MONTANA DEPARTMENT OF ENVIRONMENTAL QUALITY

Alluvial Valley Floor Determination

For Tributaries Intersected by the Proposed Area F Mine Permit Area, Rosebud Coal Mine, in the Upper West Fork Armells Creek Drainage

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I. Regulatory Framework

The Montana Strip and Underground Reclamation Act (MSUMRA) § 82-4-201 through 82-4-254, MCA, and its implementing rules, Administrative Rules of Montana (ARM) 17.24.301 through 17.24.1309, specifically § 82-4-227(3) (b) (i) MCA], and ARM 17.24.301, 17.24.325, and 17.24.805 set forth the process for identifying an alluvial valley floor (AVF) located in the arid and semi-arid lands of Montana. Any mine proposal or mine related disturbance within a valley holding a stream, or adjacent to and connected to a valley holding a stream, must have an AVF determination. MSUMRA requires protection of identified AVFs from impacts of coal mining that are adverse to agricultural activities or farming.

An AVF determination consists of three separate evaluations. See ARM 17.24.325. The first evaluation determines the presence and extent or absence of AVFs based on defined criteria. The second evaluation determines the significance of the AVF for adversely affected agricultural or farming operations. The third evaluation determines the essential hydrologic functions of each agriculturally significant AVF. If the first evaluation determines that no AVF is present, then further evaluation is not warranted.

As explained in detail, below, both geologic and hydrologic criteria must be met to designate an AVF. The key to the existence of an AVF is the presence of both geomorphic characteristics and water availability for agricultural activities or farming.

II. Presence or Absence

Analysis of Presence or Absence

Section 82-4-203(3)(a), MCA, defines an AVF as: "the unconsolidated stream-laid deposits holding streams where water availability is sufficient for subirrigation or flood irrigation agricultural activities." Section 82-4-203(3)(b), MCA, distinguishes "upland areas that are generally overlain by a thin veneer of colluvial deposits composed chiefly of debris from sheet erosion and deposits by unconcentrated runoff or slope wash, together with talus, other mass movement accumulation, and windblown deposits" from AVFs. Uplands is further defined in ARM 17.24.301 (136) as "with respect to alluvial valley floors, those geomorphic features located outside the floodplain and terrace complex, such as isolated higher terraces, alluvial fans, pediment surfaces, landslide deposits, and surfaces covered with residuum, mud flows or debris flows, as well as highland areas underlain by bedrock and covered by residual weathered material or material deposited by sheetwash, rillwash, or wind."

Alluvium and colluvium are deposits of materials resulting from erosion and deposition. Alluvium is a general term for materials deposited by water, including gravel, sand, silt, clay, and all the variations and mixtures of these. Unless otherwise noted, alluvium is unconsolidated (Brady and Weil, 2010). Colluvium is a deposit of rock fragments and soil material accumulated at the base of steep slopes as a result of gravitational action (Brady and Weil, 2010). Both of these transport processes result in unconsolidated material on the earth's surface.

According to the Dictionary of Geologic Terms, colluvial is defined as "Consisting of alluvium in part and also containing angular fragments of the original rocks." Colluvium may be mixed with alluvium. Various

processes may account for this. For example, alluvial stream channel deposits may slide down terrace banks resulting in new colluvial deposits.

The definition of AVF is further clarified as "unconsolidated streamlaid deposits holding streams" as "all flood plains and terraces located in the lower portions of valleys which contain perennial or other streams with channels." ARM 17.24.301(132). This definition of unconsolidated deposits allows for colluvium as defined above to be contained in a terrace or floodplain of an AVF. Therefore, the presence of surface colluvium does not exclude a stream from AVF status. The underlying geology rather than surface deposition dictates a determination of alluvial or colluvial character in a valley floor.

ARM 17.24.325(2)(b) sets forth the procedure for determining the presence or absence of an AVF:

> Based on the investigations conducted under [ARM 17.24.325(2)](a)] above, the department shall make a written determination of the extent of any alluvial valley floors within the study area and whether any stream in the study area may be excluded from further consideration as lying within an alluvial valley floor. The department shall determine that an alluvial valley floor exists if it finds that:
> (i) unconsolidated streamlaid deposits holding streams are present; and
> (ii) there is sufficient water to support agricultural activities as evidenced by:
> (A) the existence of current flood irrigation in the area in question;
> (B) the capability of the area to be flood irrigated, based on typical regional agricultural practices, historical flood irrigation, stream-flow, water yield, soils, water quality, and topography; or
> (C) subirrigation of the lands in question, derived from the ground water system of the valley floor; and
> (iii) the valley does not meet the definition of upland areas in ARM 17.24.301.
> (c) If the department determines in writing that an alluvial valley does not exist pursuant to (b), no further consideration of this rule is necessary[.]

Finally stream valleys "adjacent" to proposed mining operations must be evaluated for the presence or absence of AVFs. "Adjacent" is also a defined term under MSUMRA and means in pertinent part, "the area outside the permit area where a resource or resources, determined in the context in which the term is used, are or could reasonably be expected to be adversely affected by proposed mining operations[.]" § 82-4-203(2), MCA.

General Location

West Fork Armells Creek is a stream with ephemeral, intermittent, and perennial stream reaches, as defined in Section 82-4-203(17), (28) and (39), respectively. The West Fork Armells Creek drainage is nearly 150 square miles in area. West Fork and East Fork Armells Creek flow together approximately 15 miles north of Colstrip to form Armells Creek. Armells Creek eventually flows into the Yellowstone River 6 miles west of Forsyth, MT. Western Energy Company (WECo) has applied for a permit to add Area F (C2011003F), located approximately 14 miles west of Colstrip, MT, to the Rosebud Mine. Area F is approximately 10.5 square miles in area (6,746 acres), and contains portions of five named tributaries to West Fork Armells Creek: Black Hank Creek, Donley Creek, Robbie Creek, McClure Creek, and Trail Creek (Map 1). These tributaries comprise a drainage area of roughly 60 square miles and are predominantly

ephemeral with limited intermittent reaches associated with spring and wetland areas. Additionally, a small area (approximately 50 acres or less than 1% of the proposed Area F permit area) in the upper reach of Horse Creek, a tributary to Sarpy Creek, could also be impacted.

The Area F permit area straddles the Rosebud and Treasure county line. It is bordered by the WECo Area C permit to the east. To the south and west is the West Fork Armells Creek drainage divide located in the Little Wolf Mountains. There are no physical boundaries to the north confining this area. Mining operations are expected to result in 4,287 acres of disturbance.

The majority of the Area F permit area lies within the Robbie and Trail Creek watersheds, which flow northeast into West Fork Armells Creek. A small portion of the permit area is located in the upper Horse Creek watershed, which flows west into Sarpy Creek. The Robbie Creek watershed contains the following drainages, from southeast to northwest: Black Hank, Donley, and Robbie Creeks. The Trail Creek watershed contains the following drainages, from south to north: McClure and Trail Creeks. Each of the drainages will be evaluated for the presence of an AVF; both adjacent to and within the proposed mining area.

1. Unconsolidated Streamlaid Deposits

Soils and Geology:

The first step in determining the presence or absence of an AVF is to identify valleys with streams holding unconsolidated streamlaid deposits. Unconsolidated stream laid deposits are alluvium.

Soils in the Area F permit are underlain by the Paleocene Fort Union Formation. This formation is typically poorly consolidated and consists of light brown and gray interbedded sandstone, silty shale, carbonaceous shale, clay, and coal. The formation is divided into three members in ascending order, the Tullock, Lebo, and Tongue River (USDA 1980). The dominant member is the Tongue River with the thickest sandstone, shale, and most abundant coal seams. In areas where coal seams have burned, porcelanite (a.k.a. scoria or clinker) developed creating a more erosion resistant layer. This resistance protects softer underlying layers creating the unique and diverse landscapes of the Fort Union formation.

Alluvial materials are formed in a setting where more erosion resistant sandstone and clinker capped buttes are underlain by softer strata (USDA 1980). Through time, erosion and deposition have eroded the parent materials of the Fort Union formation and deposited them in drainages and lowlands as alluvium. Alluvium is sorted into finer silts and clays on floodplains that lie over clinker gravels and fine sands. Monitoring well logs may refer to alluvium using these material names.

The base line soil survey categorizes soil development into four primary soil formation groups. These four soil formation groups present in the study area are: “1) soils developing predominantly in shallow to deep residuum (weathered in place) from sandstone, shale, or scoria bedrock on upland ridges and immediately adjacent areas, 2) deep soils developing predominantly in slopewash alluvium, colluvium, or alluvial fan deposits from mixed sources on gently sloping uplands, 3) soils developing predominantly in coarser-textured alluvium or sandy eolian (wind) deposits on rolling uplands, and 4) drainage soils

developing in mixed stream laid alluvium on terraces and channels, and in moderately fine-textured deposits in eroded areas adjacent to drainages." (Area F soils Report).

Drilling Logs

A drill log is created during drilling for geologic exploration, water wells, monitoring wells, and piezometers, to document the geology or lithology encountered in the drill column. The depth, thickness, and material composition of each stratum are recorded. Additionally, a drill log documents the location, type of backfill and plugging materials for a geologic exploration hole, or well casing and screen information where a well is established. This log information provides evidence for the presence or absence of streamlaid deposits (alluvium) and groundwater levels. The log data may also be used to determine the extent, both depth and width, of alluvium. Map 2 indicates the locations of drill sites for geologic exploration and groundwater well monitoring locations in the Area F proposal. The following discussion summarizes drill log data relevant to the AVF determination.

Robbie Creek Watershed

Robbie Creek captures Black Hank and Donley Creeks as it drains water from the majority of the proposed mining in Area F to West Fork Armells Creek (Map 2). The stream channel geology of the Robbie Creek drainage is consistent throughout the watershed. Alluvium is present and generally contained within stream channels (Map 3). There are 132 exploration and 33 groundwater water well drill logs within the Robbie Creek watershed. Watershed geology as indicated in drill and well logs is summarized below.

Sandy soil and sandstone bedrock layering is demonstrated in a hay field near an unnamed tributary to Robbie Creek. Drill log F142401 (Map 2) demonstrates alternating layers of sandy clay and sand in the surface geology to 20 feet below ground surface. In the same hay field drill log F062302, at an elevation 10 feet above log F142401 and near a smaller unnamed tributary, demonstrates a 7 foot layer of soil above sandstone. A third drill log outside of the hay field, F061311, is at the same elevation and north across the unnamed tributary from log F142401. This third site is consistent with log F062302, demonstrating topsoil over sandstone.

These geologic exploration logs indicate sandstone parent material. Log F142401 indicates the presence of a fine grained alluvial like deposit; however, the data from the other two logs indicate only sandy soil development. The inconsistent unconsolidated deposition demonstrates a lack of widespread alluvial development. This same inconsistency can be identified in an unnamed tributary to the east. Drill log F062413 shows alternating sandy clay and sand layering below the topsoil; however, adjacent samples in the same area indicate sandy layers above sandstone bedrock.

These characteristics point toward weathering in place of the sandstone bedrock layer (residuum) consistent with surveyed Soil Type One. There is also no gravel layering found in the drill log data, further evidence that sandstone is weathering in place and alluvial deposits are not extensive. The unnamed tributaries of Robbie Creek occasionally contain alluvium in the channel. This channel alluvium is not extensive enough for utilization and therefore excluded as an AVF.

Alluvial materials are present in the main stream channels of Robbie Creek, Donley Creek, and Black Hank Creek (Map 3). In Black Hank, wells WA-219 and WA-227 indicate stream channel alluvium to 31 feet below ground surface. In Donley, wells WA-226 and WA-225 indicate stream channel alluvium to 19 feet below ground surface. In Robbie, wells WA-222 and WA-223 indicate alluvium down to 21 feet below ground surface. Located approximately 200 feet away from Robbie Creek and 10 feet in elevation above well WA-223, drill log F062306 indicates sandstone 5 feet below ground surface. Another drill log, F062303, located downstream but at the same elevation of well WA-223 (Map 2), indicates sandstone bedrock immediately below the soil surface layer. Drill logs outside the stream channel consistently show thin soils directly over bedrock.

Drill and well logs indicate that alluvium, where present, is limited in extent to the main stems of Robbie Creek, Donley Creek, and Blank Hank Creek. Small amounts of alluvium may extend up tributary channels; however, the extents are not large enough for utilization as alluvial valley floors.

Trail Creek Watershed

The Trail Creek watershed, located north of the Robbie Creek watershed, contains the main stem Trail Creek and McClure Creek, and drains into West Fork Armells Creek. Trail Creek watershed covers 75 square miles with less than one square mile affected by proposed mining. Geologic exploration shows these streams to match the Tongue River Member of the Fort Union Formation similar to the Robbie Creek watershed. McClure Creek is the only named stream from this watershed within the proposed permit boundary. There are 10 geologic exploration drill logs and one group of 3 water monitoring drill logs within the Trail Creek Watershed boundary.

McClure Creek

Geology of the terrace area around McClure Creek indicates a soil layer typically 2 feet deep overlying sandstone bedrock. The McClure Creek channel is highly incised and contains a narrow band of alluvial material in the stream channel bottom.

Trail Creek

The portion of the mainstem Trail Creek watershed within the permit boundary contains geologic exploration logs F061203, F061204, and F061205. These logs indicate sandy soil 8 feet deep over sandstone bedrock. This meets the definition of upland areas by demonstrating “highland areas underlain by bedrock and covered by residual weathered material.” Alluvium in this drainage is likely restricted to narrow tributary stream channels.

Horse Creek Watershed

Horse Creek watershed is located west of the proposed permit area within the Upper Sarpy Creek watershed. Approximately 50 acres or 0.8% of the proposed permit area is in the Horse Creek watershed. Historical alluvial mapping (Map 3) indicates minimal alluvium in Horse Creek. There are no geologic drill log data available for the upper Horse Creek area.

The portion of Horse Creek within the proposed permit area is a small headwater area. As previously noted, there are minimal alluvial deposits in the Horse Creek drainage and these deposits are restricted to main channels (Map 3). The proposed Area F permit area contains the headwaters area of a tributary

to Horse Creek. Because this area is located in the headwaters of a small, unnamed ephemeral drainage there is no potential for the creation of an alluvial deposit.

Geology Summary

The presence of unconsolidated streamlaid deposits is evident in geologic exploration and groundwater monitoring drill logs. The extent of the alluvial deposits is limited to active main stem or larger tributary stream channels and there is no evidence of extensive channel alluvial deposits.

Hydrology:

Black Hank Creek

The Black Hank drainage contains two alluvial monitoring wells: WA-227 and WA-219. WA-227 is located upstream in the drainage and is installed in an alluvial lens 30 feet deep. WA-219 is located downstream in the drainage and is installed in an alluvial lens 31 feet deep. While WA-219 is partially screened in coal and sandstone (six feet total), the majority of the well is screened in alluvium and water levels are likely representative of alluvium water levels.

WA-227 and WA-219 water levels were monitored for the period of record (POR) from January 2005 to July 2015 for WA-219 and December 2012 to July 2015 for WA-227. Well water levels ranged from 7.2 to 21.7 feet below ground surface, with an average of 14.9 ft. Groundwater levels in these wells do not indicate strong seasonality, but do respond to significant storm events. The Black Hank crest gage (CG-100) monitored maximum monthly stream depth for the POR of February 2013 to December 2014. Maximum monthly flow is calculated from depth data and stream channel characteristics. CG-100 shows a significant runoff event in March 2014 (~60 cubic feet per second (cfs)). This flow event is evident in both WA-227 and WA-219, with significant increases in alluvial water levels. WA-219 also had a significant water level rise in 2011, during which precipitation amounts were much higher than average. Following these rises, alluvial water levels have declined to near average depths.

Donley Creek

The Donley Creek drainage contains two alluvial monitoring wells: WA-225 and WA-226. Two other alluvial monitoring wells were initially installed: WO-192 and WM-208. However, upon completion, these two wells were largely screened in sandstone or coal and water levels are not representative of alluvial groundwater levels. WA-226 is located upstream in the drainage and is installed in an alluvial lens 19 feet deep. WA-225 is located downstream in the drainage and is installed in an alluvial lens 17 feet deep.

WA-225 and WA-226 water levels were monitored for the POR from December 2012 to July 2015. Well water levels ranged from 7.8 to 13.8 feet below ground surface, with an average depth to water of 13.1 feet. Groundwater levels in these wells did not indicate seasonality, and WA-226 had a nearly constant water level of 13.5 feet below the surface for the entire POR. WA-225 initially had a water level 7.8 feet below the surface, but steadily declined to approximately 13 feet below surface, where it remained nearly constant for the remainder of the POR. This decline is a reflection of 2011 water year, which was significantly above average and raised groundwater levels. Recent water years have been similar to historic averages, and since 2011 water levels have declined to reflect average precipitation and runoff.

Stream flows in Donley were monitored by stream gages SW-89 and SW-90, which consist of stream flumes and pressure transducers which monitor stream depths on a daily basis. From stream depths, stream discharge is determined from a flume flow equation. SW-89 is located upstream in the drainage, and flows were monitored at this location for the POR of November 2013 to December 2014. Flows were highly variable for the POR, ranging from 0 cfs to 1.9 cfs. The hydrograph is characterized by periodic, significant flow events which peak and recede quickly, without extended periods of baseflow.

SW-90 is located downstream in the drainage, and flows were monitored in this location for the POR of November 2011 to December, 2014. Similar to SW-89, flows were highly variable for the POR, ranging from 0 cfs to 446 cfs. Again, the hydrograph is characterized by periodic, significant flow events which peak and recede quickly, without extended periods of baseflow. Flows recorded at SW-90, while exhibiting similar trends to SW-89, are generally much higher in volume. This is a result of differing drainage areas, in that SW-90 is located much further downstream on Donley Creek and captures flows from a significant tributary where well WA-226 is located (Map 2). Based on these flow patterns and groundwater levels, flows at these locations are ephemeral in nature.

Robbie Creek

The Robbie Creek drainage contains two alluvial monitoring wells: WA-222 and WA-223. One other alluvial monitoring well, WD-210, was also initially installed. However, this well was not completed in alluvium and water levels were not representative. WA-222 is located downstream in the drainage and is installed in an alluvial lens 19 feet deep. WA-223 is located upstream in the drainage and is installed in an alluvial lens 21 feet deep.

WA-222 and WA-223 water levels were monitored for the POR from December 2012 to July 2015. During the entire POR, WA-223 was dry, indicating unsaturated alluvium and groundwater depth greater than 19 feet below the surface. In contrast, WA-222 was saturated for the entire POR, and showed seasonal water levels ranging from -0.2 to 4.2 feet below ground surface, with an average depth of 1.7 ft. Negative water levels can indicate an artesian aquifer; however, in this instance, these water levels likely indicate that the area around the well has flowing or ponded surface water, and part of the well casing is submerged. Given the seasonality of this well and the shallow water depths, it is interacting with the surface water system; rising with spring recharge and declining through the summer and early fall due to evapotranspiration.

The Robbie Creek crest gage (CG-101) is located slightly upstream of WA-222 on Robbie Creek. CG-101 monitored maximum monthly stream depths for the POR from February 2013 to December 2014. Stream depths are converted to discharge using streambed characteristics. Similar to other hydrographs in this area, flow for the POR at this location exhibited periodic, flashy flow events. However, this location is unusual in that water was recorded at this gage for the entire period of record, is flowing, ponded, or frozen.

The reach of Robbie Creek in the vicinity of CG-101 and WA-222 is associated with numerous springs and surveyed wetlands. While the springs are natural, the wetland may be partially artificial, as it is located upstream and downstream of the county road, which appears to be restricting water flow of Donley

Creek, as a ponded section is visible upstream of the road crossing. Regardless, this section of Donley Creek exhibits intermittent to perennial flow characteristics and a shallow water table subject to subirrigation.

McClure Creek and Trail Creek

The Area F permit area contains small portions of the McClure and Trail Creek drainages (Map 2). Surface water flows and groundwater levels were not monitored in these watersheds. However, the Area F permit contains only a small portion of the headwaters of these drainages, and the hydrology in these watersheds is likely similar to adjacent, monitored watersheds. Surface flows are likely highly variable and ephemeral, and any alluvial groundwater is likely not near the ground surface.

Horse Creek

The proposed Area F permit area contains approximately 50 acres or approximately 0.3% of the Horse Creek drainage (Map 2). Surface water flows and groundwater levels were not monitored in this watershed due to it being across the Little Wolf Mountains drainage divide, and comprising less than one percent of the permit area. Additionally, the drainage area is a headwaters area of a small, unnamed ephemeral tributary to Horse Creek.

The Area F permit contains only a small portion of the headwaters of this drainage, and the hydrology in this watershed is likely similar to adjacent, monitored watersheds. Surface flows are highly variable, ephemeral, and alluvial deposits are minimal and restricted to the main channels and are not near the surface and not subject to regular sub-irrigation. Further, Horse Creek is located across a major drainage divide from the permit area, which likely further reduces potential impacts from mining to this drainage area.

2. Sufficient Water to Support Agricultural Activities

The presence of irrigation sufficient to support agricultural activities or farming must be determined. See Section 82-4-203(3)(a), MCA; 17.24.325(2)(b). The three criteria to determine if there is sufficient water to support agricultural activities or farming are discussed in subsections a-c. See ARM 17.24.325(2)(b)(ii).

a. The Existence of Current or Historic Flood Irrigation

Flood irrigation is defined as "supplying water to plants by natural overflow or the diversion of flows, so that the irrigated surface is largely covered by a sheet of water." ARM 17.24.301(44). Surface water management structures such as dams and spreader and containment dikes indicate the existence of current or historic flood irrigation. Of these water management structures, only dams utilized for livestock water can be found in the proposed Area F permit area. These dams have no history of being used for irrigation purposes. Thus, there is no evidence of flood irrigation management structures evident across this area.

b. Capability of the Area to be Flood Irrigated

Stream flow monitoring indicates most streams in this area have ephemeral characteristics, and flow only in response to snowmelt or precipitation events. See ARM 17.24.301(39) and Section 82-4-301(17). Short sections do exist with persistent surface expression, but these areas are fed by springs and are natural wetlands or developed stock watering ponds. This limited amount of available water greatly

reduces the ability of these streams to support flood irrigation. Given the lack of yearly runoff and height of terraces, it is unlikely that this area has the capability to be flood irrigated. This was supported by comparing topographic mapping and available water quantity data. Even when significant runoff events do occur, they are of such a short duration and/or infrequent and unreliable return period, as to make flood irrigation unproductive.

Sixty-two acres of agricultural impacted alluvial deposits were identified in the application area. These are areas that have been altered for farming purposes over alluvial deposits. Of those, 16 acres are considered farmed and the remaining 46 are improved pasture. These alluvial agricultural fields have not shown evidence of flood irrigation in the past. They also have the same issues described above, in that there is insufficient water available for flood irrigation. These 62 acres are not capable of being flood irrigated.

c. The Existence of Subirrigation

Areas with unconsolidated streamlaid deposits that are sub-irrigated also qualify as AVF's. Subirrigation occurs when groundwater is close enough to the surface to support agricultural activities or farming. This happens when water reaches the root zone of the plants being grown. "Subirrigation means, with respect to alluvial valley floors, the supplying of water to plants from a sub-surface zone where water is available and suitable for use by vegetation." ARM17.24.301 (118).

When evaluating the depth to useful groundwater, the thickness of the capillary fringe needs to be considered. However, the thickness of a capillary fringe is difficult to determine. Capillary fringe refers to the ability of water to rise in the soil column above the water table due to capillary action. Pore sizes of the material above the water table determine the thickness of the capillary fringe. Montana DEQ recently defined capillary fringe to be 10 feet (5 feet rooting depth, and 5 feet of capillary rise in the soil) for the Otter Creek Alluvial Valley (Otter Creek AVF, 2016). This was determined using soil test pit data for both rooting depth and soil composition.

The Otter Creek AVF is also located in the Tongue River member of the Fort Union Formation described above. This previous investigation allowed Montana DEQ to target subirrigation influences to areas with water ten feet or less below the surface. The same values were used in this investigation due to the similar geology.

Only monitoring well WA-222, located in Robbie Creek, had groundwater levels near to the ground surface and seasonal fluctuations indicating subirrigation. This area, as described above, is a wetland area and not utilized for agricultural purposes. It also does not show any evidence that anyone has attempted to convert it for agricultural purposes in the past.

The application area contains a number of agricultural fields (1,046 acres). Many of the fields are on upslope areas adjacent to creek channels. These fields are generally 10 to 15 feet above incised channel bottoms. As part of this determination, a comparison of alluvial deposits and agriculturally impacted lands was completed. This comparison defined 62 acres where these two components intersect. These are the only lands in the application area that have the potential to be AVF's due to subirrigation and

agriculture. There is no evidence of groundwater at an elevation that could provide subirrigation to any of those fields.

As part of AVF determination request, WECo submitted a series of aerial infrared photos flown in early summer and early fall, for determination of subirrigation occurrence and rate. In addition, the U.S. Farm Service Agency recently released 2015 aerial photos of Montana, which includes the infrared band. On the photos, red areas indicate evapotranspiration (ET), evaporation of soil and groundwater through soil and plants, possibly due to subirrigation. Brighter red areas on the photos indicate higher ET rates. Map 4 shows agriculture lands, alluvium, and the 2015 infrared photography.

Early spring ET is evident throughout the watershed in the first photo, but by late fall, ET has declined and is confined to rills, incised drainages, and areas with trees or shrubs as the dominant vegetation type. The distribution of fall ET across the permit area is shown on Map 4. Using the fall ET imagery, the 62 acres of agriculture influenced alluvial materials were examined for evidence of late season subirrigation. There is no evidence that subirrigation is occurring in mapped crop areas (Map 4).

Landowner Interview

The first farm and ranch operation located downstream of proposed mining is at the confluence of Donley and Robbie Creek. The operation belongs to Kirby and Freda Kluver. This landowner was interviewed on April 18, 2016 (Kluver, 2016). The goal of the interview was to ascertain the possible use of Robbie Creek for flood or subirrigation and any benefits to farm operations from the potentially available water. According to Mr. Kluver, Robbie Creek is not used for flood irrigation nor does it provide water for subirrigation in adjacent fields. All hay at this ranch is produced using dryland farming practices.

Presence or Absence Conclusion

An AVF is defined by having unconsolidated streamlaid deposits which are either flood or subirrigated. As described above, this is not evident within the Area F application area or on adjacent properties. This is based on the evidence below:

- Unconsolidated deposits are confined to the active channels of primary drainages;
- There is no current or historic evidence of flood irrigation;
- There is no persistent or predicable surface water to support flood irrigation;
- Subirrigation is confined to small wetland areas and does not enhance crop production in agriculture lands.

Based on this evidence, Montana DEQ has concluded that there are no Alluvial Valley Floors present in, or adjacent to, the Area F Application area.

References

American Geologic Institute. Dictionary of Geological Terms, Revised Edition. Anchor Press 1976.

Application CC2011003F: Western Energy Company Area F

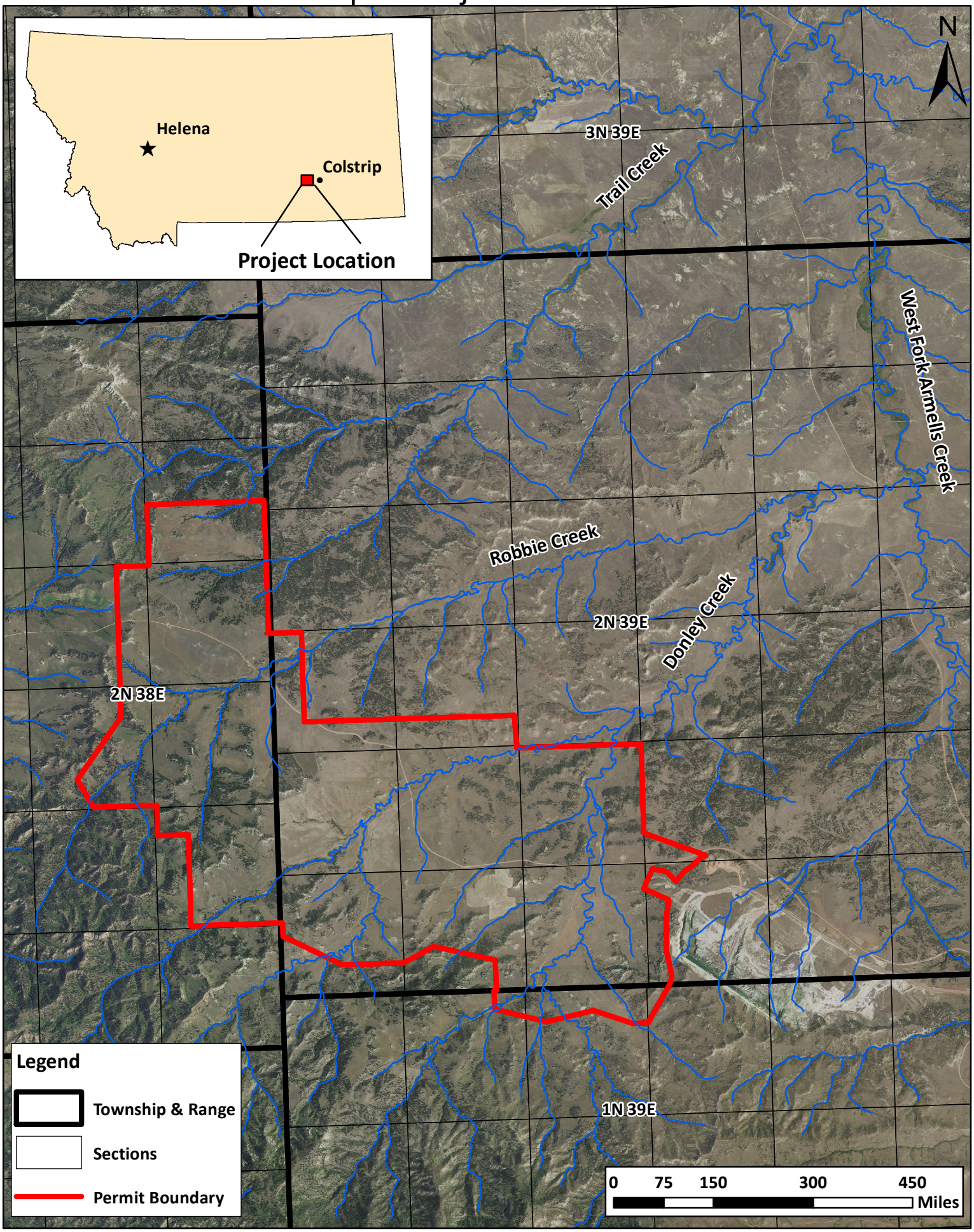
Brady, Nyle C., Weil, Ray R., 2010. Elements Of The Nature And Properties Of Soils, Third Edition, Prentice Hall/Pearson.

Kluver, Freda and Kirby (Ranchers adjacent to Area F), personal interview, April 18, 2016.

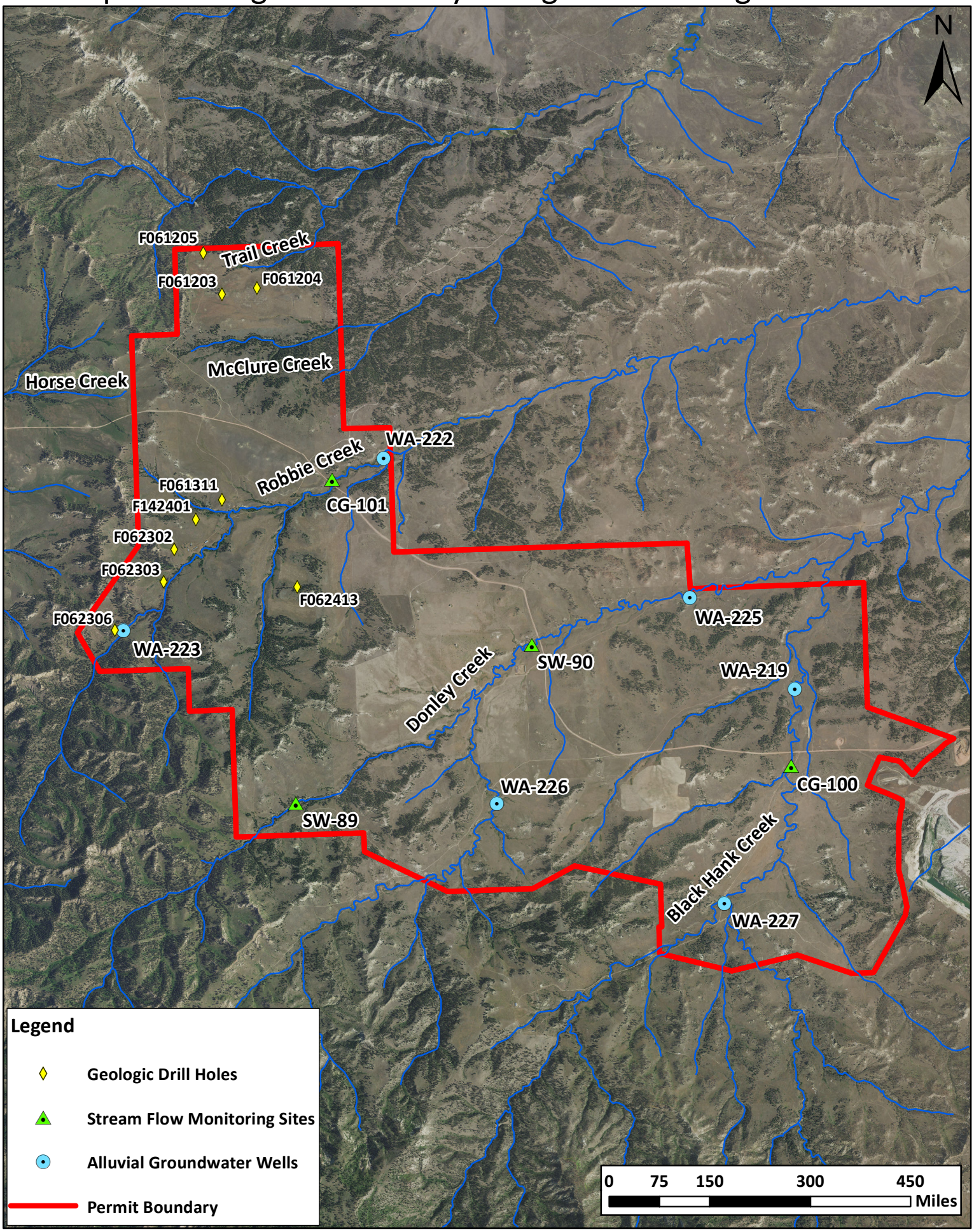
Otter Creek AVF, 2016. Partial Alluvial Valley Floor Determination for the Otter Creek Watershed In and Adjacent to the Proposed Otter Creek Mine. Montana Department of Environmental Quality, Coal and Uranium Program. February 2016.

USDA, 1980.; Geological Parent Materials of Montana Soils. Montana Agricultural Experiment Station, Montana State University – Bozeman, MT and USDA Soil Conservation Service. pp 74-81.

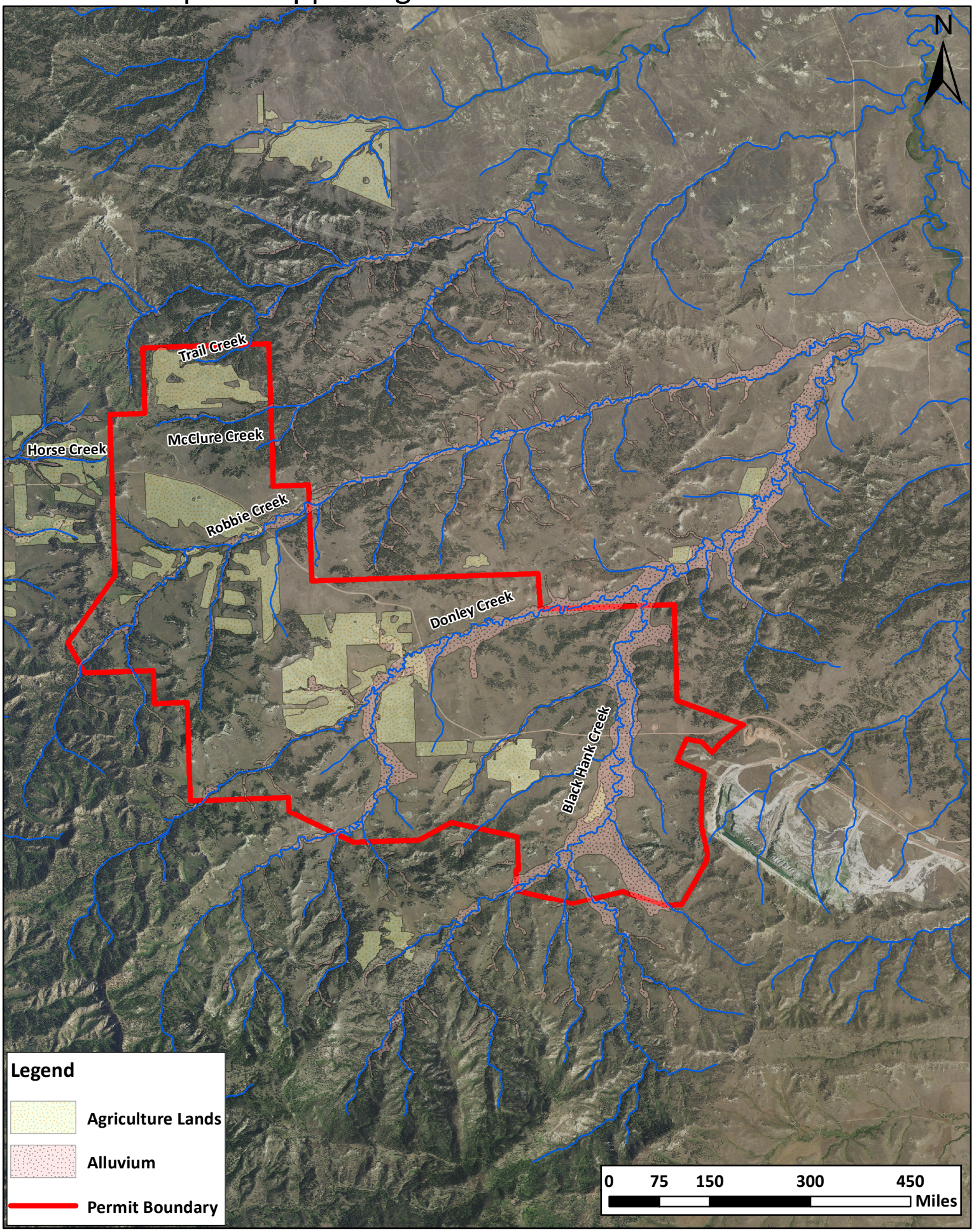
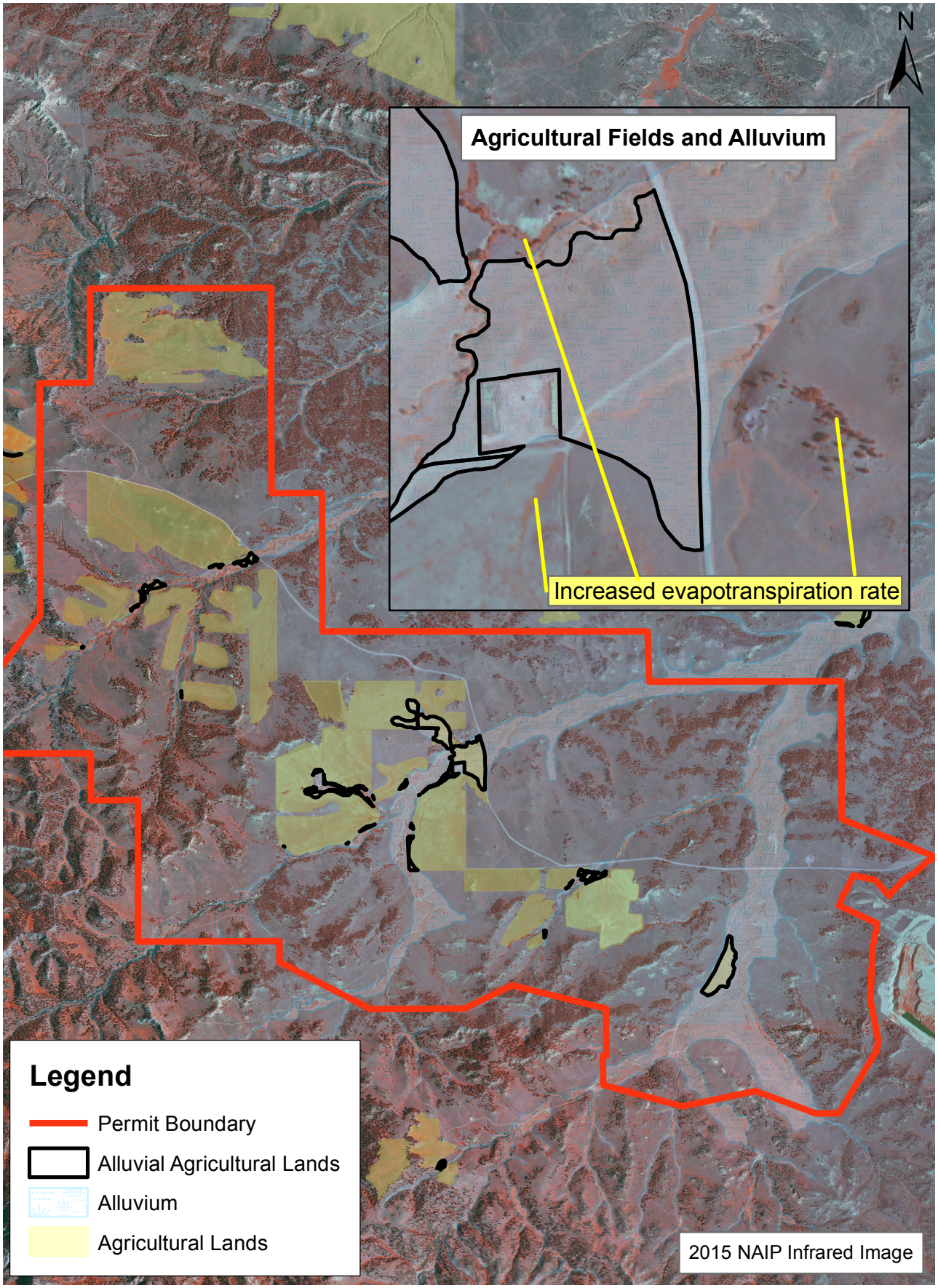
Map 1: Project Overview



Map 2: Geologic Drill and Hydrologic Monitoring Locations



Map 3: Mapped Agricultural Land and Alluvium



Map 4: Potential Late Season Subirrigation