After the extension process, only 13 of the 250 sites identified as primary in the field were designated as secondary by the UAA, resulting in 94.8% agreement between the UAA and the WACD primary surveys.

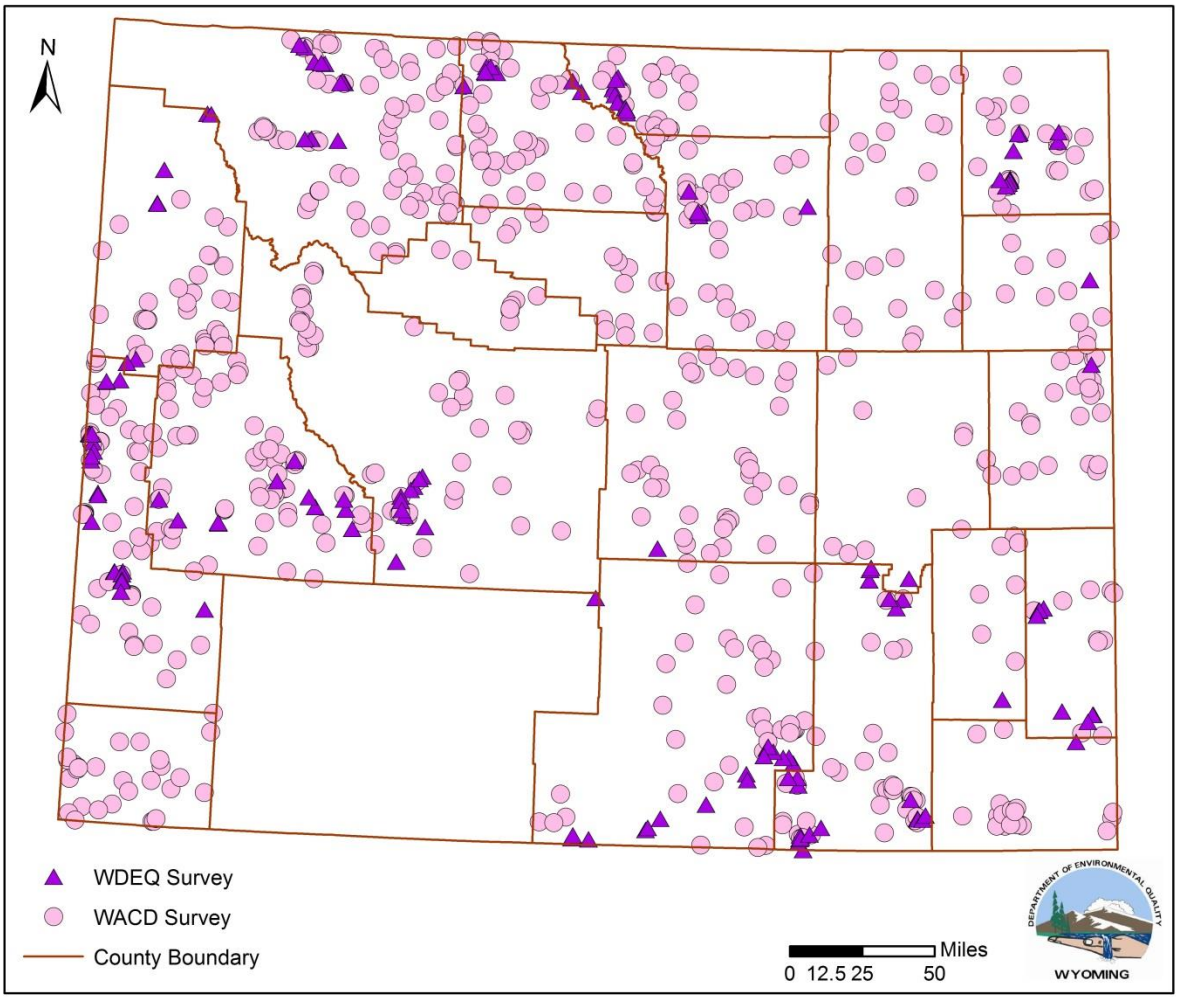

Figure 39. WDEQ/WQD and WACD survey sites. All points are not visible due to overlapping sites.

Overall, prior to extensions, the WDEQ surveys had 76.2% agreement with the UAA, while the WACD surveys had 81.3% agreement with the UAA. The results went down slightly for each of the surveys after the extension process; there was 74.8% agreement between the WDEQ surveys and the UAA and 80.7% agreement between the WACD surveys and the UAA. After combining the two sets of surveys, agreement between the primary surveys was very good, 93.4% before extensions and 94.9% after extensions. Likewise, overall agreement between the two sets of surveys and the UAA was very good; 80.4% before extensions and 79.7% after extensions.

Table 3. Number and percentage of WDEQ, WACD field surveys in agreement with the UAA before and after extensions.

	WDEQ Surveys		WACD Surveys		All Surveys	
Agreement	**No.**	**%**	**No.**	**%**	**No.**	**%**
Primary Before Extensions	96 of 101	95.0	232 of 250	92.8	328 of 351	93.4
Primary After Extensions	96 of 101	95.0	237 of 250	94.8	333 of 351	94.9
Overall Before Extensions	115 of 151	76.2	585 of 720	81.3	700 of 871	80.4
Overall After Extensions	113 of 151	74.8	581 of 720	80.7	694 of 871	79.7

7.0 CONCLUSIONS

The *Categorical UAA for Recreation* used the best information available at a state-wide scale to identify waters where primary contact recreation is not an existing or attainable use. Because the UAA was conducted at a state-wide scale, WDEQ/WQD recognizes that the UAA will not designate the recreational use of all streams of the state correctly. However, after public feedback was incorporated into the UAA, there should be very few instances where a stream is used for or supports primary contact recreation, yet is designated as secondary by the UAA. A much more common occurrence will be streams that do not support primary contact recreation, particularly due to insufficient flow, that are designated as primary. In this circumstance, site-specific UAAs can be used to remove the primary contact recreation use by demonstrating that there is insufficient flow to support primary contact recreation and showing that the stream is not located near a recreation site or area that is easily accessed by children and/or the public. For site-specific UAAs based on the "low flow" factor, information such as mean depth or mean annual flow should be collected to show that the stream is not capable of supporting primary contact recreation.

WDEQ/WQD also recognizes that recreational uses will change over time. Information indicating that a stream designated for secondary contact recreation is used for primary contact recreation will be cause for WDEQ/WQD to change the recreation designated use to primary contact. Further, WDEQ/WQD may update the *Categorical UAA for Recreation* through the formal UAA process as new data and information become available; individuals or entities interested in modifying a recreational use designation for a particular waterbody should contact WDEQ/WQD.

8.0 WORKS CITED

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LP/rm/14-0740

APPENDIX A. DATA SOURCES AND MAPS

Table A-1. Data layers and sources of data used in the categorical UAA for recreation. Sources without hyperlinks were obtained directly from the source. The data presented at these sites may not be identical to those used in the UAA as various entities update their information. For original datasets, contact WDEQ/WQD.

LAYER	SOURCE
Streams	National Hydrography Dataset (USGS; 1:100,000)
Streamflow	NHDPlus Version 2
WYPDES Flow	WYPDES Database
Municipalities/Populated Areas	US Census Bureau 2010 Data
Schools	U.S. Department of Education
	Wyoming Department of Education
National Park Service Areas, State Parks and Historic Sites	National Park Service
	Wyoming State Parks (State Parks and Historic Sites)
Campgrounds	Wyoming Geolibrary (Campgrounds from the USGS Names Database for Wyoming at 1:24,000)
	USFS Region 2 Campgrounds
	USFS Region 4 Campgrounds
	BLM Field Offices
USFS Recreation Sites, Natural Areas, WYDOT Rest Areas	USFS Region 2 Recreation Sites
	USFS Region 4 Recreation Sites
	Wyoming Geolibrary (Natural Area Tourist Visitation Places for Wyoming at 1:100,000)
	Wyoming Department of Transportation
	BLM Field Offices
Trailheads	USFS Region 2 Trailheads
	USFS Region 4 Trailheads
	BLM Field Offices
Dispersed Campsites	Bighorn, Black Hills, Bridger-Teton, Caribou-Targhee, Medicine Bow, Shoshone, and Uinta National Forests
	BLM Field Offices
	WDEQ Direct Observation (Portions of Shoshone, Bighorn and Bridger-Teton National Forests)
Roads	WYDOT Highways, WYDOT County Roads
	USFS Region 2 Roads (Categories 3, 4, and 5)
	USFS Region 4 Roads (Categories 3, 4, and 5)
Public Land	Bureau of Land Management

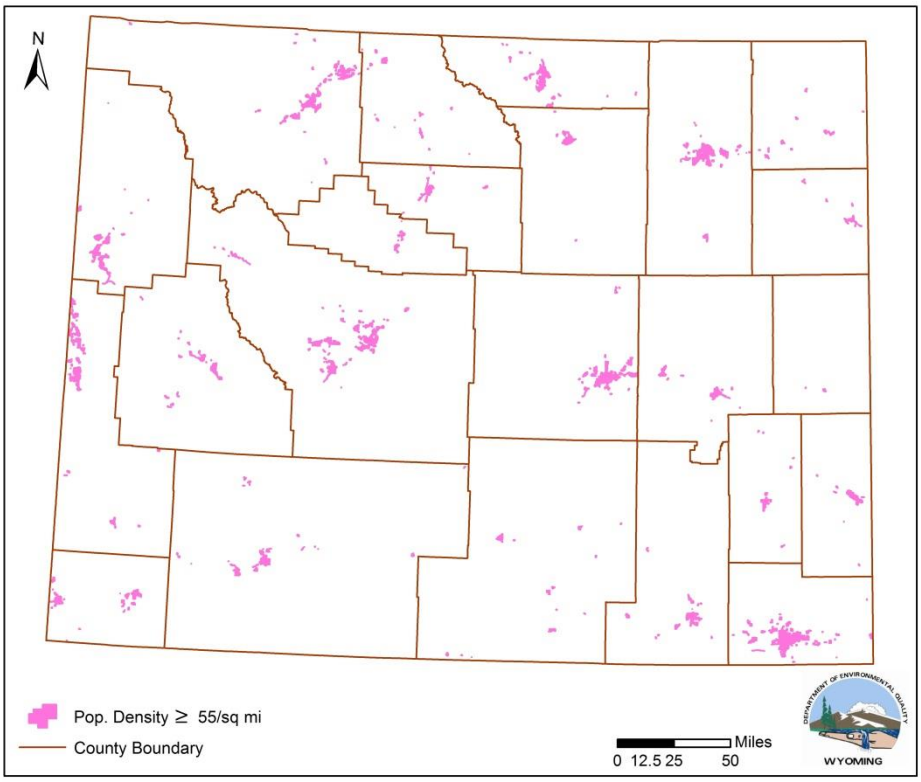

Figure A-1. Populated places (2010 US Census density ≥ 55 person per square mile) used in the Categorical UAA for Recreation.

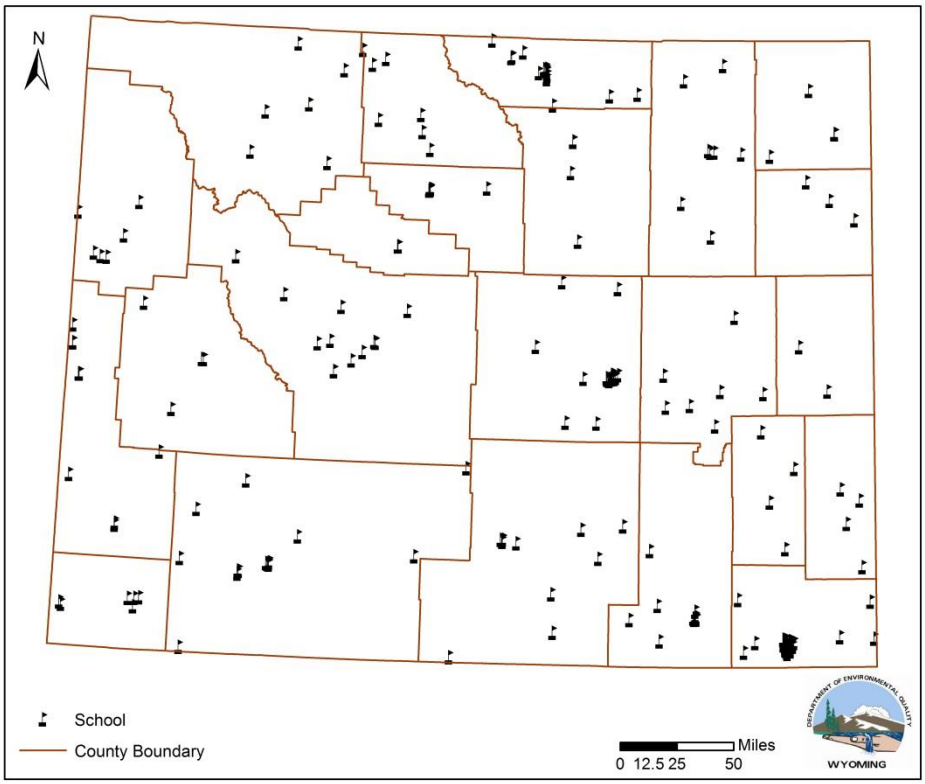

Figure A-2. School locations used in the Categorical UAA for Recreation.

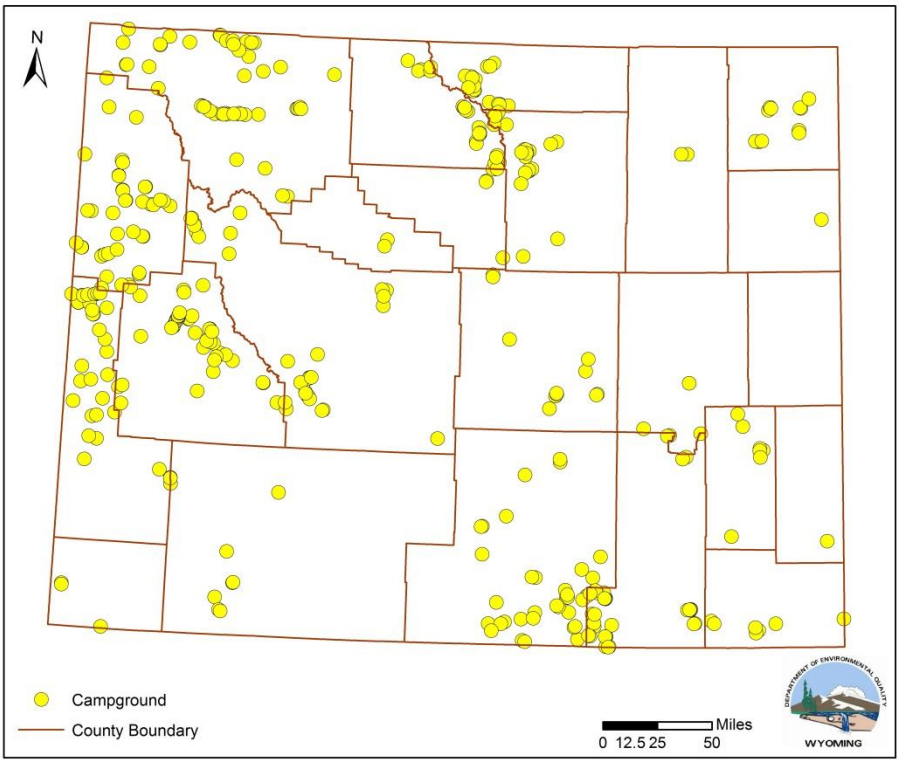

Figure A-3. Developed campground locations used in the Categorical UAA for Recreation.

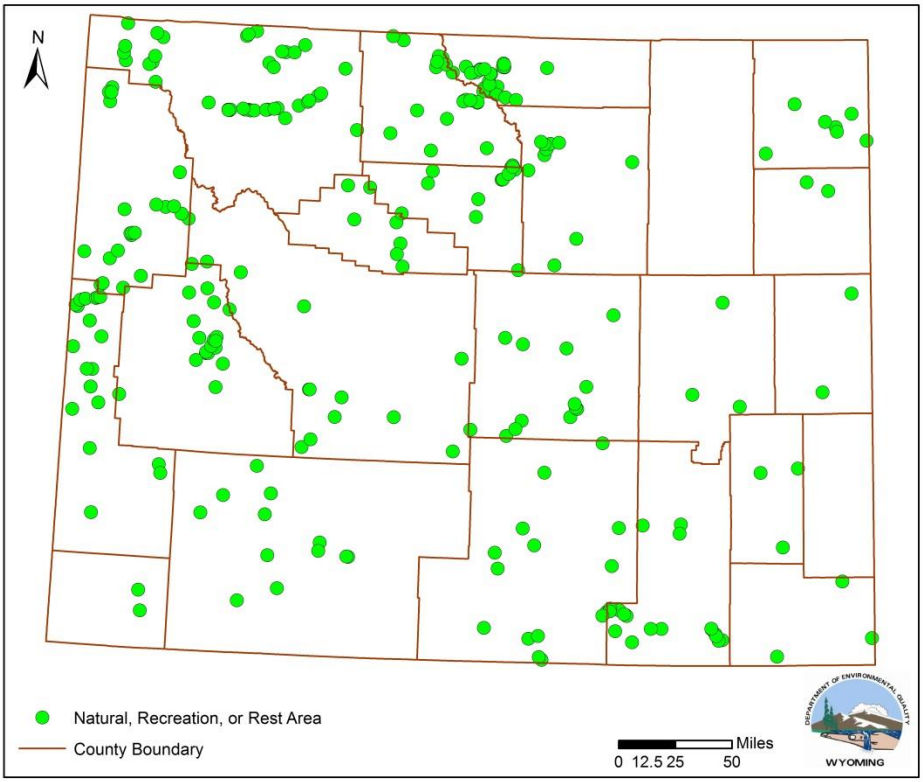

Figure A-4. United States Forest Service (USFS) and Bureau of Land Management (BLM) recreation sites, Natural Areas, and Wyoming Department of Transportation (WYDOT) rest areas used in the Categorical UAA for Recreation.

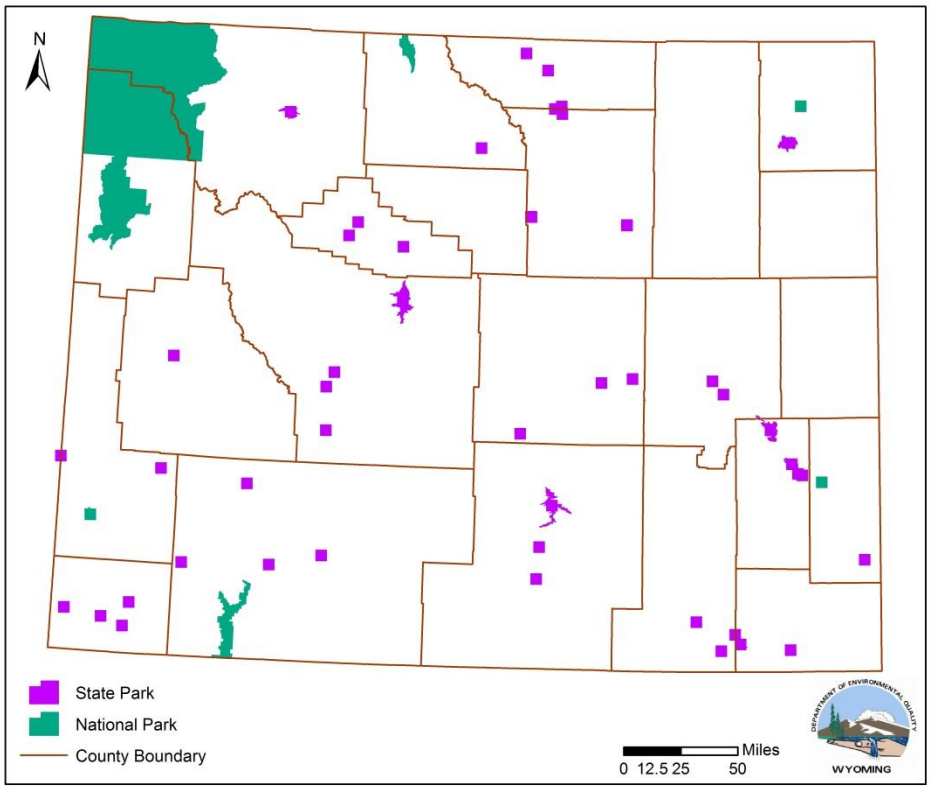

Figure A-5. National Parks and Recreation Areas, State Parks and Historic Sites used in the Categorical UAA for Recreation.

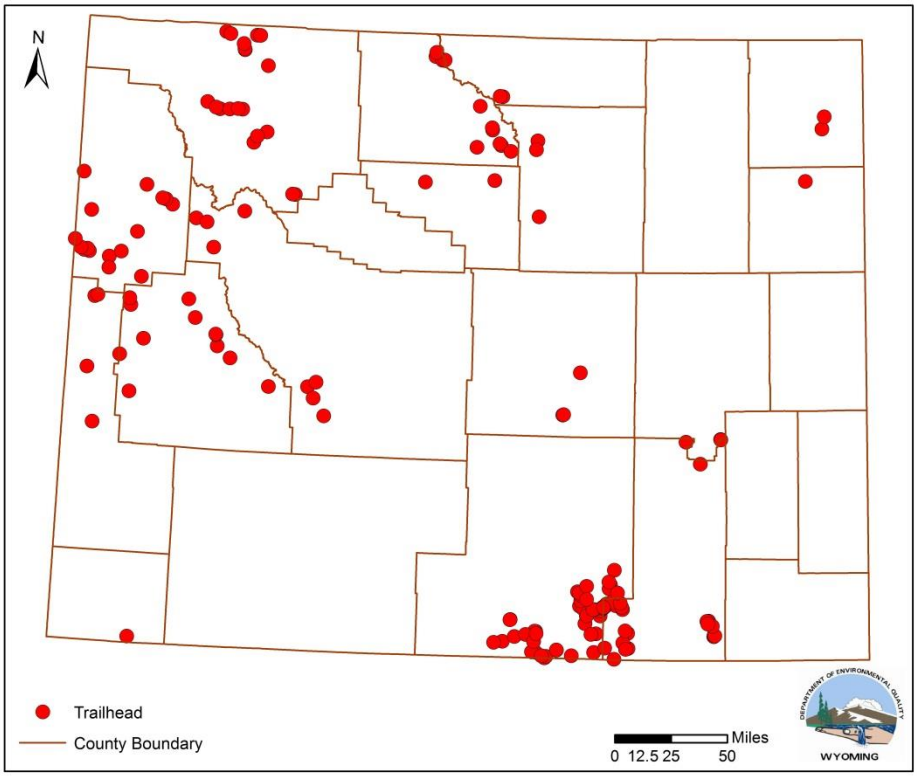

Figure A-6. Trailheads dataset used in the Categorical UAA for Recreation.

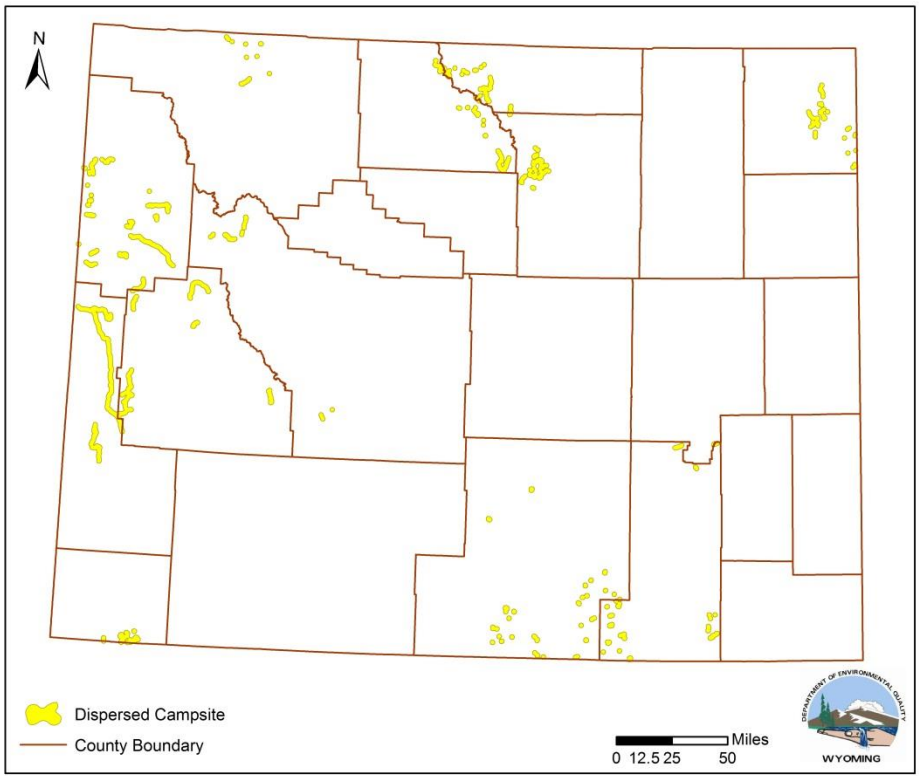

Figure A-7. Dispersed campsite dataset used in the Categorical UAA for Recreation.

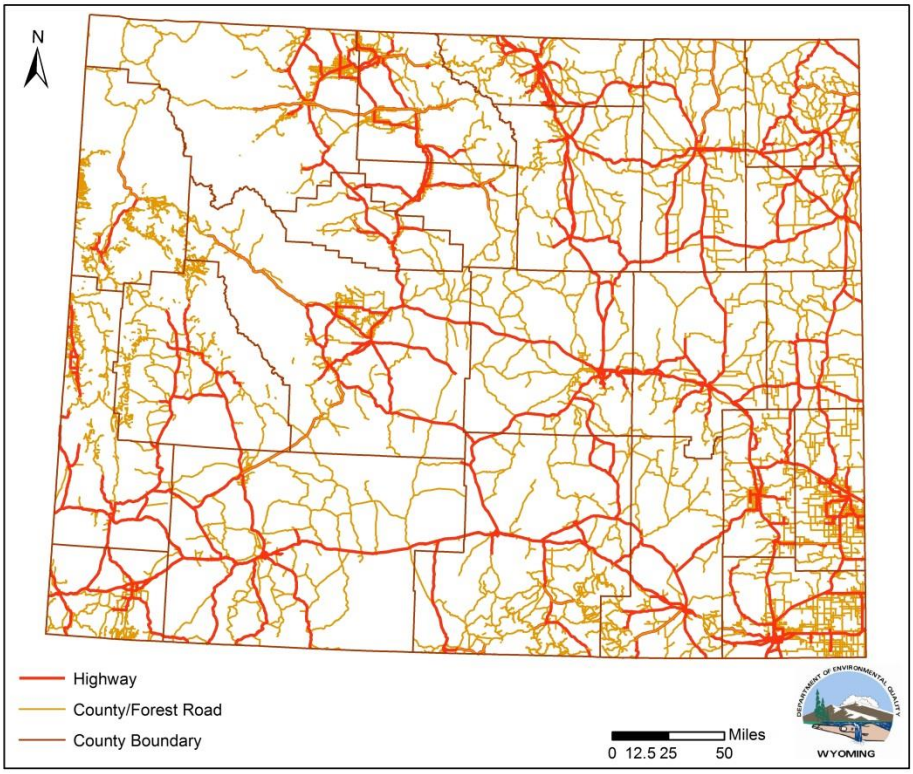

Figure A-8. Roads dataset used in the Categorical UAA for Recreation.

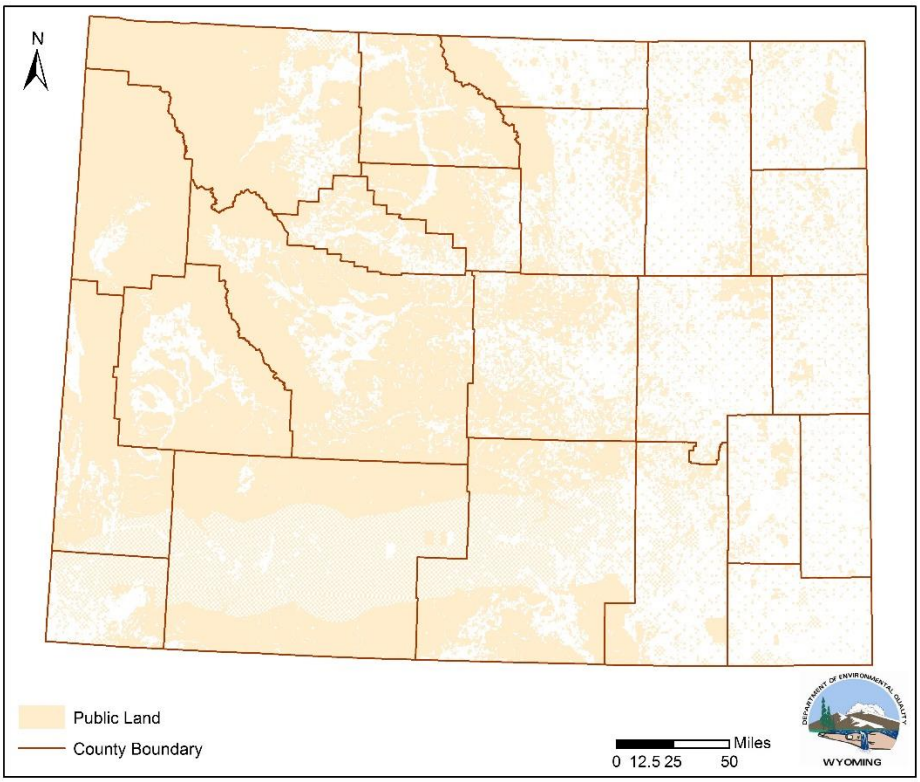

Figure A-9. Public land dataset used in the Categorical UAA for Recreation.

APPENDIX B. MODEL STEPS

1. Create new mxd. Add polygon file of Wyoming. From NHDPlus, version 2, download NHD Snapshot and data files for all five basins found in WY. (http://www.horizon-systems.com/NHDPlus/NHDPlusV2_data.php). Add NHD Flowline and NHD Waterbodies from all five basins to mxd. Merge all five NHD Flowline files into one file and merge all five NHD Waterbody files into one file. Clip each of the new files to Wyoming state boundaries. Continue to work with Flowline file.

2. Add new field. Add flow data from NHDPlus data file downloaded in step one to Flowline file. Add two new fields. Add any site-specific flow data from USGS gaging stations or measured flow to 'MeasFlow' field; and observed flow conditions to 'ObsCond' field. Add new field. Add WYDES average discharge for 2012 (for discharge within 300 feet of 100k stream) (F:\Division\WQD\WYPDES Business Views). Add new field and calculate total flow by adding WYPDES flow to MeasFlow or 'NHD-Flow.' Split file into two files, one with flow ≥ 6cfs ('Primary Due to Flow') and one with flow < 6cfs ('Low Flow'). Keep 'Primary Due to Flow' file as is. Continue to work with the 'Low Flow' file.

3. Add Census Blocks (https://www.census.gov/geo/maps-data/data/tiger.html) file to mxd. Add new field. Calculate area in square miles. Add new field. Calculate population density per square mile. Select density ≥ 55 people per square mile and create new file. Create buffer at 1 mile. Clip and erase 'Low Flow' file using buffer. Add 'PopDens' field to 'Low Flow' attribute table. For 'Low Flow' segments intersecting buffer, assign 'Yes' to attribute table (used to denote primary contact recreational use). Merge back into one file.

4. Add School locations (US Dept of Education: http://nces.ed.gov/surveys/sdds/ed/index.asp, WY Dept of Education: fusion.edu.wyoming.gov/MySites/Director) to mxd. Verify locations of rural schools using Google Earth. Create buffer at 1 mile. Clip and erase 'Low Flow' file using buffer. Add 'School' field to 'Low Flow' attribute table. For 'Low Flow' segments intersecting buffer, assign 'Yes' to attribute table. Merge back into one file.

5. Add campgrounds (Wyoming GeoLibrary: http://piney.wygisc.uwyo.edu/data/recreation/Campgrounds_USGS.zip, USFS campgrounds: http://www.fs.usda.gov/main/r2/landmanagement/gis, http://www.fs.usda.gov/main/r4/landmanagement/gis, individual BLM field office campgrounds) to mxd. Create buffer at 0.5 miles. Clip and erase 'Low Flow' file using buffer. Add 'Campground' field to 'Low Flow' attribute table. For 'Low Flow' segments intersecting buffer, assign 'Yes' to attribute table. Merge back into one file.

6. Add Natural Areas, Recreation Sites, and Rest Areas (http://piney.wygisc.uwyo.edu/data/recreation/natural_areas.zip, USFS recreation sites, Wyoming Department of Transportation rest areas, BLM recreation sites) to mxd. Create buffer at 0.5 miles. Clip and erase 'Low Flow' file using buffer. Add 'NatRecArea' field to 'Low Flow' attribute table. For 'Low Flow' segments intersecting buffer, assign 'Yes' to attribute table. Merge back into one file.

7. Add National and State Parks (nrdata.nps.gov for National Parks; State Park files supplied by Wyoming State Parks, Historic Sites) to mxd. Merge into one file. Clip and erase 'Low Flow' file for boundary. Add 'Parks' field to 'Low Flow' attribute table. For 'Low Flow' segments within boundary, assign 'Yes' to attribute table. Merge back into one file.

8. Add Roads (WDEQ@SDE WYDOT County Roads, Highways; http://www.fs.fed.us) to mxd. Some of the forests have separate files for Roads and for Trails; some are combined. For the combined files, split out the roads by the CFF field. Create buffer at 0.25 miles. Clip and erase 'Low Flow' file for the buffer. Add 'Roads' field to 'Low Flow' attribute table. For 'Low Flow' segments within buffer, assign 'Yes' to attribute table. Merge back into one file.

9. Add Landownership (WDEQ@SDE WY_NamedLandowner) to mxd. Split Landowner file into 2 files: 'Public Land' and 'Private Land'. ('Open Water' layer was identified as public or private by surrounding land). Clip and erase 'Low Flow' file for 'Public Land'. Add 'PublicLnd' field to 'Low Flow' attribute table. For 'Low Flow' segments within boundary, assign 'Yes' to attribute table. Merge back into one file.

10. Add Trailheads (http://www.fs.usda.gov/main/r2/landmanagement/gis , http://www.fs.usda.gov/main/r4/landmanagement/gis, BLM field office data) to mxd. Merge into one file. Select sites on Public Land and within Roads buffer. Export selected sites to new file. Create buffer at 0.5 miles. Clip and erase 'Low Flow' file using buffer. Add 'Trailhead' field to 'Low Flow' attribute table. For 'Low Flow' segments intersecting buffer, assign 'Yes' to attribute table. Merge back into one file.

11. Add Dispersed Campsites to mxd – individual forests sent data; gathered missing areas by GPS. Select sites on Public Land and within Roads buffer. Export selected sites to new file. Create buffer at 0.5 miles. Clip and erase 'Low Flow' file using buffer. Add 'DispCamp' field to 'Low Flow' attribute table. For 'Low Flow' segments within buffer, assign 'Yes' to attribute table. Merge back into one file.

12. Select all 'Low Flow' segments with 'Yes' in at least 3 of the access fields (PopDens, School, Campground, NatRecArea, Parks, Trailhead, DispCamp), export selected segments to 'Primary Due to Access' file. Switch selection and export selected segments to 'LowFlow2' file.

13. Using 'LowFlow2' file select segments which extend two primary segments (from either 'Primary Due to Flow' or 'Primary Due to Access' files) separated by an isolated secondary (low flow) segment and extend side channels of braided primary streams. Export selected segments to 'Primary Due to Extension' file. Switch selection and export selected segments to 'Secondary Stream' file.

13. Merge and dissolve all buffer clips with 'Yes' in attribute table for Census Blocks, Schools, Campgrounds, Natural Areas, Parks, Trailheads, and Dispersed Campsites to create 'Primary Area' file.

APPENDIX C. WDEQ AND WACD SURVEY WORKSHEETS

Figure C-1. WDEQ Recreation Site Survey Worksheet.

Segment ID _____

Wyoming Department of Environmental Quality, Water Quality Division

Recreational Use UAA Survey Worksheet

Department worksheet for calibrating model.

Date _____ Observer(s) _____

Time _____ River Basin (6-digit HUC number) _____

Waterbody Name _____ Watershed (8-digit HUC number) _____

Survey Location Description, including land ownership _____

_____

County _____ Elevation (ft) _____

Latitude*(WDEQ) _____ Longitude*(WDEQ) _____

Latitude*(CD) _____ Longitude*(CD) _____

GPS Datum and Coordinate System _____

Photo identification

1 _____ 2 _____

3 _____ 4 _____

Photo notes: _____

_____

Answer each of the following questions with either a *yes* or *no*:

1. _____ Is the survey location within a designated federal, state, or local park or recreational area? (*Federal, state or local parks should not be construed to mean all public lands, but rather, specifically developed and/or designated recreational use areas such as campgrounds, picnic grounds, trailheads, greenways, etc.*)

2. _____ Is the survey location part of a lake, reservoir or other still body of water. *(Exclude small (less than 1 square acre) stock watering ponds and waste effluent treatment ponds).*

3. _____ Is the survey location contained within a municipality or unincorporated high density housing area.

4. _____ Is the survey location on a water that is a larger perennial stream or game fishery known to be used by sportsmen or other recreationists?

1

Segment ID _____

5. _____ Is the survey location either currently known to be *or* do you believe that it has a reasonable potential to be used for recreational activities such as fishing, swimming, floating, rafting, canoeing or kayaking?

6. _____ Are there any schools within view of the survey location?

7. _____ Is there currently water within the surveyed stream, lake, reservoir or wetland?

8. _____ Does the survey location occur on public land?

9. _____ Are there any major recreational trails, trailheads or developed campgrounds within view of the survey location?

10. _____ Modeled as Primary Stream?

11. _____ Assessed on a Primary Segment (as modeled)?

Primary characteristics observed: _____

_____

_____

_____

Secondary characteristics observed: _____

_____

_____

_____

Appropriate stream classification assigned by model? Yes _____ No _____

Notes: _____

_____

_____

_____

_____

2

Figure C-2. WACD Recreation Site Survey Worksheet.

Wyoming Department of Environmental Quality, Water Quality Division

Recreational Use UAA Survey Worksheet

Each of Wyoming's 34 Conservation Districts has been provided with a randomly generated list of *survey locations* occurring on waters within their district. Each *survey location* refers to a single set of randomly generated latitude and longitude coordinates provided by WDEQ. The information gathered during this statewide survey will ultimately be compared to the predictions of a Geographic Information System (GIS) based Recreational Use Model that is currently being developed by WDEQ. Please fill out a separate worksheet completely for each survey location.

Date _____ Observer(s) _____

Conservation District _____ River Basin (6-digit HUC number) _____

Waterbody Name _____ Watershed (8-digit HUC number) _____

Survey Location Description, including land ownership _____

_____

County _____ Elevation (ft) _____

Latitude*(WDEQ) _____ Longitude*(WDEQ) _____

Latitude*(CD) _____ Longitude*(CD) _____

GPS Datum and Coordinate System _____
(Datum: NAD 83 [alternative WGS 84], Coordinate: UTM [12 - west part of state, 13 – east part of the state] are the preferred GPS settings)

*Please record both the coordinates supplied by WDEQ (on left above) and the coordinates observed using GPS in the field by CD personnel to verify that the correct survey location was visited.

Photographs (Please take one digital photograph looking upstream and one looking downstream from each survey location. Photo names should include the water's name and a unique number):

_____

Answer each of the following questions with either a *yes* or *no*:

1. _____ Is the survey location within a designated federal, state, or local park or recreational area? (*Federal, state or local parks should not be construed to mean all public lands, but rather, specifically developed and/or designated recreational use areas such as campgrounds, picnic grounds, trailheads, greenways, etc.*)

2. _____ Is the survey location part of a lake, reservoir or other still body of water. *(Exclude small (less than 1 square acre) stock watering ponds and waste effluent treatment ponds).*

3. _____ Is the survey location contained within a municipality or unincorporated high density housing area.

4. _____ Is the survey location on a water that is a larger perennial stream or game fishery known to be used by sportsmen or other recreationists?

5. _____ Is the survey location either currently known to be *or* do you believe that it has a reasonable potential to be used for recreational activities such as fishing, swimming, floating, rafting, canoeing or kayaking?

6. _____ Are there any schools within view of the survey location?

7. _____ Is there currently water within the surveyed stream, lake, reservoir or wetland?

8. _____ Does the survey location occur on public land?

9. _____ Are there any major recreational trails, trailheads or developed campgrounds within view of the survey location?