RECLAMATION

Managing Water in the West

Middle Methow Reach Assessment Methow River

Okanogan County, Washington

U.S. Department of the Interior
Bureau of Reclamation
Pacific Northwest Region
Pacific Northwest Regional Office, Boise, Idaho

August 2010

U.S. DEPARTMENT OF THE INTERIOR

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Cover Photo: View is to the northwest looking upstream at a levee (Sugar Dike) placed on river right along the Methow River near Twisp, Washington. Subreach MM-IZ-7 – Methow Subbasin, Washington – Bureau of Reclamation.

Date: May 21, 2007 Photo by: David Walsh

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ACKNOWLEDGEMENTS

We would like to thank the Methow Restoration Council (MRC) for their input in the development of this reach assessment. Their local knowledge and expertise improved the content of this report, including potential implementation actions to improve the viability of Endangered Species Act-listed species. We appreciate their efforts and look forward to a collaborative effort with them to implement habitat improvement actions.

We would also like to acknowledge U.S. Bureau of Reclamation personnel, Richard Link, L.E.G., L.G., Program Manager for the Geology and River Systems Analysis Groups and Terril Stevenson, L.G., Manager of the River Systems Analysis Group, who were the peer reviewers and provided comments that helped further refine and clarify the concepts presented in this report.

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EXECUTIVE SUMMARY

The Bureau of Reclamation (Reclamation) produced this reach assessment to assist in meeting tributary habitat commitments contained in the 2008 Federal Columbia River Power System Biological Opinion (BiOp) (NOAA Fisheries 2008). This Biological Opinion includes a Reasonable and Prudent Alternative (RPA), or a suite of actions, to protect listed salmon and steelhead across their life cycle. This report provides scientific information to Federal, Tribal, State, and local partners that can be used to develop and monitor actions that are intended to improve the survival and recovery of salmon and steelhead listed under the Endangered Species Act (NOAA Fisheries 2008).

Located in Okanogan County, Washington, the Methow subbasin has a drainage area of about 1,890 square miles and flows into the Columbia River near river mile (RM) 524. About 89 percent of the subbasin is in public ownership and the remaining 11 percent is under private ownership that is primarily within the valley bottoms. The Methow subbasin is comprised of the following ten subwatersheds: Early Winters Creek, Upper Methow River, Lost River, Middle Methow River, Chewuch River, Twisp River, Beaver Creek, Gold Creek, Libby Creek, and the Lower Methow River (UCSRB 2007).

The Middle Methow reach is located between RM 50.0 and 41.0 on the Methow River, a 6th field Hydrologic Unit Code (HUC) watershed (#170200080605). The reach is characterized as moderately confined (RM 50.0-47.0), unconfined (RM 47.0-41.3), and confined (RM 41.3-41.0) based on valley constraints.

The species of concern found in the Methow River include Upper Columbia River (UCR) spring Chinook salmon (*Oncorhynchus tshawytscha*), UCR steelhead (*Oncorhynchus mykiss*), and Columbia River bull trout (*Salvelinus confluentus*) that are included in the Endangered Species Act Threatened and Endangered list (UCSRB 2007) and the Pacific lamprey (*Entosphenus tridentatus*). The reach has Class A waters (WDOE 1990) and is classified as a Category 2 watershed in which Restoration and Protection habitat action classes have been recommended in the *Upper Columbia Spring Chinook Salmon, Steelhead, and Bull Trout Recovery Plan* (UCSRB 2007), referred to as the *Recovery Plan,* and *A Biological Strategy to Protect and Restore Salmonid Habitat in the Upper Columbia Region* (UCRTT 2007), referred to as the *Biological Strategy*.

Limiting factors, the "condition that limit the ability of habitat to fully sustain populations of salmon" (State of Washington 1998 Engrossed Substitute House Bill 77RCW), affecting the Middle Methow River subwatershed habitat conditions include the following (UCSRB 2007, UCRTT 2007):

- Residential development is affecting riparian and floodplain condition.
- Low flows in late summer and winter may affect juvenile survival.

- Structures in tributaries are passage barriers for adult and juvenile salmonids.
- The mainstem Methow is on the state 303(d) list for temperatures.
- Decreased habitat diversity and quantity due to roads, riprap, residential development and agriculture.
- Excessive artificial channel stability due by roads, riprap, residential development, and agriculture.

It should be noted that the Methow Valley Irrigation District's (MVID) east division structures and fish screens were listed as limiting factors. The diversion structures and fish screens have since been corrected and are no longer a fish passage barrier or impingement hazard.

An analysis was conducted on the Middle Methow reach using reach-based ecosystem indicators (REI) (Appendix A). The indicators used were adapted from the National Oceanic and Atmospheric Administration (NOAA) and United States Fish and Wildlife Service (USFWS) matrix of pathways and indicators, and those contained in the *Monitoring Strategy for the Upper Columbia Basin (Hillman 2006),* referred to as the *Monitoring Strategy*. The lateral channel migration indicator was modified in the REI, and vertical channel stability indicator was added to provide more clarity on channel dynamics. Although the interpretation of the condition of each indicator is somewhat subjective, the data upon which the interpretation is based in many cases has been quantified. The quantified data provides an environmental baseline condition that can be repeated to establish a time series that can be used to conduct an intervention or trend analysis (i.e. effectiveness monitoring).

The condition of each indicator for the Middle Methow reach was interpreted for this report by a technical team composed of a geologist, a hydraulic engineer, and biologists who were familiar with the Middle Methow to be in the following conditions (Appendix A):

1. ***Unacceptable condition***
    a. Vegetation condition (disturbance) due to past floodplain clearing (about 51 percent of floodplain) for agriculture, commercial and residential development, and the removal of beaver activity within the floodplain that create and maintain complex vegetation structure.
2. ***At risk condition***
    a. Water temperature due to past clearing of the riparian buffer zone, reduced instream flows, and reduced floodplain connectivity caused by floodplain development and infrastructure.

b. Main channel physical barriers due to a diversion structure (Barkley diversion dam). Technically this diversion structure is not a main channel physical barrier, but it does entrain juvenile salmonids and is modified during low summer flows creating a potential velocity barrier for juvenile salmonids. The condition ranking is based on the diversion causing fish mortality by entrainment when the canal is turned off in the fall and the instream manipulation of the dam that may cause a velocity barrier during some biological significant flows.

c. Large wood due to the lack of instream wood from channel clearing, and reduced recruitment potential due to artificial channel stability and floodplain development. Technically, the reach is functioning in an unacceptable condition based on the criterion in the REI. However, this indicator was given an "at risk condition" ranking because the large size of this unconfined alluvial river transports large wood as sediment at high flows depositing the wood primarily on bars, islands and the head of side channels.

d. Pools due to the lack of fish cover typically provided by appropriate riparian vegetation and large wood. Although there are an adequate number of deep, bedrock pools that provide fish cover, there are shallow, lateral scour pools along the channel margins that lack appropriate vegetation and large wood which would provide adequate fish cover.

e. Off-channel habitat because of levees and roads disconnecting side channels and floodplain processes, bank protection that restricts lateral channel migration, and the reduction of beaver activity that create complex aquatic habitats.

f. Floodplain connectivity due to levees and road embankments that disconnect floodplain processes, bank protection that may result in bed scour and localized channel incision, and commercial and residential floodplain development.

g. Bank stability/channel migration due to artificial channel stability caused by bank protection restricting lateral channel migration and unstable channel sections that erode laterally into banks where riparian vegetation has been removed for floodplain development.

h. Vertical channel stability due to bank protection that may result in bed scour and localized channel incision and due to instream hydrologic impacts from loss of floodplain connectivity.

i. Vegetation condition (structure) due to about 51 percent of the floodplain being cleared for development, about 49 percent of the floodplain successional stage is in a small-to-large tree condition, and past removal of beavers and their activity that help create and maintain complex riparian vegetation structure.

j. Vegetation condition (canopy cover) due to clearing and grazing of riparian vegetation along the streambanks that provides shading and moderates the local climate (i.e., air temperature) along the river.

3. Adequate condition

a. Turbidity based on Washington Department of Ecology water quality determinations.

b. Chemical contamination/nutrients based on Washington Department of Ecology water quality determinations.

c. Channel substrate based on Wolman pebble counts conducted in several locations along the river throughout the reach.

d. Fine sediment based on visual estimates of the percentage of surface fines and substrate embeddedness.

The geomorphic potential, which is a measure of the streams capability to dynamically adjust to changes in the hydrologic, geomorphic, and biotic regimes, was interpreted to be moderate from RM 50.0 to 47.0; high from RM 47.0 to 41.3; and low from RM 41.3 to 41.0. Geomorphic potential for the reach is interpreted to be in a degraded condition primarily due to the following: (1) floodplain development for agriculture, residential, and commercial uses restricts floodplain connectivity, and has altered the riparian vegetation structure , (2) irrigation diversions within the main channel reduce instream flows and during low flow periods may reduce habitat quality and availability, (3) levees disconnect historic channel paths and disconnect floodplain areas, (4) bank protection restricts lateral channel migration, affects hydraulics and sediment transport that could result in localized scour and channel incision, and (5) large wood removal from the river and along riparian buffer zone reduces channel complexity and roughness, and reduces large wood recruitment potential.

Based on the indicator condition analysis and geomorphic potential, following prioritized habitat action classes, adapted from Roni et al. (2002, 2005), are recommended to achieve a cumulative reach scale response. These recommendations and appropriate actions are further discussed in the **Subreach Profiles** section of this report:

1. Protect and maintain current habitat: this habitat action class includes protecting intact tracts of quality habitats throughout the reach. Quality aquatic and terrestrial habitats are fragmented in the reach, and protection of these habitats will maintain current physical and ecological processes. There are several conservation easements already in-place throughout the reach. Some examples of quality habitats include tracts of intact riparian vegetation, cold water sources, off-channel habitats, and beaver colony areas.

2. Reconnect isolated habitat: this habitat action class includes reconnecting both aquatic and terrestrial habitats throughout the reach. Re-establish and protect a continuous riparian buffer zone (maximize width where possible, otherwise a minimum width of 30 meters) along the alluvial area of the reach and along all secondary waterways (minimum width of 10 meters). In addition, all tributaries, main channel barriers, and off-channel barriers (i.e., Bear Creek, Barkley Diversion Dam, "Sugar Dike" area, and Doran side channel area) should be reconnected to the Methow River to provide appropriate fish passage, transfer of energy, and rearing habitat. These actions address most of the reach scale deficiencies and will help provide long-term resiliency to all species reliant on riverine habitat and processes. Some benefits include (1) aquatic re-colonization of disconnected habitat, (2) transfer of energy (i.e., food web), (3) expanding macroinvertebrate habitat, (4) improving water quality, (5) increasing channel complexity, (6) allowing lateral channel migration, and (7) increasing habitat connectivity of terrestrial dependent species (amphibian, avian, reptilian, and mammalian species).

3. Reconnect processes: this habitat action class includes improving fluvial and ecological interactions between the channel and its floodplain. Remove or modify anthropogenic features that presently disconnect floodplain processes. Reconnection of the floodplain processes improves groundwater recharge, expands the hyporheic zone, and increases off-channel habitat. Beaver re-introduction in suitable floodplain type side channels would further increase the above processes and habitat quantity, and improve diversification of aquatic and vegetation species. These actions include (1) removal or modification of bank protection (i.e., riprap and levees), where appropriate, that inhibit lateral channel migration and exaggerate vertical channel migration that may result in the possible disconnection of the floodplain, (2) install large wood (i.e., instream and floodplain wood loading) that contribute to the creation and maintenance of side channels, provide fish cover, and increase biomass, and (3) re-introduction of beavers where appropriate to create complex off-channel habitat and riparian vegetation structure, and to store water on the floodplain for additional groundwater recharge.

4. Reconnect isolated habitat units: this habitat action class includes the placing of boulders along high energy reaches where wood would not be retained and the use of large wood to provide habitat connectivity, fish cover, and increase biomass. Large boulder placements (using rounded to subrounded boulders) could be considered along the high energy reaches to provide hydraulic roughness and resting areas for migrating salmonids. Large wood placements could be considered in side channels and alcoves to provide additional fish cover, side channel complexity, and biomass. Creation of habitat, such as alcoves and off-channel area, could be considered to provide rearing habitat and high-flow refugia.

This report summarizes the above habitat action classes at relevant spatial scales to provide the necessary information to identify appropriate actions within a reach concept. Once actions have been identified for implementation, further analysis will need to be completed (i.e., alternatives evaluation) to address the appropriateness of the action, biological benefit, socio-economic considerations, construction and cost considerations, and an analysis of risks and liabilities to life and property.

OVERVIEW

The Bureau of Reclamation (Reclamation), U.S. Army Corps of Engineers, and Bonneville Power Administration contribute to the implementation of salmonid habitat improvement projects in Columbia River Basin tributaries to help meet commitments contained in the 2008 Federal Columbia River Power System Biological Opinion (BiOp) (NOAA Fisheries 2008). This BiOp includes a Reasonable and Prudent Alternative (RPA), or a suite of actions, to protect listed salmon and steelhead across their life cycle. Habitat improvement projects in various Columbia River tributaries are one aspect of this RPA. Reclamation provides technical assistance to States, Tribes, Federal agencies, and other local partners for identification, design, and construction of stream habitat improvement projects that primarily address streamflow, access, entrainment, and channel complexity limiting factors. This report provides scientific information that can be used to help identify, prioritize, implement, and monitor sustainable fish habitat improvement projects and to help focus those projects on addressing key limiting factors to protect and improve survival of salmon and steelhead listed under the Endangered Species Act (ESA).

The Middle Methow reach assessment area has Class A waters (WDOE 1990) and is classified as a Category 2 watershed in which Restoration and Protection habitat action classes have been recommended in the *Upper Columbia Spring Chinook Salmon, Steelhead, and Bull Trout Recovery Plan* (UCSRB 2007), referred to as the *Recovery Plan*, and *A Biological Strategy to Protect and Restore Salmonid Habitat in the Upper Columbia Region* (UCRTT 2007), referred to as the *Biological Strategy*.

The tributary and reach assessments maximize the potential to implement successful improvement actions that benefit anadromous species, and native aquatic and terrestrial species listed under the ESA considering the physical and ecological processes at work in the watershed. Assessments also define environmental baseline conditions that complement monitoring activities designed to evaluate the physical and biological responses associated with implemented actions.

Many authors have documented strategies that emphasize physical and ecological relationships that need to be addressed prior to identifying and implementing actions in order to improve their sustainability and biological benefits (Beechie et al. 1996, 2010; Kauffman et al. 1997; Beechie and Bolton 1999; Montgomery and Bolton 2003). In addition, Roni et al. (2002, 2005) have proposed a hierarchical strategy to implement habitat action classes at the watershed and reach scales that should maximize ecological benefits versus cost of implementation. Based on understanding of these hierarchical relationships, this assessment uses the conceptual model in Figure 1 to analyze physical and ecological processes across the landscape, and for identifying and monitoring actions within an adaptive management framework.

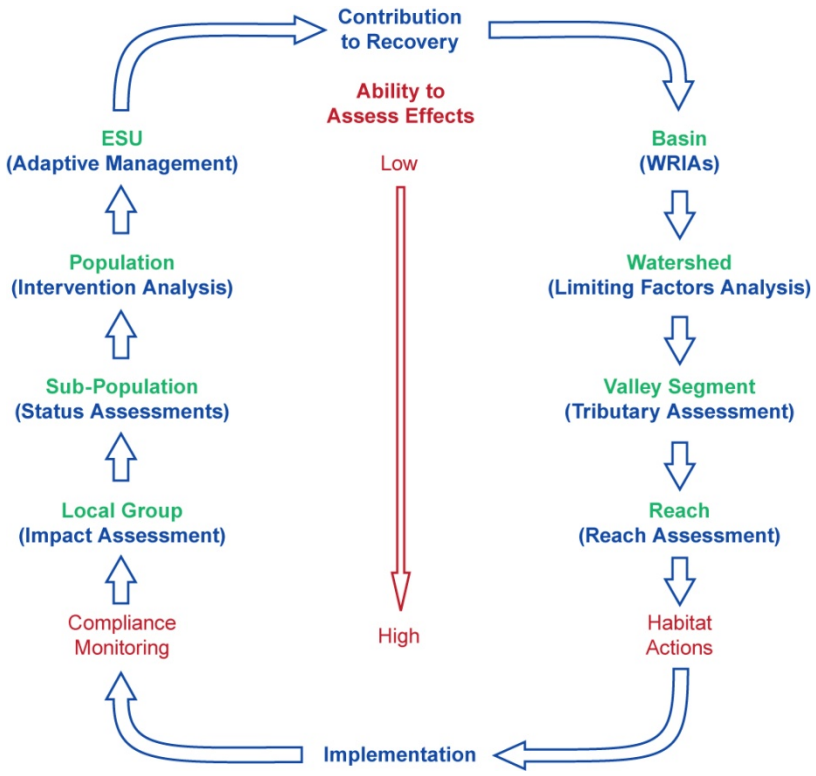

Figure 1. Conceptual model showing how assessments and monitoring are hierarchically nested and related. Compiled from Hillman (2006), UCSRB (2007), and Stewart-Oaten and Bence (2001).

LOCATION AND PURPOSE

Located in Okanogan County, Washington, the Methow subbasin has a drainage area of about 1,890 square miles and flows into the Columbia River near river mile (RM) 524 (Figure 2). About 89 percent of the subbasin is in public ownership and the remaining 11 percent is under private ownership that is primarily within the valley bottoms. The Methow subbasin is comprised of the following ten subwatersheds: Early Winters Creek, Upper Methow River, Lost River, Middle Methow River, Chewuch River, Twisp River, Beaver Creek, Gold Creek, Libby Creek, and the Lower Methow River (UCSRB 2007).

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(*Entosphenus tridentatus*). Columbia River Basin species of concern found in the Middle Methow River include UCR spring Chinook salmon, UCR steelhead, Columbia River (CR) bull trout, and Pacific lamprey. The Methow River is a major spawning area for UCR spring Chinook salmon and UCR steelhead, important for Pacific lamprey spawning and rearing, and it is also an important migration corridor for UCR spring Chinook salmon, UCR steelhead, CR bull trout and Pacific lamprey.

The Middle Methow reach has Class A (excellent) waters (WDOE 1990) and is classified as a Category 2 watershed in which Restoration and Protection actions have been recommended (UCSRB 2007). Reclamation recognizes that *Restoration* to conditions prior to the influx of Western civilization is not attainable in most cases and uses the term *Rehabilitation* in which the physical and ecological processes are improved, but are not necessarily restored to their "natural" condition.

The purpose of this reach assessment is to refine the scientific understanding of physical and ecological processes at a reach scale, establish environmental baseline conditions for future monitoring, and describe potential actions for implementation at the reach scale. Several limiting factors were identified in the *Recovery Plan* and *Biological Strategy* for the Middle Methow River subwatershed (UCSRB 2007). Many of these limiting factors were based on professional judgment, local expertise, and biological models, but much of the data had not been quantified. This reach assessment documents environmental baseline conditions, identifies the condition of the indicators, and quantifies several indicators for future monitoring. When possible, quantifiable data was collected and entered in a reach-based ecosystem indicators (REI) table for evaluation (Appendix A). A qualitative condition ranking was assigned to each specific and general indicator. Although these condition rankings are qualitative, much of the data upon which they are based have been quantified, and, in some cases, have been georeferenced (i.e., channel units, anthropogenic features and vegetation structure) for future monitoring efforts. Upon evaluation of the REI, protection and rehabilitation approaches were proposed that could address long-term and short-term improvements to physical and ecological processes.

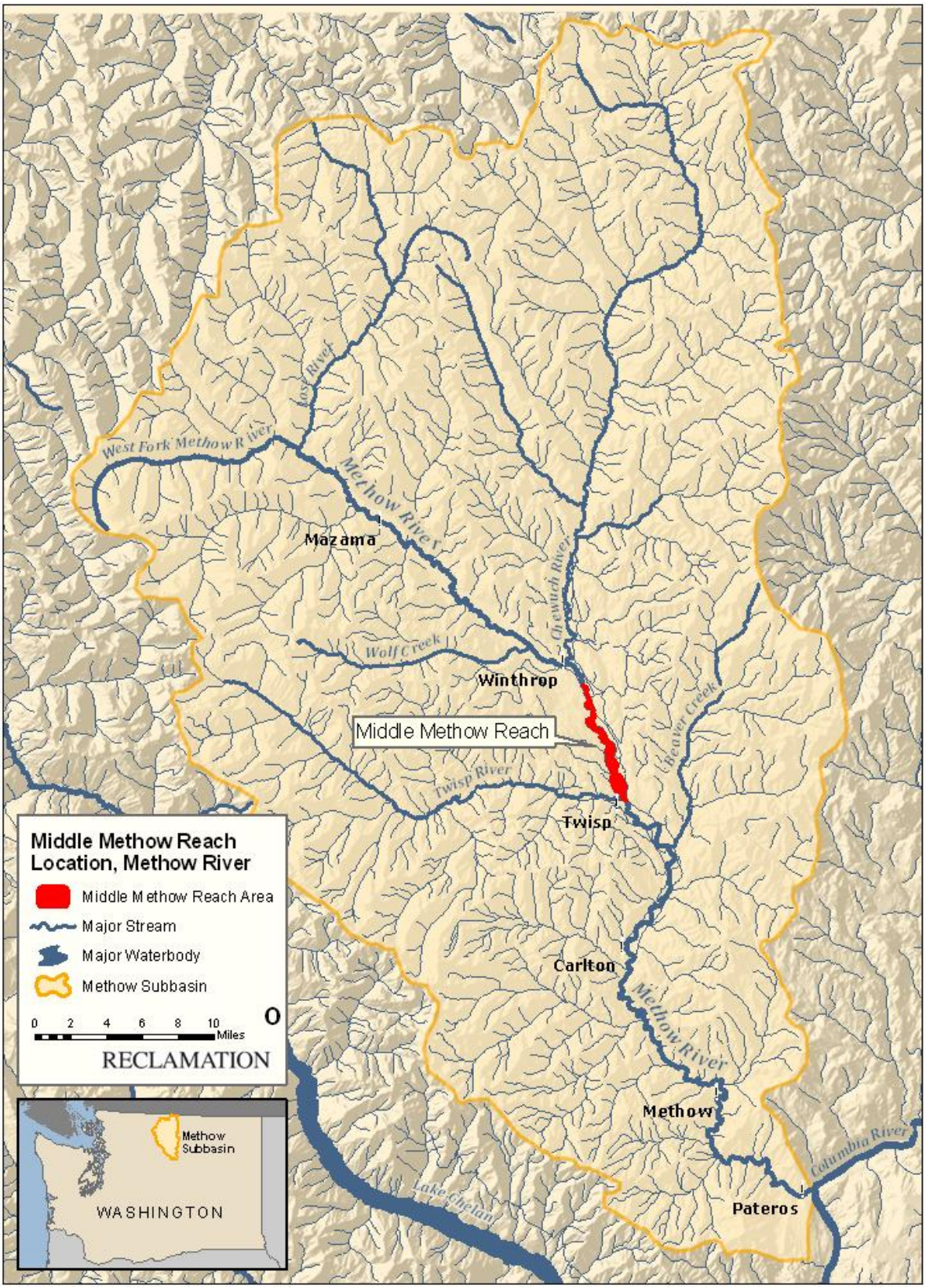

Figure 2. Location of the Middle Methow reach, Okanogan County, Washington.

The *Recovery Plan* and the *Monitoring Strategy for the Upper Columbia Basin* (Hillman 2006), referred to as the *Monitoring Strategy*, recommend effectiveness monitoring of actions taken to improve habitat in the Upper Columbia. An effectiveness monitoring program was initiated for the Middle Methow reach in 2008. The US Geological Survey (USGS) is conducting an effectiveness monitoring program in cooperation with Reclamation. This effectiveness monitoring program involves collecting and analyzing pre- and post-implementation physical and biological data to assess population level effects before actions are implemented (2008-2010), and then will follow-up after actions are completed (scheduled for 2012-2014). This Level III monitoring (Hillman 2006) is complemented by the documentation of physical and ecological processes contained in this reach assessment. In addition, other monitoring efforts are occurring throughout the subbasin (Figure 3) and a full report by Crandall (2009) is included as Appendix B.

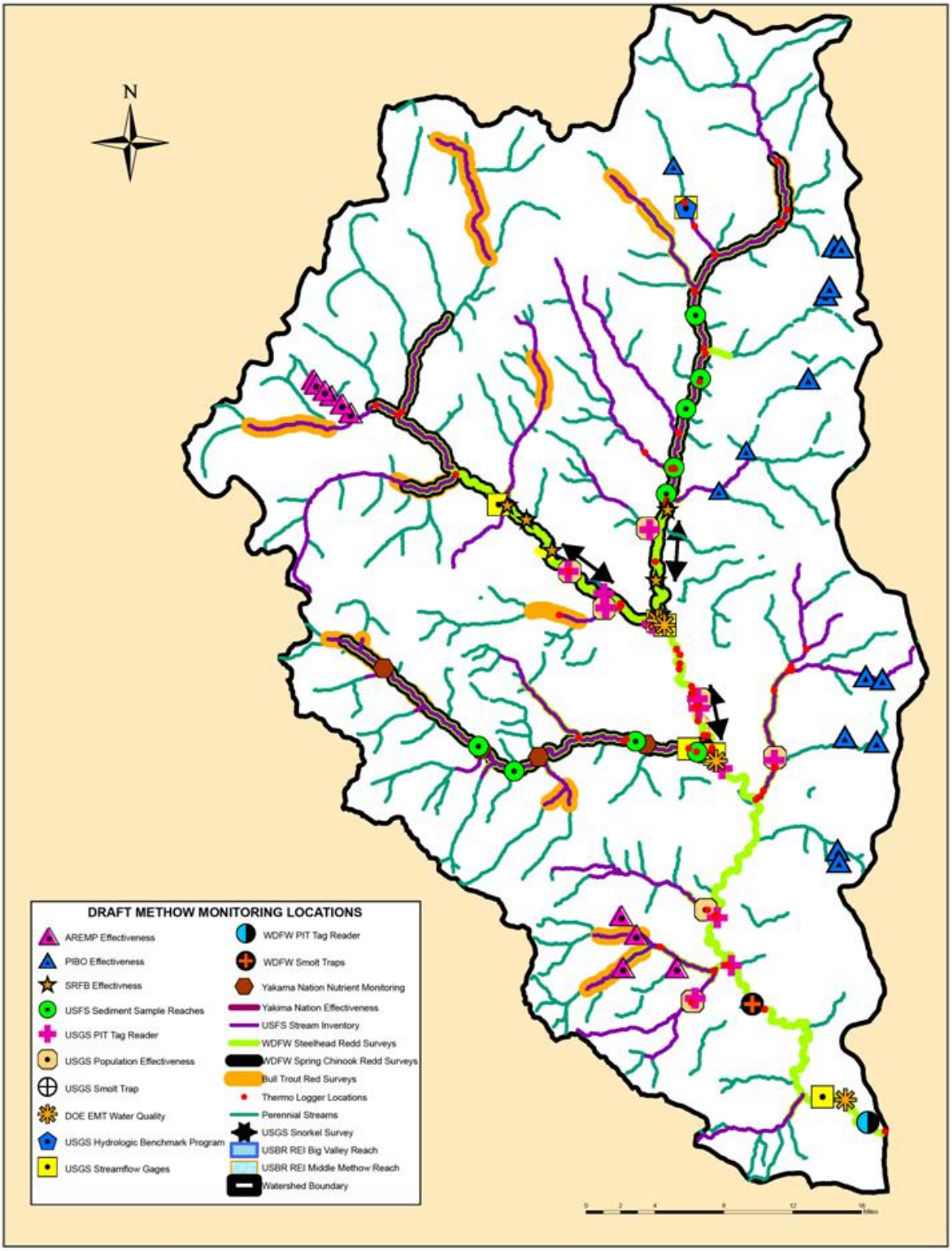

Figure 3. Location of monitoring efforts occurring throughout the Methow subbasin (Crandall 2009).

REACH CHARACTERIZATION

The following sections provide context for the Middle Methow reach at the watershed and reach scales. Watershed characteristics were evaluated to understand physical processes including geologic and hydraulic processes, geomorphic reaches, and common geomorphic and hydraulic attributes (Reclamation 2007). Primary limiting factors and management objectives for the Middle Methow River subwatershed are summarized from the *Recovery Plan* and *Biological Strategy*. Reach scale characteristics were evaluated to refine the description of physical and ecological processes including geologic and geomorphic mapping, hydraulic modeling, habitat assessment, and vegetation assessment. Geomorphic potential, defined for this report as the capability of streams to form, connect, and sustain fluvial systems (including fish habitat) by dynamically adjusting longitudinally, vertically, and laterally to changes in the hydrologic, geomorphic, and biotic regimes over time, is evaluated at the reach scale.

Watershed Scale Context

To place the Middle Methow reach into a watershed context, a summary is provided of the *Methow Subbasin Geomorphic Assessment, Okanogan County, Washington*, referred to in this report as the *Tributary Assessment* (Reclamation 2007). In addition, a summary is provided of the limiting factors and recommended management objectives for the Middle Methow River subwatershed based on the *Recovery Plan* and *Biological Strategy*.

Summary of the 2007 Tributary Assessment

The *Tributary Assessment* was completed by a multidisciplinary team of hydraulic engineers, geologists, hydrologists, biologists, and botanists (Reclamation 2007). The focus of the *Tributary Assessment* was to complete a comprehensive geomorphic analysis of the fluvial system along 80 miles of the Chewuch, Methow, and Twisp Rivers (Figure 4).

The purpose of the *Tributary Assessment* was to identify geologic and hydraulic processes active within the valley segments; explore whether geomorphic and hydraulic conditions upstream and downstream affect conditions within each segment; and identify geomorphic reaches that share common geologic and hydraulic physical attributes. The *Tributary Assessment* identified eleven geomorphic reaches on the Methow River (Table 1). These geomorphic reaches were characterized into three general reach types based on valley confinement, referred to as confined, moderately confined, and unconfined (Reclamation 2007). The Middle Methow reach is a moderately confined (M4) to unconfined (M5) geomorphic reach that is bounded by confined geomorphic reaches (M3 and M6) (**Error! Reference source not found.**).

The *Tributary Assessment* found no large-scale change to the balance between incoming water and sediment loads that would indicate a potential for incision or aggradation on a decadal scale. The river hydraulics and sediment sizes present along the channel bed within

the *Tributary Assessment* area are most notably dominated by geologic features that control the river bed slope and the lateral extent (width) of the active channel and floodplain. The average sediment particle sizes measured in the bars and channels are gravel to cobble (40 to 140 mm) for the Methow, Chewuch and Twisp Rivers, with the larger sizes present in the reaches with steeper slopes. Except for a few steep, confined reaches, the bars and channels can be reworked at the more frequent 2-year and 5-year floods. This indicates that the energy, in most geomorphic reaches, is not exceeding sediment supply. Combined with findings from historical channel analysis and field observations there appears to be a limited tendency for channel incision.

The effects of human features and activities have not been detected on hydraulics and sediment characteristics at the reach scale. At a more localized scale, human features and activities have impacted hydraulics; habitat features formed by large wood and riparian vegetation; and spawning-sized sediment availability. Hydraulic conditions have been most impacted by reducing flow access to off-channel areas at the entrance to side channels, and to some degree altering access to overbank flooding.

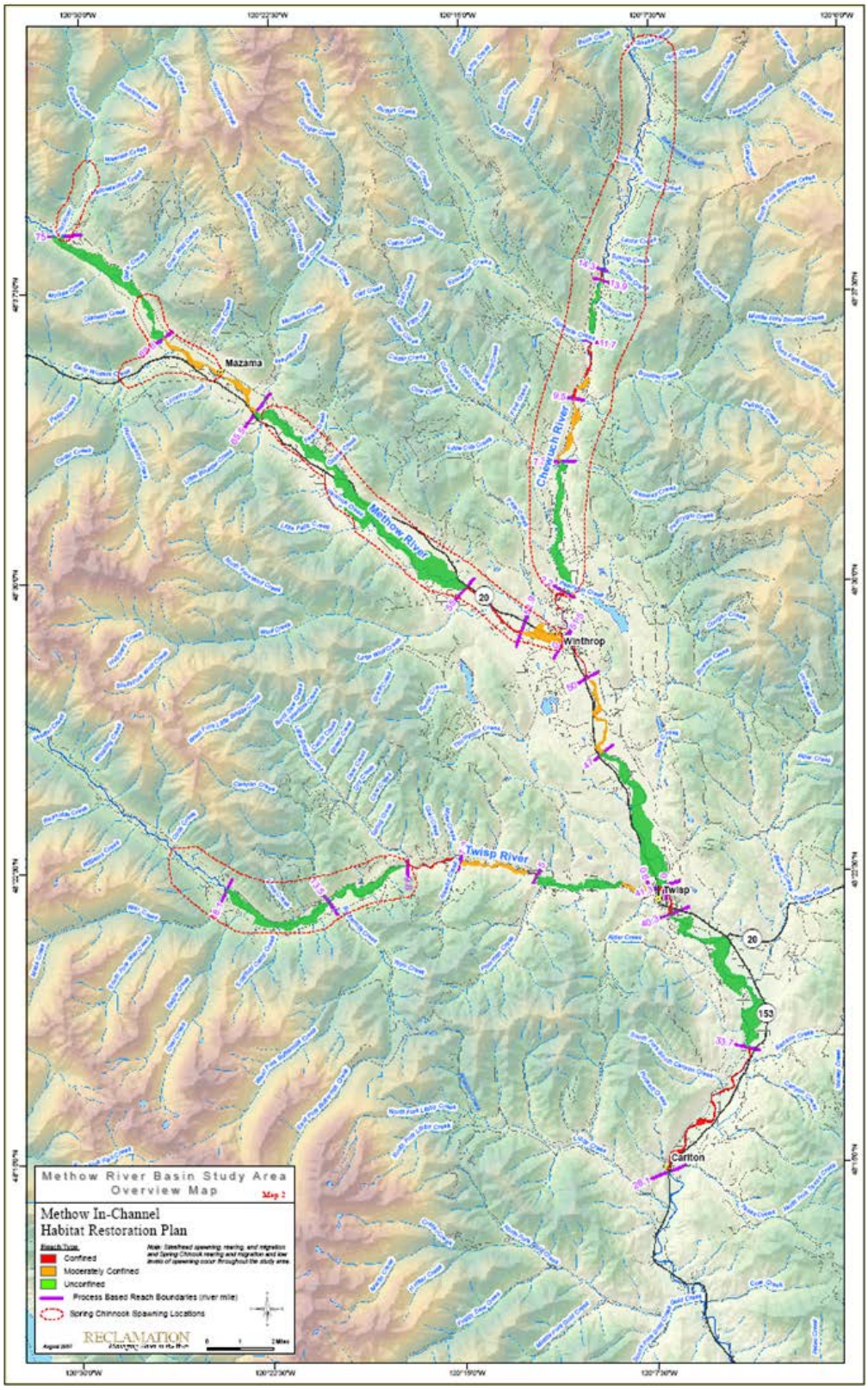

Figure 4. Location of the tributary assessment area within the Methow subbasin (Reclamation 2007).

Table 1. Summary of geomorphic reach characteristics for the methow River

Geomorphic Type	Reach Name	Down-stream River Mile	Up-stream River Mile	Protection Area with No Human Features (% of total reach)	Length of Side Channels (mi)		Indicator of Disruption to Processes		Cleared Vegetation (% of total reach)
					Presently Accessible[3]	Presently Cut Off by Human Features	Connectivity Within Floodplain[1]	% of Floodplain Boundary that is Armored [2]	
Confined	M1	28.1	33.7	NA	0	0	0.13	27	11.1
Unconfined	M2	33.7	40.3	7%	0.5	7.6	0.66	23	24.4
Confined	M3	40.3	41.3	NA	0	0	0.06	61	5.3
Unconfined	M4[4]	41.3	47	9%	0.8	6.3	0.80	17	37.0
Moderately confined	M5[4]	47	50	26%	0.2	0.9	0.38	14	26.6
Confined	M6	50	51.5	NA	0	0	0.00	12	0.0
Moderately confined	M7	51.5	52.9	0%	0	1.4	1.89	04	40.9
Confined	M8	52.9	55	NA	0	0	0.01	40	10.6
Unconfined	M9	55	65.5	34%	8.5	9.5	0.54	10	13.2
Moderately confined	M10	65.5	69.6	56%	0.9	1.2	0.05	7	11.6
Unconfined	M11	69.6	75	38%	1.3	0.6	0.40	7	7.8

1/ Computed by taking the total length of human features located within the floodplain (low surface) divided by the total reach length.
2/ Computed by taking the total length of riprap and bank armoring located along the floodplain (low surface) boundary divided by the total length of the boundary.
3/ Although presently accessible, the natural frequency of inundation may still be disrupted in some cases due to channel incision from human activities or other human induced factors.
4/ Geomorphic reaches comprising the Middle Methow reach assessment area.
Red font indicates the area of the Middle Methow reach assessment.

Summary of Limiting Factors and Management Objectives

The Middle Methow River subwatershed is defined in the *Biological Strategy* as the mainstem Methow River between the Chewuch River confluence (RM 51.5) at Winthrop and Texas Creek (RM 28.25) near Carlton with a drainage area of about 15,600 acres. Its status is a Category 2 subwatershed with major spawning areas for steelhead and spring Chinook salmon (based on historic intrinsic potential). The mainstem Methow River is also an important migration corridor for spring Chinook salmon, steelhead and bull trout, and provides spawning and rearing habitat for summer Chinook salmon and steelhead. Tributaries include Alder Creek, Bear Creek, Beaver Creek, Benson Creek, and the Twisp River.

Limiting factors affecting the Middle Methow River subwatershed habitat conditions include the following (UCSRB 2007, UCRTT 2007):

- Residential development is affecting riparian and floodplain condition.
- Low flows in late summer and winter may affect juvenile survival.
- Structures in tributaries are passage barriers for adult and juvenile salmonids.
- The mainstem Methow is on the state 303(d) list for temperatures.
- Decreased habitat diversity and quantity due to roads, riprap, residential development and agriculture.
- Excessive artificial channel stability due to roads, riprap, residential development, and agriculture.

It should be noted that the Methow Valley Irrigation District's diversion structures and fish screens were listed as limiting factors. The diversion structures and fish screens have since been corrected and are no longer a fish passage barrier or impingement hazard.

Recommended management objectives for the Middle Methow River include the following (UCSRB 2007, UCRTT 2007):

- Improve and protect riparian habitat conditions
- Increase off-channel habitat by rehabilitating floodplains and reconnecting side channels
- Increase habitat diversity and quantity by rehabilitating riparian habitat, reconnecting side channels and floodplains (where feasible), and adding instream structures (low priority action) within the river. Modify existing bank hardening projects to incorporate roughness elements to reduce water velocity and increase instream complexity

- Use practical and feasible means to increase stream flows within the natural hydrologic regime and existing water rights.

Reach Scale Context

Several assessments were conducted on the Middle Methow reach to determine (1) current physical processes, (2) condition of aquatic and terrestrial habitat, and (3) historical and ongoing anthropogenic activities that have impacted physical and ecological processes. These assessments are summarized in the following sections.

Summary of 2008-2009 Reach Documentation

An assessment was conducted during the fall of 2008 and 2009 to document anthropogenic, geologic and geomorphic features (Appendix C). The reach's valley bottom-type is classified as a wide mainstem valley (F3) with a valley bottom gradient of less than 3 percent, and an unconstrained, moderately sinuous channel (Naiman et al. 1992). The stream type is predominantly an F-type (Rosgen 1996) channel in the moderately confined geomorphic reach and a C-type (Rosgen 1996) channel in the unconfined geomorphic reach. The bedforms are predominantly pools, riffles and runs; and gravel and cobbles are the dominant substrate. Geology includes predominantly sedimentary deposits and metamorphic rocks that are further defined as glacial and alluvial deposits, and bedrock.

Figure 5 is a composite geologic map (compiled from Stoffel et al. 1991; Reclamation 2010; and Waitt 1972) that shows an example of the geology and geomorphic landscape between RM 49.00 and 46.25, and the majority of cold water upwelling areas in the reach. Geology, and geomorphic landforms, and their spatial arrangement influence groundwater recharge, hydraulic gradients, and hydraulic conductivity. These interactions are the drivers and controls in routing groundwater flows and cold water upwelling areas.

The Twin Lakes area west of the Methow River between RM 50.0 and 47.0 is a kame terrace, a terrace deposited by a stream that ran along the margin of a glacier, that is cored by bedrock, and is a significant groundwater recharge and source area for the Methow River (Aspect 2009). The hydraulic gradient is primarily from the Twin Lakes area toward the Methow River to the north and southeast (Aspect 2009). The alluvium and/or fractured bedrock have high hydraulic conductivities that provide avenues for groundwater flow in the reach between RM 49.00 and 46.25. In contrast, bedrock that is not fractured (competent) has low hydraulic conductivity and impedes groundwater flows resulting in cold water upwelling areas. Table 2 summarizes the cold water upwelling areas interpreted from thermal infra-red (TIR) imagery and geologic mapping. The majority of cold water upwelling areas are interpreted to be created by bedrock controls that force groundwater to rise to the surface. Other cold water upwelling areas are interpreted to be from groundwater or hyporheic flows through glacial and alluvial deposits that surface in the downstream direction.

Table 2. Summary of cold water upwelling sites.

Side Channel Identifier or Upwelling Location	Local Name	Total Acres	Side Channel Type*	Cold Water Source	Wetted
SC_48.37_L	Gilbertson Springs	0.68	Gravel Bar (although the spring surfaces along a terrace prior to flowing down to the secondary channels along the gravel bar)	Yes	Perennial
47.95_R	River Rock	NA	NA: Upwelling within the river	Yes	Perennial
SC_47.90_R	River Rock	0.99	Floodplain	Yes	Perennial
SC_46.70_L	Boesal	0.75	Gravel Bar	Yes	Perennial
SC_45.10_R	Habermehl	4.74	Floodplain	Yes	Ephemeral

* Side channel type classifications are based on the predominant location of secondary (and sometimes tertiary) channels and are designated as either gravel bar or floodplain type side channels.

Bedrock provides lateral and vertical channel controls in the reach. These outcrops restrict (1) lateral channel migration forcing creation of deep scour pools, and (2) vertical channel migration by providing grade controls. Bedrock outcrops are located along the margins and within the channel in several locations. Table 3 summarizes the locations of bedrock controls. Figure 5 contains an example between RM 49.00 and 46.25.

Table 3. Location of lateral and vertical bedrock controls.

River Mile	Description
RM 49.8	Crops out in floodplain along river right indicating shallow alluvium
RM 49.7	Crops out along river left controlling lateral channel migration
RM 49.3	Crops out along river right controlling lateral channel migration
RM 49.0	Crops out along river left controlling both vertical and lateral channel migration
RM 48.7	Crops out along river right controlling lateral channel migration
RM 48.0	Crops out along river left controlling both vertical and lateral channel migration
RM 47.7	Crops out along river right controlling lateral channel migration; scour pool forced by bedrock at lower end of side channel (3R side channel)
RM 47.2	Crops out along river right controlling lateral channel migration
RM 45.5	Crops out along river right controlling both vertical and lateral channel migration
RM 44.1	Crops out along river right controlling lateral channel migration
RM 41.2	Crops out along river left controlling lateral channel migration; opposes Twisp River alluvial fan to form geologic floodplain constriction

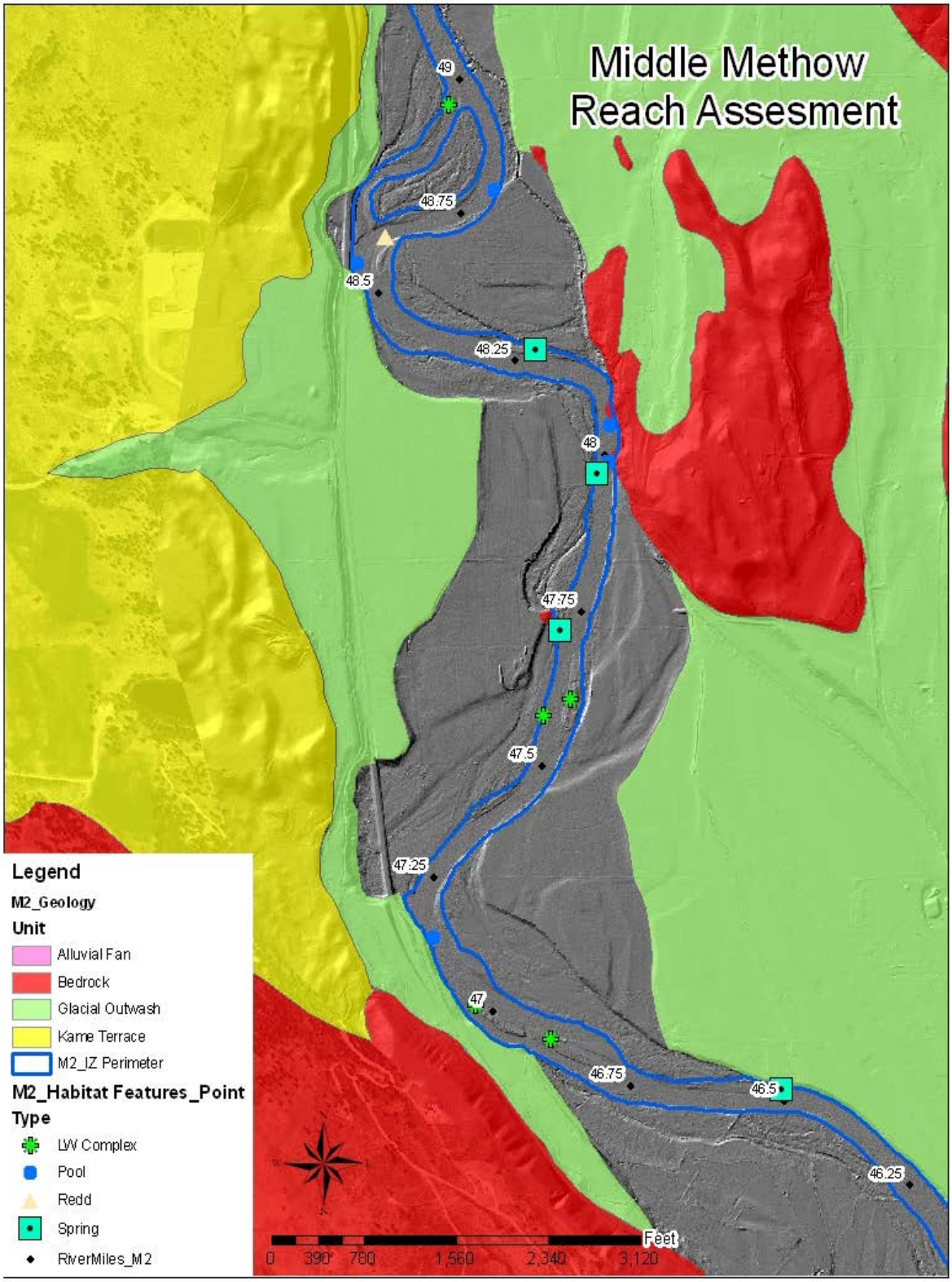

Figure 5. Locations of cold water upwelling sites and bedrock channel controls between RM 49.00 and 46.25, and their relationship to geologic landforms (map scale 1:12,000). Grey area is interpreted to have been reworked by the river during the Holocene epoch.

Large wood is typically found as apex log jams on medial gravel bars and islands, high on lateral gravel bars, and at the head of side channels (Figure 6). Generally in unconfined reaches, large wood contributes to the creation of side channels during channel forming flows, producing a continuum of side channel types (gravel bar and floodplain) that are in varying stages of development. Clearing of the riparian buffer zone for agriculture, commercial and residential development, and placement of levees and bank protection have reduced large wood recruitment and recruitment potential. These anthropogenic impacts and instream removal of wood by recreationists have led to channel simplification, reduced floodplain connectivity, and reduced side channel development.

Figure 6. Example of large wood complexes that contribute to the creation and development of side channels (map scale 1:2,800).

The reach assessment area encompasses about 1,500 acres on the Middle Methow River from RM 50.0 to RM 41.0. The reach was further broken down into two types of morphologically distinct areas that include the active channel and floodplain areas to describe greater local geomorphic control and variability. Referred to as inner (active channel) and outer (floodplain) zones, these areas represent existing riverine habitat within the reach. The limit of the outer zone was determined by interpreting the extent of inundation for the 1948 flood (estimated at greater than a 100-year flood event) using aerial photographs, a light detection and ranging (LiDAR) hillshade elevation model, and surficial mapping (Reclamation 2010).

The inner zone is characterized by the presence of primary and secondary channels, a repetitious sequence of channel units, and relatively uniform physical attributes indicative of localized transport, transition, and deposition. They are generally associated with ground-disturbing flows with sufficient frequency that mature deciduous and coniferous trees are rare (adapted from USDA 2008). The active main channel was subdivided into eight inner zones based on local sediment transport and deposition trends interpreted from the channel unit mapping, channel gradient, channel confinement, hydraulics, and dominant substrate. Inner zones that are not hydraulically connected to the river because of anthropogenic features are described as disconnected inner zones.

In contrast, an outer zone is typically a terrace tread(s) and generally coincidental with the historic channel migration zone unless the channel has been modified or incised leading to the abandonment of the floodplain. This zone includes side channels, overflow channels, and oxbows. An outer zone is further distinguished from an inner zone by the presence of flood deposits, a change in vegetation (mature deciduous and coniferous trees present unless removed for development), and bounding geologic landforms such as older terraces, valley walls, alluvial fans, colluvium, or glacial deposits (Table 4).

Table 4. Acres (and percentage of total area) by zone type on the Middle Methow reach, Methow River, Methow Subbasin, Okanogan County, Washington.

Total Area	Connected Inner Zones	Connected Outer Zones	Disconnected Inner Zones	Disconnected Outer Zones
1,498 acres (100 percent)	322 acres (21 percent)	957 acres (64 percent)	24 acres (2 percent)	195 acres (13 percent)

These inner and outer zones were further refined as subreaches and subreach complexes that are delineated by longitudinal, lateral and vertical controls (Figure 7). Subreaches that have several anthropogenic impacts that affect physical processes in multiple areas are identified as subreach complexes. These areas are identified in a subreach context in order to sequence potential actions to address complex anthropogenic impacts.

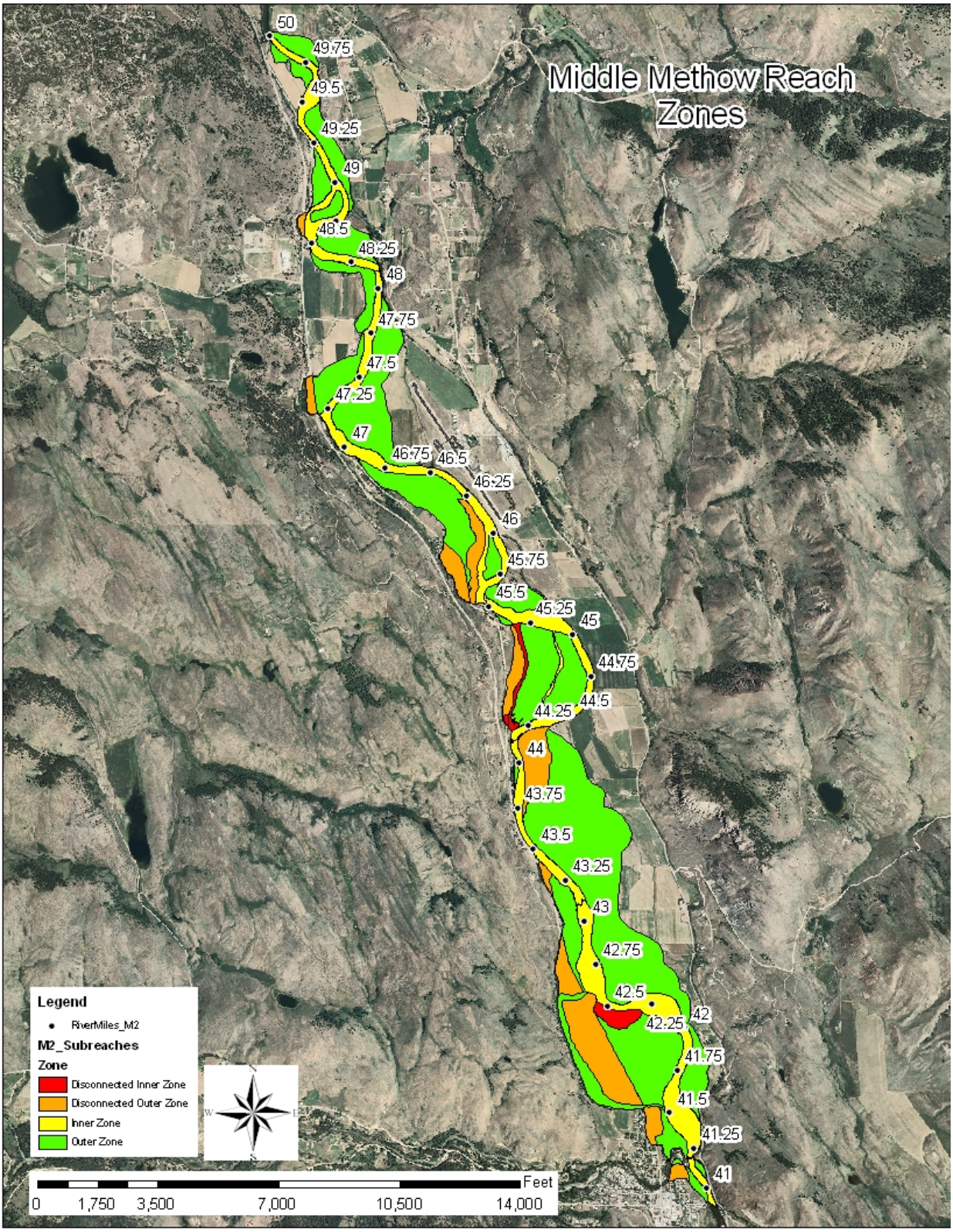

Figure 7. Locations of zones, subreaches, and parcels (i.e., sub-units of the subreach) and their connectivity to the river.

Summary of 2009 Geomorphic Mapping and Hydraulic Modeling Summary

A report was completed on the refinement of geologic/geomorphic mapping conducted during the *Tributary Assessment* and a hydraulic model analysis for the reach (Reclamation 2010).

Geologic/geomorphic mapping was conducted to better understand the spatial distribution of the surficial geology, related landforms, and the physical processes responsible for their formation (Figure 8). Four distinct deposits that could be attributed directly to deposition or reworking by the river included the active channel, floodplain deposits, and two terraces. The active floodplain (Qa3) is inset into older but distinct terrace deposits.

The report concluded that there was no evidence of reach-scale channel incision or aggradation. Bedrock (Br) provides grade control in a few locations where it crops out in the channel. There is also a geologic floodplain constriction near RM 41.2 where the Twisp River alluvial fan impinges the channel against bedrock. Bedrock restricts lateral channel migration in several locations and deep pools have developed by scour.

Based on historical aerial photographs the floodplain processes were dominated by (a) erosion of the active floodplain (Qa3) between 1945 and 1948; (b) formation (deposition) of the active floodplain between 1954-1964 and 1974-2004; and (c) about equal amounts of erosion and formation of the active floodplain between 1964 and 1974. These floodplain processes were most active in the unconfined section of the reach upstream from the geologic floodplain constriction at RM 41.2 to about RM 43.

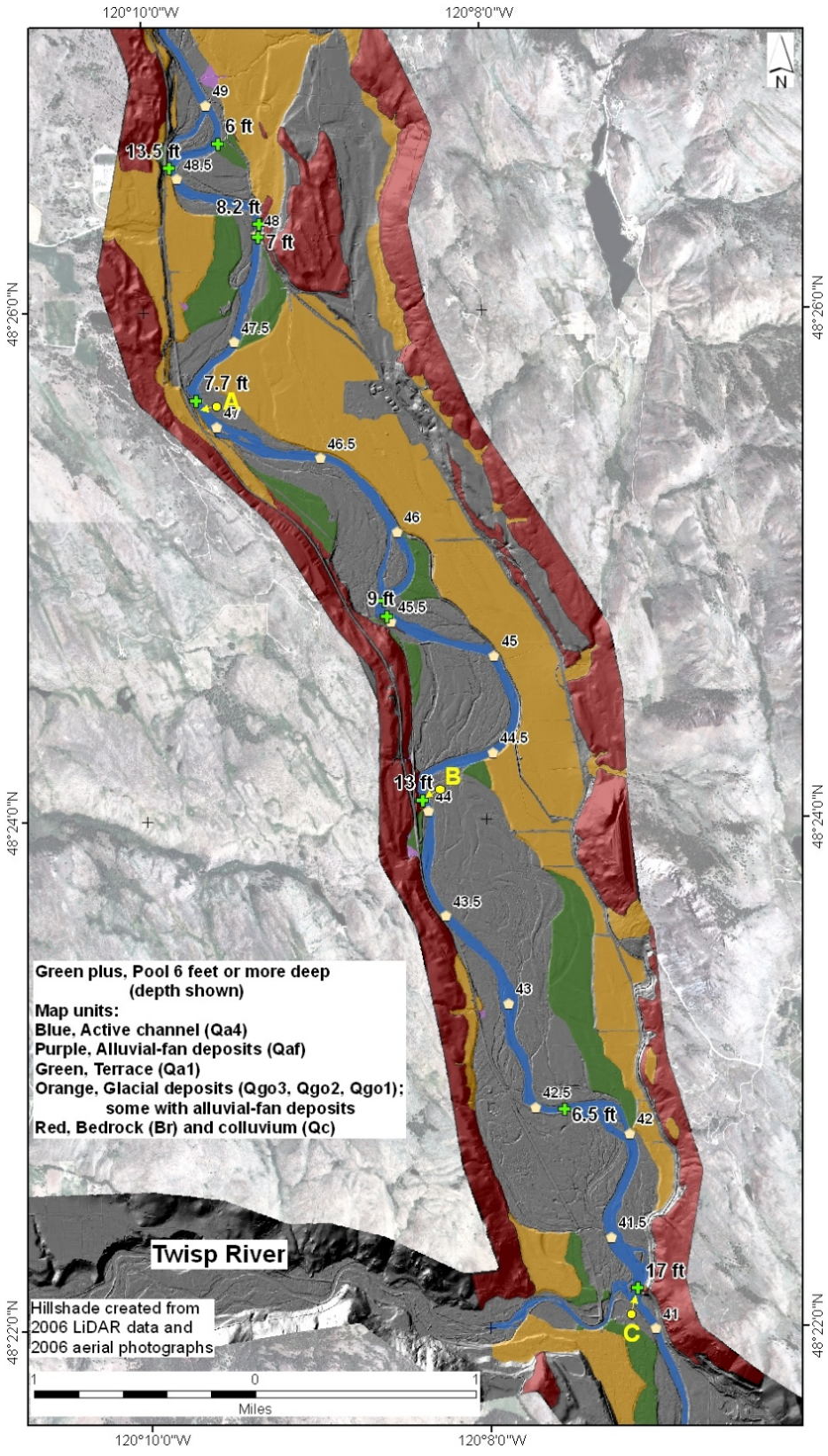

Figure 8. Surface geology of the Middle Methow reach (Reclamation 2010). The grey area is the extent of terrace deposits Qa3 and Qa2 adjacent to the main channel in blue.

A two-dimensional hydraulic model was developed to evaluate floodplain processes, side channel connectivity, and split flow channel dynamics. Simplified hydraulic parameters, including depth-averaged velocity, bed shear stress, and depth, were determined along the channel thalweg and across the areal extent of the floodplain. Connected floodplain was defined as the area with depths exceeding 0.5 feet outside of the low flow channel. The model evaluated low flow conditions, and the estimated 2-year, 10-year, 25-year and 100-year discharges under existing conditions (Table 5). Model results indicate that some side channels within the active floodplain (Qa3) are activated during the 2-year flood (about 11,000 cfs) and that most of the active floodplain surface becomes inundated during the 10-year flood (about 16,000 cfs).

Table 5. Discharges used in the two-dimensional hydraulic model for the Middle Methow (Reclamation 2010).

Methow River (cfs)[1]	Twisp River (cfs)[2]	Notes
285	70	Low flow discharge recorded at USGS gages; mean daily flows during channel survey in October 2008
10,900	2,020	Falling limb of May 23, 2006 flood recorded at USGS gages when oblique aerial photographs were taken; equivalent to about 2-yr flood;
16,600	3,890	10-yr flood frequency values based on hydrologic analysis of annual peaks at USGS gages
24,400	1,720	1972 flood peak recorded at USGS gage on Methow at Winthrop; equivalent to about the 25-yr flood frequency on mainstem Methow; estimate on Twisp River is less than 2-year flood based on difference between recorded flow at Winthrop and estimate on Methow below Twisp (no gage data available for this flood on Twisp)
31,360	9,440	1948 flood peak; larger than the 100-yr flood for both mainstem Methow and Twisp Rivers

The hydraulic model predicts that most of the active floodplain (Qa3) is overtopped at a discharge of about 16,600 cfs (about a 10-year flood) and the variability of inundation reflects the irregular topography (Figure 9). The hydraulic model also predicts the following:

- That side channels within the active channel (Qa4) have the most potential to be inundated during low-flow periods.
- That prominent side channels within the active floodplain (Qa3) are generally not inundated by the 2-year flood (about 11,000 cfs).
- That overflow channels within the active floodplain (Qa3) and higher floodplain (Qa2) are only inundated by larger floods greater than 5-to-10-year flood frequency.

[1] Based on USGS Gage No. 12448500 (Methow River near Winthrop, WA) and USGS Gage No. 12449500 (Methow River near Twisp, WA)

[2] Based on USGS Gage No. 12448998 (Twisp River near Twisp, WA)

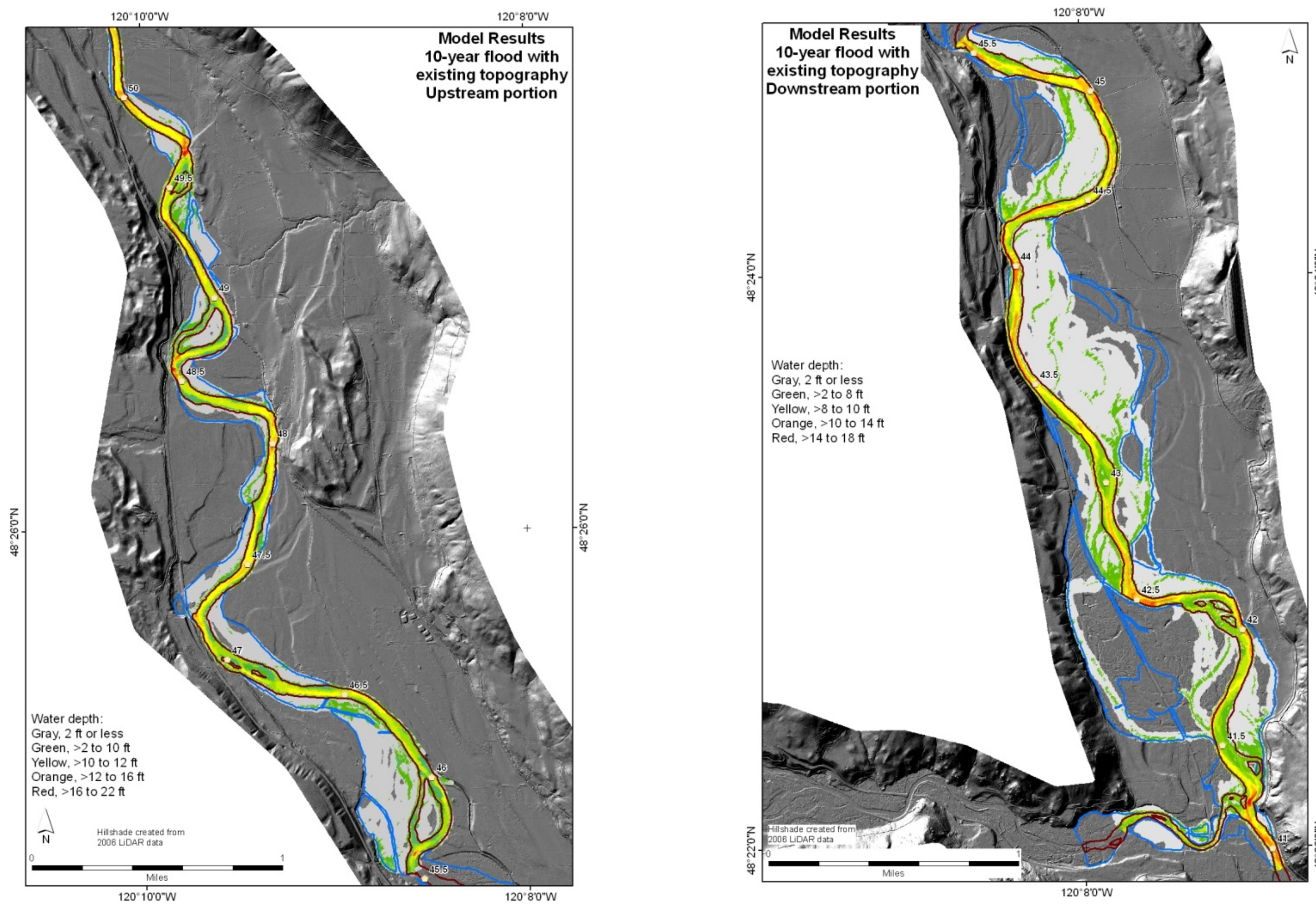

Figure 9. Inundation of Qa4 and Qa3 surfaces based on modeling of a 10-year flood for upstream section (left) and downstream section (right) (Reclamation 2010).

Colors indicate potential water depths as indicated. Channel area within the brown outline is Qa4. Areas outlined in blue are Qa3. Unshaded areas are other map units older than the Qa3 and Qa4.

Summary of 2009 Channel Unit Mapping

Channel unit mapping was conducted for this reach assessment (detailed channel unit maps appear in Appendix C). Channel unit mapping is a useful tool in interpreting subreach scale hydraulic conditions in addition to sediment movement through a given reach or channel segment at channel forming flows. Channel units are mapped in the field based on observed physical characteristics and then each unit is redrawn on rectified aerial photographs in ArcGIS (Figure 10). "Channel units" should not be confused with "habitat units" that are a measure of habitat type and quantity available at low flows. For example, the habitat assessment includes the long pool tail-out in the glide-pools (usually lateral scour pools) as pool habitat even though this area of the pool is functioning as a run hydraulically. For the channel unit mapping the pools (area of pool scour) and runs are spatially defined and mapped separately as geomorphic channel units.

The channel units were charted using the percent of total area occupied by each unit to graphically illustrate the existing condition and to help interpret current trends in sediment transport and deposition (Figure 11). The reach includes a combination of channel types including moderately confined plane-bed to pool-riffle and unconfined pool-riffle segments. Conceptually, confined channel segments should have more pools and runs (scour and transport channel units); moderately confined segments should have a balance of runs (transport channel unit) with riffles and bars (depositional channel units); and unconfined segments should also have a balance of different types of channel units but with increasing area of riffles and bars (depositional channel units).

Moderately confined channels with higher gradients and more plan-bed type morphology do not typically form pools except where forced by significant hydraulic structures such as bedrock outcrops. In the moderately confined section from RM 50.00 to 46.25 (subreaches MM-IZ-1, MM-IZ-2, and MM-IZ-3) the reduction in lateral channel migration capability combined with the effect this has on sediment transport may be the most important factor since pool formation is typically associated with energy concentration at the meander bend apex. A balance of transport and depositional channel units would be expected in this plane-bed to pool-riffle system. In subreaches MM-IZ-1 and MM-IZ-2 there is an adequate balance of runs and pools (transport units) with riffles, rapids and bars (depositional units). However, in subreach MM-IZ-3 runs significantly increase most likely due to bedrock controls that restrict lateral and vertical channel migration.

In the unconfined section of the reach from RM 46.25 to 41.15 (subreaches MM-IZ-4, MM-IZ-5, MM-IZ-6, and MM-IZ-7) depositional channel units would be expected to increase in the downstream direction in this pool-riffle type system as the channel gradient decreases and large wood becomes more mobile. In these types of unconfined sections wood becomes less important as a channel control and functions more like sediment. Riffles and bars increase from MM-IZ-4 through MM-IZ-7, but there are also a high percentage of runs in MM-IZ-4,

MM-IZ-5, and MM-IZ-6. This may be due to bank protection (i.e., riprap and levees) that has reduced lateral channel migration resulting in vertical channel instability (i.e., scour and localized channel incision). The impact on channel processes caused by the bank protection is interpreted to be a reduction in the sediment supply due to artificially stable streambanks and an increase in channel transport capacity at channel forming flows due to a change in channel geometry caused by scour.

In the moderately confined section of the reach there are an adequate number of pools for this plane-bed to pool-riffle system. However, in the unconfined section pools are underrepresented compared to what is expected for a pool-riffle type system. Even though the pool indicator is rated adequate for the reach based on pool frequency (total number per mile) and spacing (generally a pool for every 5 to 7 channel widths) for unconfined alluvial valley types with widths greater than 100 feet and channel slope less than 2 percent (Montgomery and Buffington 1993). This implies that pools should comprise about 14 to 20 percent of the channel units in these unconfined low-gradient river channels. Pool, riffle, run, and rapid channel units (bars excluded) were analyzed for the entire reach and the pool channel units were found to comprise about 8 percent of the active channel area.

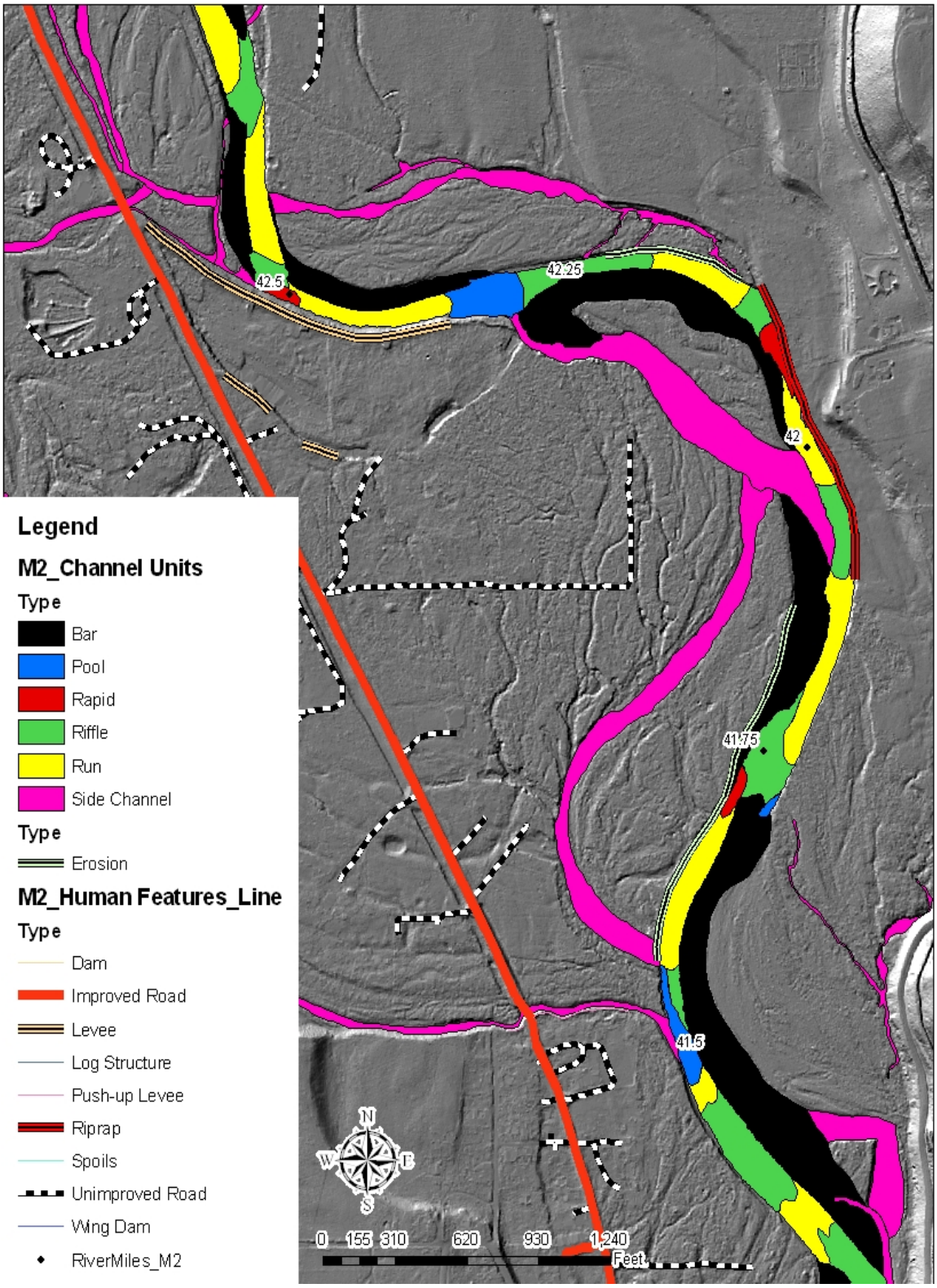

Figure 10. Example of channel unit mapping from RM 43.10 to 41.15 in the "Sugar Dike" area. Complete coverage of the reach is provided in Appendix C and in the Middle Methow geodatabase.

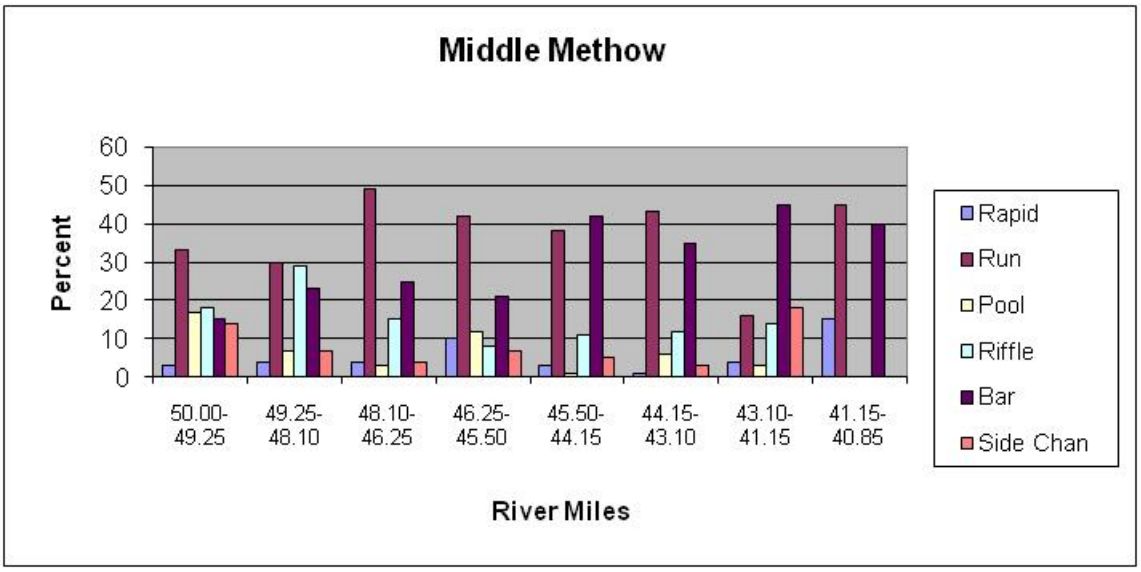

Figure 11. Percent of channel units by channel segment.

Summary of 2008 Habitat Assessment

The U.S. Forest Service completed a Level II Stream Inventory Survey (habitat assessment) between RM 52.4 and 40.3 along the Middle Methow River. This habitat assessment included the Middle Methow reach between about RM 50.0 and 41.0 which is summarized in this section. The methods used are contained in the Stream Inventory Handbook, Level I & II, Pacific Northwest Region, Region 6, Version 2.8 (USFS 2008). Specific data collected for the reach are contained in the REI table (Appendix A) and the complete stream inventory survey report is contained in Appendix D.

The reach has about 138 acres of habitat area consisting of predominantly riffles and pools. Between RM 50.0 and 47.0 the Methow River flows through a moderately confined geomorphic reach and the habitat units are predominantly riffles and bedrock-formed pools. From about RM 47.0 to 41.3 the river is in an unconfined geomorphic reach with habitat units comprised predominantly of riffles and lateral scour pools. In addition, the unconfined geomorphic reach contained the most off-channel habitat as the river accesses the floodplain and activates side channels and alcoves.

Instream large wood is scarce, except in the Barkley diversion side channel area. Wood is transported through the upstream confined geomorphic reach and accumulates in this area because it is on an outside bend and the river begins to access the floodplain. The side channel is cleared annually and the large wood is stacked by excavators on the floodplain and gravel bar. Large wood throughout the reach was predominantly in log jams along the channel margin, at the head of side channels, and high up on gravel bars which is appropriate for the size and type of channel. The large wood remains accessible to the river during channel forming flows. Future large wood recruitment potential is generally low because of

removal of riparian vegetation primarily for agriculture development. However, there are areas where riparian vegetation has not been removed and provides adequate wood recruitment potential.

Deep pools (greater than 5-feet deep) are present throughout the reach. The deepest pools are associated with bedrock outcrops that restrict lateral channel migration and force channel bed scour. These deep pools provide cover from predators, holding habitat for migratory fish, and refugia. Although there are adequate numbers of deep, bedrock pools that provide fish cover, there are shallow, lateral scour pools along the channel margins that do not have appropriate vegetation and lack large wood which would provide adequate fish cover.

The average thalweg depths of the riffles and runs are adequate for fish migration. Large cobbles, small boulders, and riprap provide hiding cover for juvenile salmonids while rearing. The substrate is too coarse for anadromous fish spawning in many areas, but some spawning habitat was observed in riffles, runs and pool tail-out crests. Substrate embeddedness does not appear to be problematic; however, cobble and coarse gravel substrate were embedded at two large pool tail-out crests.

Side channel habitat was about 3 percent of the total habitat area in the moderately confined geomorphic reach and about 8 percent in the unconfined geomorphic reach (Table 6). Many of the side channels are ephemeral and dewater in late summer. The table below summarizes side channel habitat.

Table 6. Summary of side channel habitat within the Middle Methow reach (Appendix D).

River Mile	Bank	Length	Avg. Width	Avg/Max Depth	Date De-Watered	% Pool Habitat	% Riffle	Lwd/Mile > 35', 12"	Max Water Temp	Notes
49.3	Left	1,225'	39'	2'/6'	-	70%	30%	112	n/m	Barkley Side Channel
48.6	Right	1,700'	Dry	-	? Mid-summer	-	-	6	n/m	Wide channel (up to 140')
48.1	Left	950'	15'	1.0'/2.0'	-	n/m	n/m	22	11.6◦C	Gilbertson Springs
47.7[1]	Right	100'[1]	5'	0.2'/0.2'	06-09-08[2]	-	-	0	n/m	Nancy Farr Property[1] (aka 3-R)
46.7	Left	1,255'	80'	1.2'/5.0'	-	66%	34%	8[5]	n/m	End of reach
45.6	Right	1,585'	70'	1.0'/4.0'	-	63%	37%	23[5]	18.72◦C	McNae S.C.
44.5[3]	Right	2,600'	Dry	-	09-20-08	-	-	4[4]	19.37◦C	State land
44.2	Right	1,250'	70'-100'	n/m	-	100%	-	n/m	23.23◦C	Beaver Ponds
42.9	Left	1,100'	15'	0.6'/3.0'	-	n/m	n/m	0	n/m	3' pool
42.7	Left	n/m	Dry	-	07-07-08	-	-	n/m	n/m	Lehman S.C.
42.5	Right	>1,000	Dry	-	06-09-08	-	-	n/m	n/m	Didn't walk
42.0	Right	1,350'	Dry	-	07-11-08	-	-	47	16.92◦C	Below dike
41.2[1]	Left	1,500'[1]	Dry	-	?	-	-	0	n/m	Wetland[1]

n/m = not measured

[1]The lower 100' of the side channel was flowing. The remaining length of side channel (1,050') was dry, with 4 pools that are possibly stranding fish. The largest of the pools was about 75' long and 30' wide, with a depth of about 5.5'. No fish were observed in the pools at the time of the survey. Only one piece of wood > 35' long with a diameter of at least 12" was observed in the dry segment of the side channel.

[2]Approximate date that the top of the side channel was disconnected from the river.

[3]Two dry side channels, total length 1,500'. One of the side channels connects to a series of wetland ponds. On 10-02-08 (low flow), the six ponds had a total area of about 22,500 sq. ft., with depths ranging from 0.4' to 3.0'.

There were a few disconnected, wetted pools in the lower part of the channel at the time of the habitat survey. Although there were few pieces of large wood > 35' and > 12", the side channel had numerous small pieces of wood.

The wood in the large jams at the top of these side channels was counted in the main channel.

Water temperatures exceeded the 16°C between June 15 and September 15, Washington State Department of Ecology standard for summer salmonid habitat for water temperature, for 35 consecutive days at RM 49.6, for 28 consecutive days at RM 48.9, and for 43 consecutive days at RM 46.3 during the summer of 2008 (Figure 12). This water temperature data is based on water temperature loggers that were deployed by the Forest Service in June 2008 and retrieved on October 2008. Gilbertson springs was found to contribute cold water during the summer. The Methow River water temperatures were cooler below Gilbertson springs than at Barley diversion dam near RM 49.6. Water temperatures generally warmed in the downstream direction within the reach except between RM 45.6 and 44.2 where water temperatures cooled by about 0.5°C probably from upwellings or springs (for additional information refer to Appendix D).

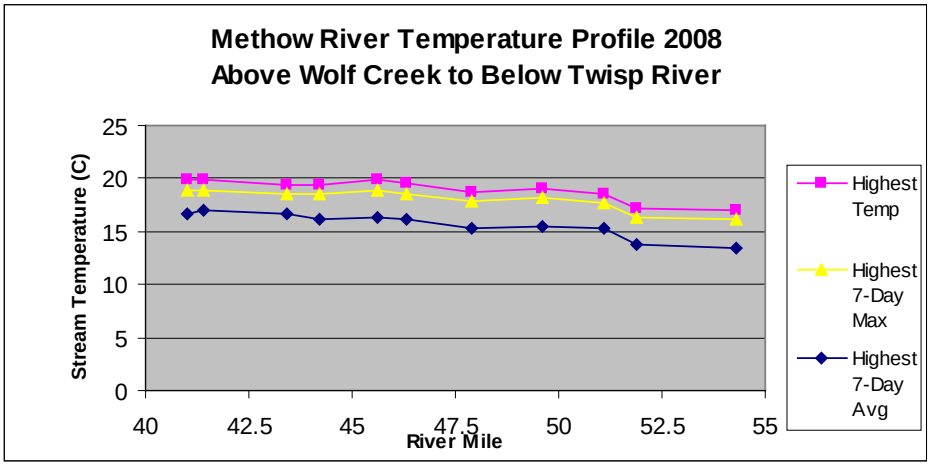

Figure 12. Middle Methow River water temperature profile.

Summary of 2009 Vegetation Assessment

Riparian vegetation was surveyed in 2009 between river miles RM 51.50 and 41.30 (refer to Appendix E for the full report). The main goals of the vegetation survey were to establish a baseline for future monitoring and to identify potential riparian habitat protection and enhancement projects.

Riparian forests in the reach are dominated by relatively short-lived species that depend on episodic flood events and channel migration to regenerate. The riparian forests are dominated by black cottonwood (*Populus trichocarpa*) with locally abundant quaking aspen (*Populus tremuloides*), thin-leaf alder (*Alnus incana*), water birch (*Betula occidentalis*), and ponderosa pine (*Pinus ponderosa*). The upper segment (RM 51.5 to 47) is moderately confined with relatively narrow bands of riparian vegetation along the main channel. Adjacent areas are predominantly non-forested agricultural and residential lands.

The lower segment (RM 47 to 41.5) is generally unconfined, and broad sections of floodplain forest are supported by river meander and channel migration processes in several areas. Most

trees in this segment are small-diameter trees, and many stands likely date back to the 1948 flood event (Figure 13). Cottonwood regeneration and growth on several gravel bars is not detectable in the 2006 orthophotographs. This condition may be due to the 2006 spring high flow event (2006 orthophotographs were taken in the fall) that may have removed some older vegetation and the regeneration of cottonwoods may be too young to detect on the photographs. Large tracts of the active floodplain have been converted to agricultural fields or residential property. Black cottonwood trees are common near the river edge in agricultural fields, but their sprouts are heavily browsed by deer and beaver.

An important factor in maintaining and enhancing riparian vegetation along the Middle Methow is to allow for disturbance associated with channel migration, flooding of floodplain surfaces, and beaver colony utilization. Without regeneration opportunities provided by disturbance and periodic inundation of floodplain surfaces, wide floodplain forests could decline and be replaced by drier site species, including ponderosa pine and Douglas-fir.

Black cottonwood is a keystone riparian species (Braatne et al. 2006) and plays a critical role in large woody debris dynamics, provides habitat for a host of terrestrial and aquatic organisms, and contributes to nutrient cycling in hyporheic zones. With regulated flow, channel restriction, and floodplain development in many watersheds throughout the inland West, black cottonwood and other riparian species have dramatically declined over the past century (Kauffman et al. 1997, Rood et al. 2003). The riparian vegetation has been altered along the reach with an estimated 27 percent of the forest cover cleared between RM 51 to 47 and 37 percent between RM 47 and 41.3. However, large portions contain intact riparian forest and hydrological processes, and these areas represent opportunities to protect and enhance riparian habitat, particularly along unconfined segments of the river.

Agricultural fields border the river along many portions of the reach and often support only a narrow line of riparian trees along the river bank. Deer browse is particularly heavy on cottonwood sprouts adjacent to agricultural fields as compared to recruitment on gravel bars. Repeated browse appears to be limiting tree recruitment and forest cover development in these areas. Stark differences in browse damage between cottonwood regeneration on gravel bars and near agricultural fields may be due to a combination of factors. Regeneration is generally so dense on gravel bars that it may overwhelm the effects of deer browse. Agricultural fields also probably support larger concentrations of deer, and browsing on sprouts is likely more common near fields than on gravel bars.

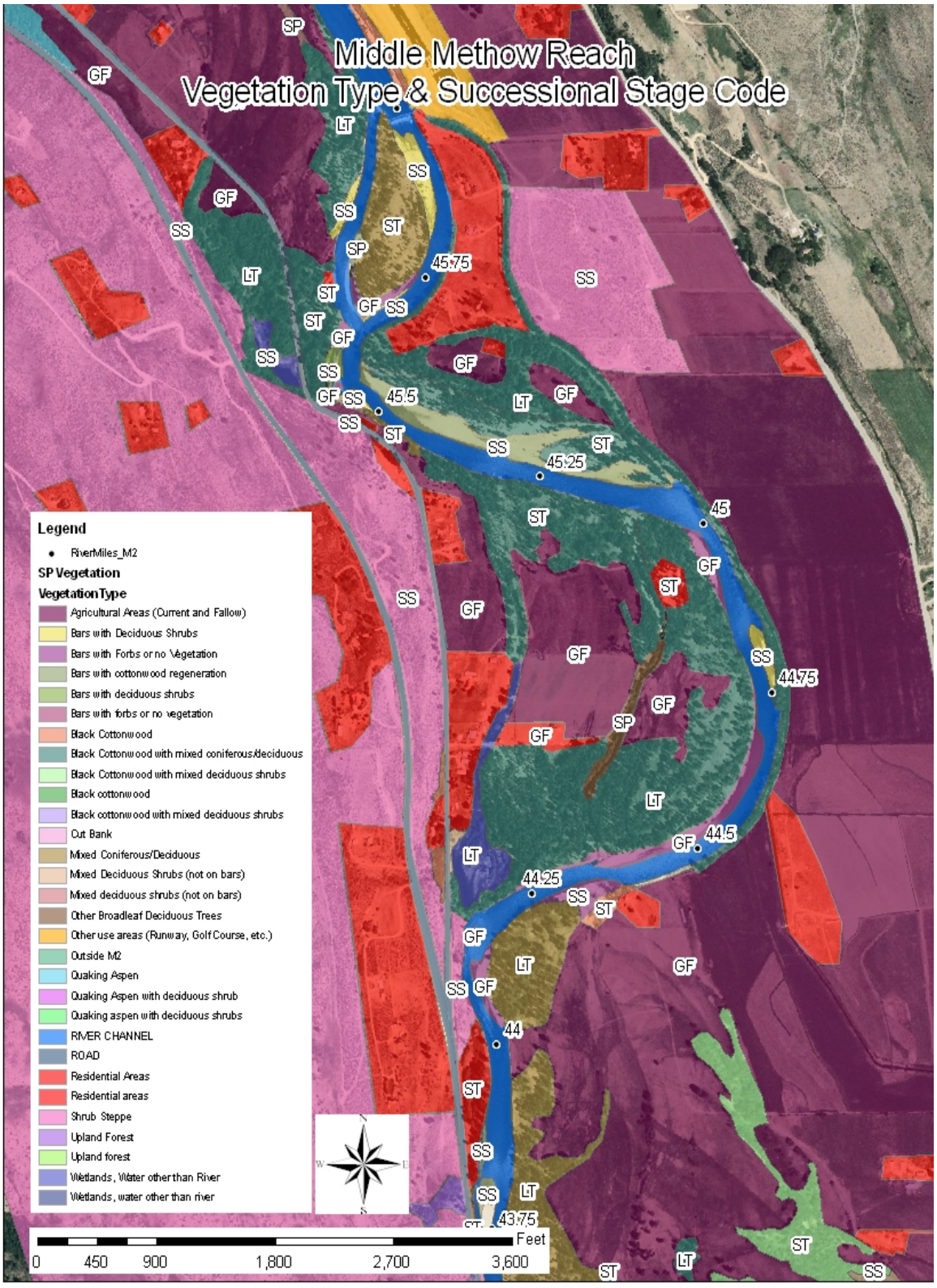

Figure 13. Example of vegetation mapping showing vegetation type and successional stage code (i.e. GF-grass/forbes; SS-shrub/seedling; SP-sapling/pole; ST-small trees; and LT-large trees).

Summary of Beaver Activities

This summary of beaver activities and their potential contributions are predominantly from the *Vegetation Assessment* (Appendix E). Because beavers significantly influence habitat conditions and processes, they are discussed in this section to highlight their importance.

Beavers (*Castor Canadensis*) were more prevalent along the Middle Methow River in the past based on historical anecdotal accounts. Beaver and other fur-bearing animals were trapped extensively throughout the Methow Valley and the surrounding Okanogan County. Near extirpation of beaver likely altered the structures of streams and rivers. Because trapping predated any historic records, we have no clear reference on how numerous beavers were along the Middle Methow or how they influenced riparian forests and hydrology. Beaver are slowly recovering along the Methow River but may be at only a small fraction of their original population (Kent Woodruff, Methow Valley Ranger District, personal communication).

Through their felling of cottonwood, aspen, and other trees, beaver actively recruit large woody debris into water channels (Naiman et al. 1988). Beaver require ample numbers of trees and can locally alter stand conditions, changing canopy cover, and altering species composition and successional stages. Beaver prefer black cottonwood and quaking aspen over conifer species, and riparian stand structure and composition can be influenced by beaver activity. Both cottonwood and aspen sprout vigorously when felled. Felled trees increase the structural complexity of river channels, and during flood events, large woody debris tends to accumulate in log jams and can initiate gravel bar recruitment. Once anchored, black cottonwoods can sprout and regenerate in their new location.

Ponds and channels associated with beaver complexes provide protected habitat for numerous fish species (Pollock et al. 2003) and have been linked with reproductive success of salmonid species (Pollock et al. 2004). Beaver complexes are associated with slower water flow and support abundant aquatic invertebrates, both of which benefit foraging salmonids. Juvenile salmonid species in reaches with beaver complexes have been found to be more abundant, larger in size, and have greater overwinter survival rates than reaches without beavers (Bustard and Narver 1975; Swales et al. 1986).

Anthropogenic impacts have disrupted floodplain connectivity resulting in a reduction of floodplain-type side channels that are suitable for beaver colonization. The cumulative anthropogenic impacts affecting floodplain-type side channels and beaver populations are qualitatively interpreted to have resulted in the following:

- a reduction of complex off-channel habitats provided by beaver activities
- reduction in groundwater recharge due to the lack of beaver complexes (i.e., ponds) that store surface water on the floodplain that eventually infiltrates into the groundwater table and/or to the hyporheic zone and river

REACH CONDITION – REACH-BASED ECOSYSTEM INDICATORS

An analysis was conducted on the reach using reach-based ecosystem indicators (REI) (Appendix A). The indicators used were adapted from the National Oceanic and Atmospheric Administration (NOAA) and United States Fish and Wildlife Service (USFWS) matrix of pathways and indicators, and those contained in the *Monitoring Strategy*. The lateral channel migration indicator was modified in the REI, and vertical channel stability indicator was added to provide more clarity on channel dynamics. Although the interpretation of the condition of each indicator is somewhat subjective, the data upon which the interpretation is based in many cases has been quantified. The quantified data provides an environmental baseline condition that can be repeated at a later date to establish a time series that can be used to conduct an intervention or trend analysis (i.e. effectiveness monitoring) following implementation of habitat improvements.

The REI is a compilation of information and data collected from multi-disciplinary analyses that were conducted prior to or during this investigation. Specific data collected and utilized in the analyses came from the *Geomorphology and Hydraulic Modeling for the Middle Methow River from Winthrop to Twisp* (Reclamation 2010), Reach Documentation (Appendix C), Habitat Assessment (Appendix D), Vegetation Assessment (Appendix E), and Middle Methow Reach Geodatabase (described in Appendix F). Based on the criteria contained in the REI, each indicator was determined to be functioning at one of three conditions: **Adequate**, **At Risk**, or **Unacceptable** (Table 7). The condition determinations were made by a technical team comprised of Edward Lyon, Jr. (geologist), Jennifer Molesworth (subbasin liaison/fisheries biologist), Jennifer Bountry (hydraulic engineer), David Hopkins (fisheries technician), and Susan Pritchard (research scientist). Indicators described in the REI record an environmental baseline that reflects the condition of higher-level indicators.

The condition of each indicator for the reach was interpreted for this report to be in the following conditions:

1. ***Unacceptable condition***
    a. Vegetation condition (disturbance) due to past floodplain clearing (about 51 percent of floodplain) for agriculture, commercial and residential development, and the removal of beaver activity within the floodplain that create and maintain complex vegetation structure.

2. ***At Risk Condition***
    a. Water temperature due to past clearing of the riparian buffer zone, reduced instream flows, and reduced floodplain connectivity caused by floodplain development and infrastructure.

b. Main channel physical barriers due to a diversion structure (Barkley diversion dam). Technically this diversion structure is not a main channel physical barrier, but it does entrain juvenile salmonids and is modified during low summer flows creating a potential velocity barrier for juvenile salmonids. The condition ranking is based on the diversion causing fish mortality by entrainment when it is turned off in the fall and the instream manipulation of the dam that may cause a velocity barrier during some biological significant flows.

c. Large wood due to the lack of instream wood from channel clearing, and reduced recruitment potential due to artificial channel stability and floodplain development. Technically, the reach is functioning in an unacceptable condition based on the criterion in the REI. However, this indicator was given an "at risk condition" ranking because the large size of this unconfined alluvial river transports large wood as sediment at high flows depositing the wood primarily on bars, islands and the head of side channels.

d. Pools due to the lack of fish cover typically provided by appropriate riparian vegetation and large wood. Although there are an adequate number of deep, bedrock pools that provide fish cover, there are shallow, lateral scour pools along the channel margins that lack appropriate vegetation and large wood which would provide adequate fish cover.

e. Off-channel habitat because of levees and roads disconnecting side channels and floodplain processes, bank protection that restricts lateral channel migration, and the reduction of beaver activity that create complex aquatic habitats.

f. Floodplain connectivity due to levees and road embankments that disconnect floodplain processes, bank protection that may result in bed scour and localized channel incision, and commercial and residential floodplain development.

g. Bank stability/channel migration due to artificial channel stability caused by bank protection restricting lateral channel migration and unstable channel sections that erode laterally into banks where riparian vegetation has been removed for floodplain development.

h. Vertical channel stability due to bank protection that may result in bed scour and localized channel incision along bank protection and due to instream hydrologic impacts from loss of floodplain connectivity.

i. Vegetation condition (structure) due to about 51 percent of the floodplain being cleared for development, about 49 percent of the floodplain successional stage being in a small-to-large tree condition, and past removal of beavers and their activity that help create and maintain complex riparian vegetation structure.

j. Vegetation condition (canopy cover) due to clearing and grazing of riparian vegetation along the streambanks that provides shading and moderates the local climate (i.e., air temperature) along the river.

3. Adequate condition

a. Turbidity based on Washington Department of Ecology water quality determinations.

b. Chemical contamination/nutrients based on Washington Department of Ecology water quality determinations.

c. Channel substrate based on Wolman pebble counts conducted in several locations along the river throughout the reach.

d. Fine sediment based on visual estimates of the percentage of surface fines and substrate embeddedness.

Reclamation recognizes that there may be systemic watershed limiting factors that impact the reach. However, these systemic factors are, in general, poorly understood and have not been determined if they are from natural processes or anthropogenic impacts. As such, all reach-scale deficiencies are described with the assumption that rehabilitation of the reach and adjacent reaches will have cumulative benefit toward addressing potential watershed limiting factors.

Table 7. Summary results of the REI for the Middle Methow reach. Each indicator was interpreted to be in one of three conditions: *Adequate, At Risk, or Unacceptable.*

Spatial Scale	General Indicator		General Inidicator Condition	
Watershed Characteristics	Effective Drainage Network and Watershed Road Density		At Risk	
	Disturbance Regime (Natural/Human)		At Risk	
	Flow/Hydrology		At Risk	
	Water Quality		At Risk	
	Habitat Access		At Risk	
Spatial Scale	**General Indicator**	**Specific Indicator**	**Specific Indicator Condition**	**General Indicator Condition**
Reach Characteristics	Water Quality and Quantity	Water Temperature	At Risk	At Risk
		Turbidity	Adequate	
		Chemical Contamination/Nutrients	Adequate	
	Habitat Access	Main Channel Physical Barriers (Natural/Human)	At Risk	At Risk
	Habitat Quality	Channel Substrate	Adequate	At Risk
		Fine Sediment	Adequate	
		Large Wood	At Risk	
		Pools	At Risk	
		Off-channel Habitat	At Risk	

Spatial Scale	General Indicator		General Inidicator Condition	
	Channel Condition and Dynamics	Floodplain Connectivity	At Risk	At Risk
		Bank Stability/Channel Migration	At Risk	
		Vertical Channel Stability	At Risk	
	Riparian/Upland Vegetation	Vegetation Condition (Structure)	At Risk	At Risk
		Vegetation Condition (Disturbance)	Unacceptable	
		Vegetation Condition (Canopy Cover)	At Risk	

Existing conditions at the reach-scale are based on criteria defined in the REI (Appendix A). Existing conditions at the subreach-scale may be substantially different.

DISCUSSION

Based on the analysis conducted by Reclamation for the reach and input from local scientists, the following prioritized habitat action classes, adapted from Roni et al. (2002, 2005), are recommended. These recommendations and appropriate actions are further discussed in the **Subreach Profiles** section of this report:

1. Protect and maintain current habitat: this habitat action class includes protecting intact tracts of quality habitats throughout the reach. The aquatic and terrestrial habitats are fragmented and protection of these habitats will maintain current physical and ecological processes. There are several conservation easements already in-place throughout the reach. Some examples of quality habitats include tracts of intact riparian vegetation, cold water sources, off-channel habitats, and beaver colony areas.
2. Reconnect isolated habitat: this habitat action class includes reconnecting both aquatic and terrestrial fragmented habitats throughout the reach. Some examples of actions to reconnecting isolated habitats include connecting fragmented tracts of riparian vegetation with riparian plantings, reconnecting isolated watersheds, modifying instream physical barriers to improve fish passage and reduce fish entrainment, and reconnecting off-channel habitats (i.e., side channels). This habitat action class was modified for this reach assessment to also include habitat isolation caused by anthropogenic actions resulting in fish mortality.
3. Reconnect processes: this habitat action class includes improving the physical and ecological processes that create and maintain habitats. Some examples of actions to improve processes include strategic placement of large wood that contribute to side channel development and create channel complexity, removal or modification of anthropogenic features inhibiting lateral channel migration and floodplain

connectivity, beaver re-introduction to improve groundwater recharge by storing surface water on floodplain and creating complex off-channel habitat, and riparian rehabilitation to provide channel/floodplain roughness and increase biotic energy transfer (i.e. food web improvements).

4. Reconnect isolated habitat units: this habitat action class includes increasing low velocity resting areas, improve channel complexity, increase fish cover, and improve habitat unit connectivity. Some examples of actions include constructing alcoves and side channels, placing large boulders to provide roughness elements in high energy channel sections, placing wood along the margins of the channel and on thefloodplain, and placing wood in low energy off-channel areas (i.e. side channels and alcoves) to provide habitat complexity, increase biomass, and improve fish cover.

The ongoing anthropogenic impacts that limit geomorphic potential are as follows: (1) floodplain development for agriculture, residential, and commercial uses that limit physical and ecological processes, (2) irrigation diversion dams that reduce instream flows and alter sediment transport and deposition processes, (3) levees disconnecting historic channel paths and floodplain areas, (4) degradation of suitable beaver habitat, (5) bank protection restricting lateral channel migration resulting in localized scour and potentially channel incision, and (6) the lack of large wood, both instream and on the floodplain, that may contribute to side channel creation and provide channel complexity.

SUBREACH PROFILES

Within this section, the anthropogenic features and existing conditions of the inner zone and adjoining outer zones are summarized. Additionally, strategies for rehabilitation and/or protection are suggested to improve reach-based ecosystem indicators.

The habitat action classes are adapted from Roni et al. (2002 and 2005). This provides a hierarchical structure for implementing the habitat action classes and their associated actions. Potential actions will require additional evaluation to determine risk and liability to property owners, and the risk and benefits to resources and species.

Each potential action is relatively ranked as (1) “Maintain” for protection only, (2) “Maintain/High” for protection and enhancement, and (3) “High”, ”Moderate”, or ”Low” for potential actions based on their importance in achieving a reach-scale rehabilitation response. The overall strategy is structured around process-based principles that are applied at the reach scale (Beechie et. al 2010; Roni et. al 2005). Process-based principles target the systematic causes of ecosystem change and then (or concurrently) the symptomatic changes. The potential actions and the relative rankings are based solely on physical and ecological parameters. Socioeconomic elements such as landowner participation, increased risk to communities and infrastructure and physical feasibility of implementation are not considered at this stage. These socioeconomic elements will need to be addressed as projects are selected

and developed. Although the ultimate goal is full "restoration" of ecosystem processes throughout the reach, socioeconomic constraints may only allow partial "rehabilitation" thereby improving selected or partial ecosystem processes.

Beginning at the upstream boundary of the reach and working downstream, the inner zone was analyzed to understand local trends in sediment movement through the reach by channel segments. Channel segments were interpreted to have one of the following trends: transport, transition, or deposition. These trends can be the result of geologic or anthropogenic controls and how the river interacts with its floodplain. The inner zone was divided into subreaches based on the interpreted trends in sediment movement and channel dynamics.

Outer zones were divided into subreaches based on lateral and longitudinal geologic controls (i.e., bedrock, glacial terraces, etc.). Some subreaches were further subdivided into parcels (or sub-units) and are addressed as subreach complexes because of compounding anthropogenic impacts. Potential actions are discussed for each subreach or parcel, and the order in which actions should be implemented is sequenced to achieve a cumulative benefit.

Roughness elements (i.e., wood and rock spurs) are recommended in many of the potential actions and these actions will need further analysis during an alternatives evaluation to determine the appropriate type of treatment (i.e., wood, rock, bioengineering, etc.). Potential wood placement actions should also be further analyzed because they do not fall into the "acceptable conditions" guidelines for wood placement in rivers (ODFW 1995). The large wood size classes described in the following are primarily based on general habitat evaluation protocols for the eastside forests (east of the Cascades) with the exception of the term large wood "key" member which is considered large wood for the westside forests (west of the Cascades) (USFS 2006). The large wood "key" member is used in this report to denote wood with a minimum diameter of 36-inches with rootwad attached and a length of about 50 feet. The general term large wood is used to denote wood with a minimum diameter of 20-inches and a length of 30 feet or more. Medium wood with a minimum diameter of 12-inches and a length of 30 feet or more could be used in some instances.

Channel Segment RM 50.00 – 49.25

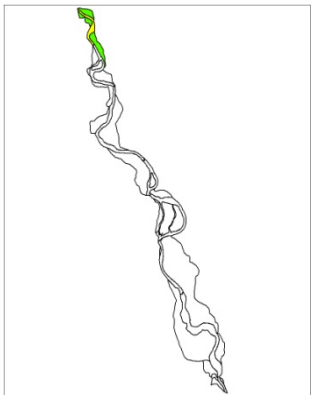

Figure 14. Location of channel segment RM 50.00 - 49.25 within the reach.

Characteristics

Between RM 50.00 and 49.25 (Figure 14), the channel is transitioning from a confined reach into a moderately confined reach and flows begin to access the floodplain thereby dissipating stream power (Figure 15 and Figure 16). Average channel slope is about 0.25 percent based on 2008 thalweg profile data (Reclamation 2010) with an average bankfull width of about 150 feet as measured from the 2006 LiDAR hillshade elevation model, and the predominant channel units are runs and riffles with cobbles and gravel substrate. A main channel irrigation diversion dam (Barkley diversion dam) impacts instream flows, is annually manipulated changing the channel's geometry, and affects large wood distribution and arrangement. Bank protection restricts lateral channel migration, affects hydraulics, and sediment transport.

The geomorphic potential of this channel segment has been impacted primarily by floodplain development that has resulted in the clearing of riparian vegetation, in-channel manipulations and water withdrawals, restricted lateral channel migration, and reduced floodplain connectivity that degrade the physical and ecological processes. An overview of the potential habitat action classes are listed in Table 8. Specific actions for each subreach are addressed in the following sections.

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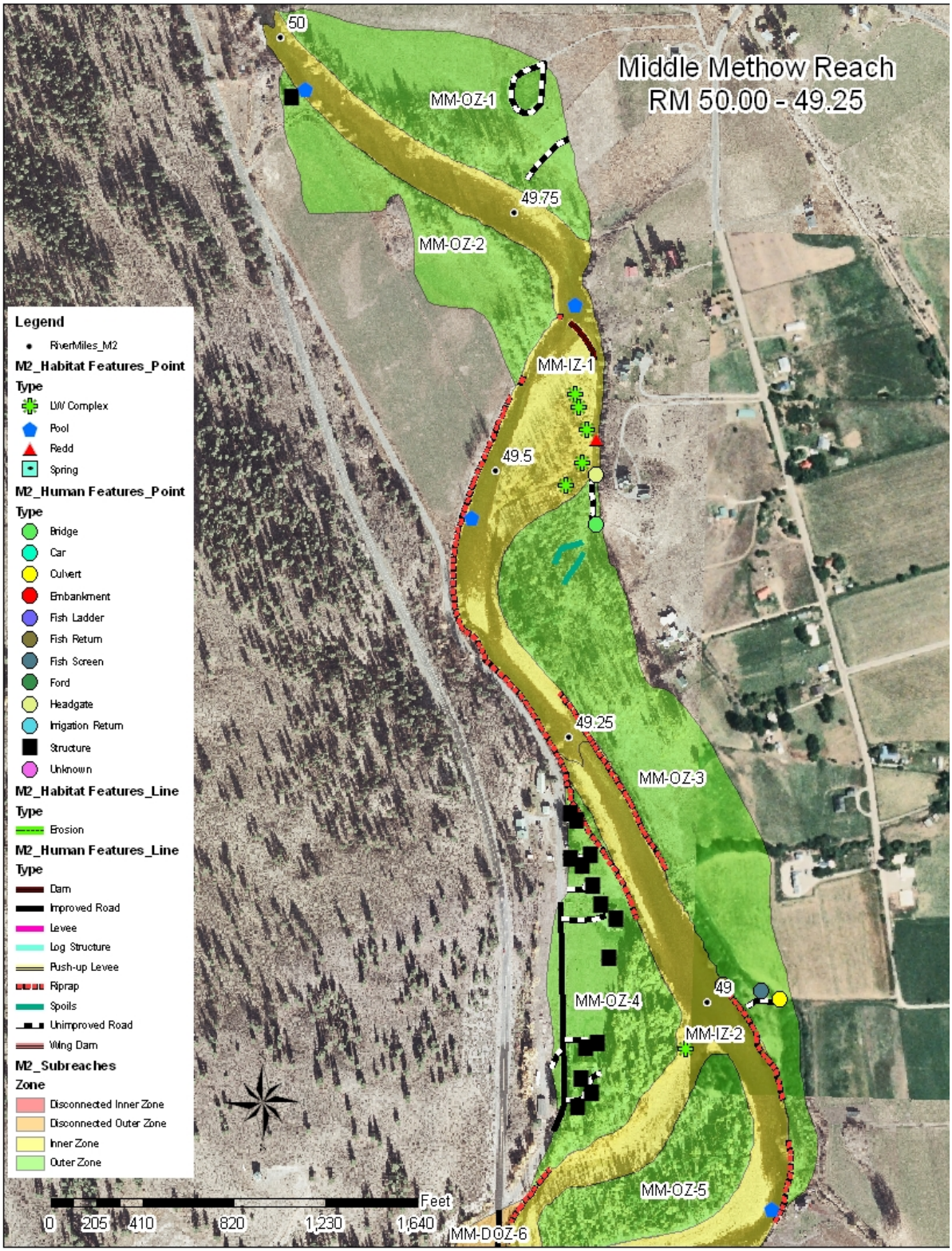

Figure 15. Aerial photograph showing the locations of subreaches and existing natural and anthropogenic features between RM 50.00 and 49.25 (map scale 1:6,000).

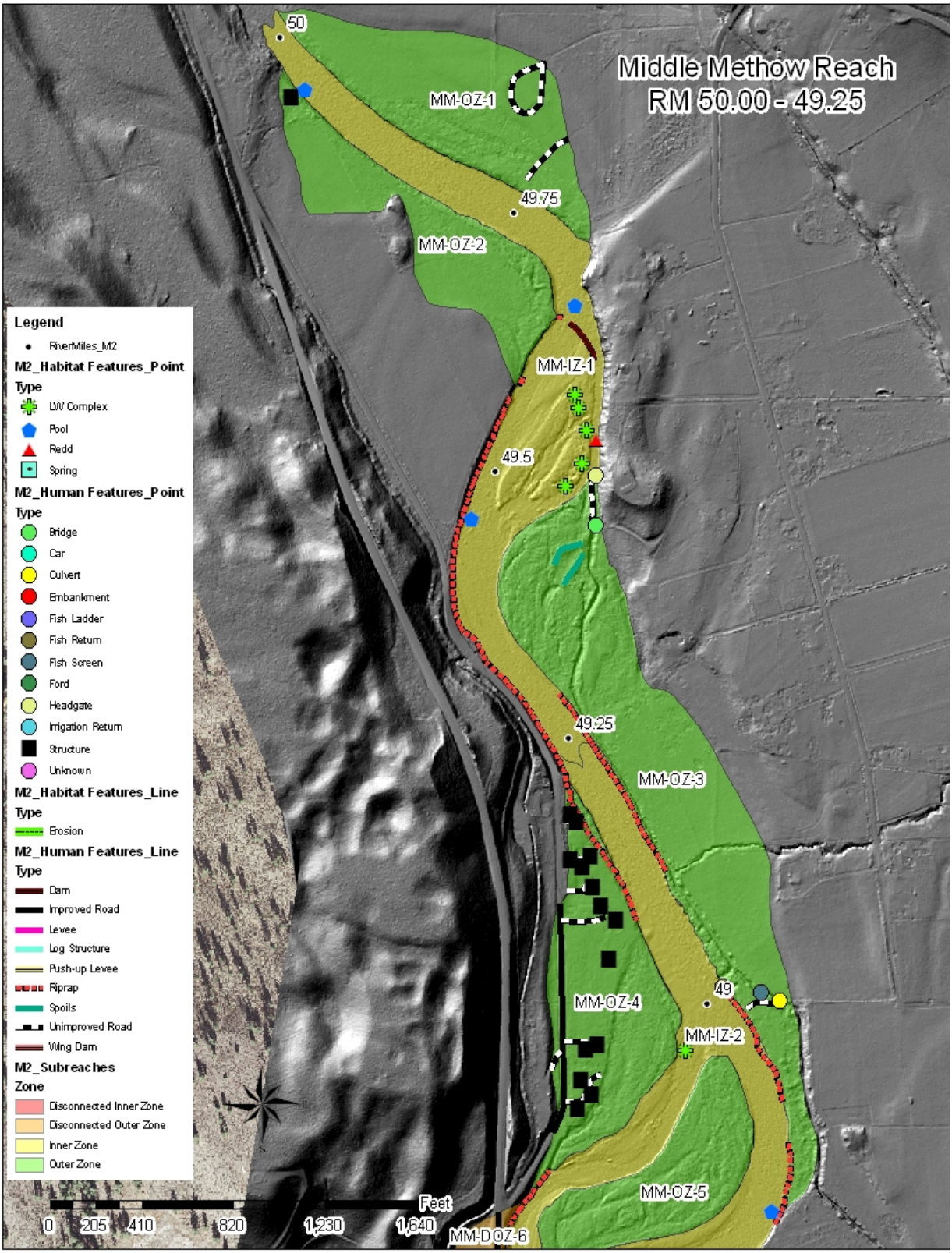

Figure 16. Hillshade elevation model showing the locations of subreaches and existing natural and anthropogenic features between RM 50.00 and 49.25 (map scale 1:6,000).

Table 8. Summary table of subreaches from RM 50.00 to 49.25, anthropogenic impacts and potential habitat action classes.

Parcel	River Mile (RM)	Acreage	Anthropogenic Features	Habitat Action Classes
MM-IZ-1 SUBREACH				
MM-IZ-1 (inner zone)	RM 50.00 - 49.25	21 acres	Barkley diversion dam Instream flows Intake canal Annual channel manipulation and wood removal Riprap (~1,900 ft)	Reconnect processes Reconnect isolated habitat units
MM-OZ-1 SUBREACH				
MM-OZ-1 (outer zone)	RM 50.00 - 49.70 (river left)	14 acres	Unimproved road (~850 ft)	Protect and maintain current habitat Reconnect processes
MM-OZ-2 SUBREACH				
MM-OZ-2 (outer zone)	RM 49.60 - 49.95 (river right)	10 acres	Structure (1) Floodplain development (agriculture)	Reconnect processes
MM-OZ-3 SUBREACH				
MM-OZ-3 (outer zone)	RM 49.50-48.80 (river left)	26 acres	Bear Creek disconnected from river Barkley canal and appurtenances Riprap (~ 1,830 ft) Unimproved road and bridge (~340 ft) Spoil piles (~340 ft)	Reconnect isolated habitat Reconnect processes

Potential Implementation Actions

The objectives for implementing the proposed actions between RM 50.00 and 49.25 are as follows (refer to Figure 17 and Figure 18):

1. Protecting the fragmented tracts of riparian vegetation and reconnecting these tracts by rehabilitating the cleared areas between them. These actions would provide a long-term cumulative benefit to both the physical and ecological processes.

2. Reconnecting isolated habitats by implementing the following actions: (1) reconnecting Bear Creek to the Methow River to provide additional habitat for aquatic species and create an avenue for the transfer of energy that helps drive food web productivity, (2) disconnecting the Barkley canal downstream of the headgate to the fish screens (about ¾ mile) to eliminate fish entrainment, stranding, and mortality when the ditch is turned off in the fall or modifying it so that there is year-round ingress and egress for fish.

3. Reconnect floodplain processes by implementing the following actions: (1) remove or modify the Barkley diversion dam that is manipulated annually which changes channel geometry, hydraulics, sediment transport, and inhibits the passage of wood, (2) remove or modify bank protection to allow lateral channel migration, provide channel boundary roughness to help retain sediment being transported through the system, and potentially raise the channel bed to improve floodplain connectivity, and (3) strategically placing large wood "key" members on bars and large wood at the head of overflow channels that contribute to the creation of side channels and provide complexity.

4. Connecting habitat units by implementing the following actions: (1) using appropriate methods to stabilize banks and re-establish appropriate vegetation, (2) increasing channel boundary roughness and habitat complexity, and (3) strategically placing large wood to improve fish cover, habitat complexity, and biomass in side channels and alcoves.

Only the actions that have been identified through field observations and local input from the Methow Restoration Council (MRC) are described. Many other potential actions could be implemented as described in the *Recovery Plan* or that are identified during future alternatives evaluation.

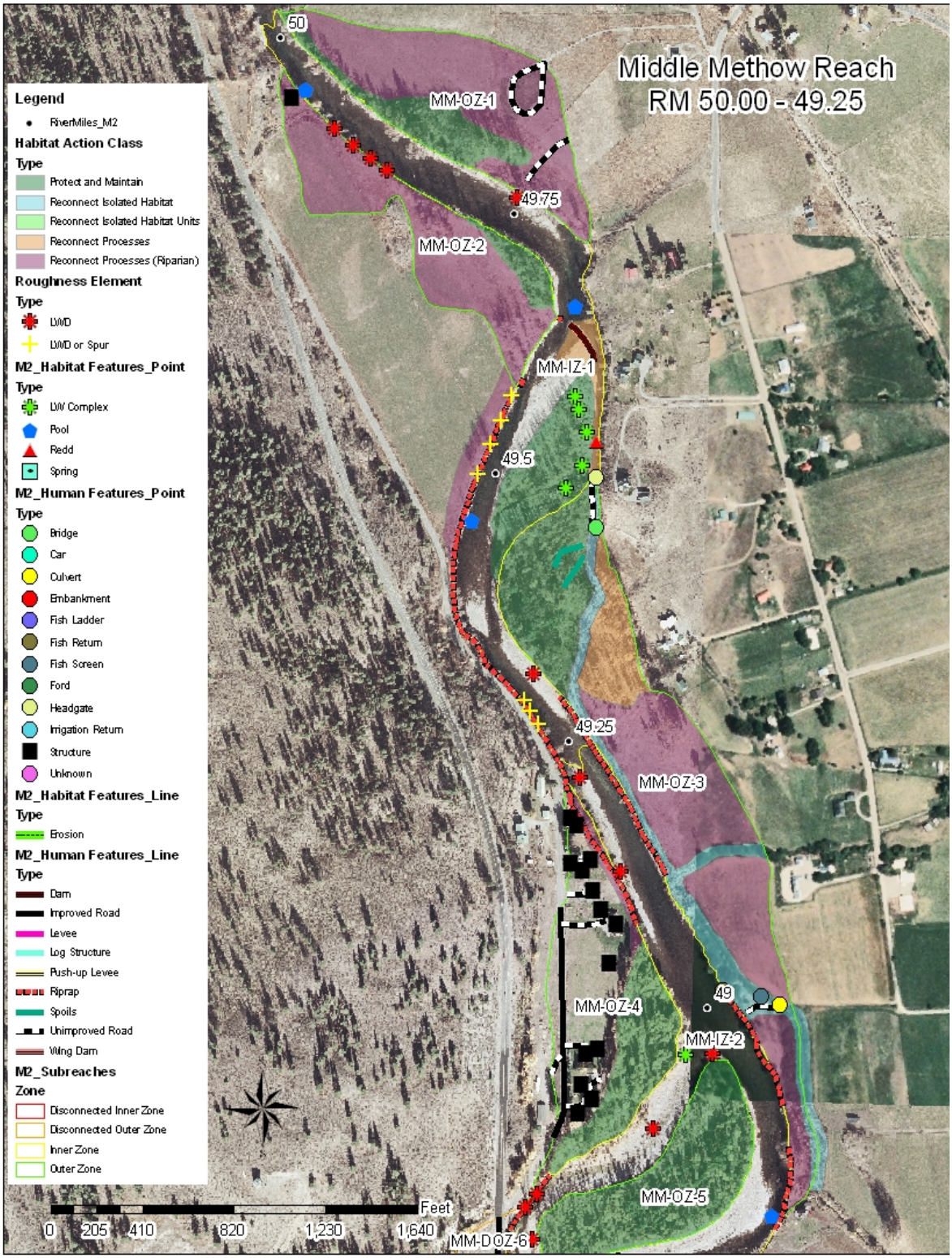

Figure 17. Aerial photograph showing the locations of subreaches, potential implementation actions, and existing natural and anthropogenic features between RM 50.00 and 49.25 (map scale 1:6,000).

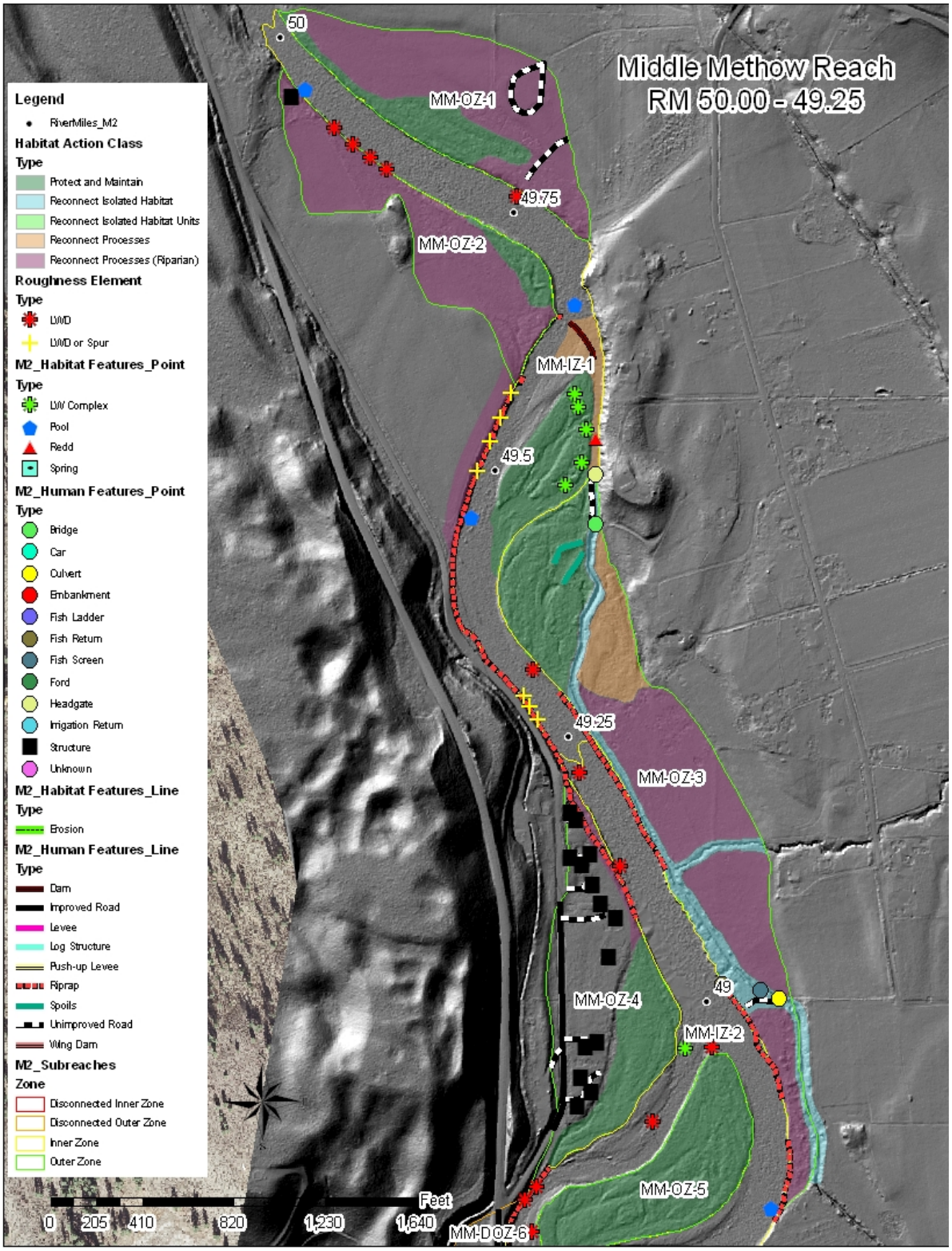

Figure 18. Hillshade elevation model showing the locations of subreaches, potential implementation actions, and existing natural and anthropogenic features between RM 50.00 and 49.25 (map scale 1:6,000).

MM-IZ-1 (Inner Zone)

Inner zone MM-IZ-1 is located between about RM 50.00 and 49.25 and covers about 21 acres of the active channel. The channel is transitioning from a confined reach into a moderately confined reach and flows begin to access the floodplain thereby dissipating stream power.

Bedrock crops out in the floodplain at about RM 49.8 on river right and RM 49.7 adjacent to the channel on river left which controls the lateral channel migration upstream of the Barkley diversion dam. The Barkley diversion dam (Figure 19) near RM 49.65 is a push-up dam that during summer low flows is manipulated to maintain irrigation flows which changes channel geometry, hydraulics, sediment transport and inhibits the passage of wood. The Barkley intake canal between the dam and the headgate provide perennial off-channel habitat (Table 9), but downstream of the headgate to the fish screens (about ¾ mile) the canal is an entrainment hazard for fish (see subreach MM-OZ-3) and causes stranding and mortality when the canal is turned off in the fall (refer to the fish salvage report in Appendix D).

Riprap placed on river right from RM 49.55 to 49.35 and on river left from RM 49.30 to 49.10 restricts lateral channel migration and changes channel hydraulic conditions resulting in increased sediment transport capacity and may result in vertical channel instability (localized incision). The potential actions for this subreach are described in Table 10.

Figure 19. View is to the southeast looking downstream at a large pool created by the Barkley diversion dam near RM 49.5. Methow Subbasin, Washington – Bureau of Reclamation photograph by E. Lyon, October 3, 2008.

Table 9. Summary of side channel within MM-IZ-1.

Side Channel Identifier	Total Acres	Side Channel Type	Cold Water Source	Wetted
SC_49.63_L (Barkley intake canal and overflow channel)	2.19	Artificial	No	Perennial

Table 10. Potential actions for MM-IZ-1.

Option	Habitat Action Class	Potential Actions	Reach-scale Rehabilitation Response Potential
1	Reconnect processes	The Barkley diversion dam is annually manipulated during low flows to maintain irrigation flows. These instream manipulations changes channel geometry, hydraulics, sediment transport, and inhibits the passage of wood. Alternatives evaluation on modifications to the dam and appurtenances should to be conducted to address these issues. Plant appropriate vegetation and protect riparian buffer zone (minimum of 30 meters where appropriate as recommended in *Monitoring Strategy*) along the margin of the inner zone to provide channel boundary roughness, bank stability, and terrestrial habitat connectivity. Wood placements may be necessary to provide bank stability until vegetation matures. If wood placements are used, the placements should provide additional habitat complexity and connectivity. Ungulate exclusion may be necessary in some areas. Place large wood "key" members on lateral bars to increase hydraulic and sediment transport variability, resulting in more natural or appropriate rates of bedform development, lateral channel migration and possible side channel development in order to alter hydraulic processes to provide diversity of flow regimes within the channel, creating improved migration and resting conditions for fish. Remove riprap, where appropriate, to allow lateral channel migration, or modify with roughness elements to reduce stream power.	High
2	Reconnect isolated habitat units	Consider placing appropriate roughness elements (such as boulders,large wood, bioengineering treatments, etc.) along lateral bars in lower energy channel segments to provide resting areas and channel complexity.	Low

MM-OZ-1 (Outer Zone)

Outer zone MM-OZ-1 is located between RM 50.00 and 49.70 on river left and covers about 14 acres. There is about 850 linear feet of unimproved roads that are not raised and do not disrupt floodplain connectivity. Past clearing of riparian vegetation has occurred for agriculture development. The potential actions for this subreach are described in Table 11.

Table 11. Potential actions for MM-OZ-1.

Option	Habitat Action Class	Potential Actions	Reach-scale Rehabilitation Response Potential
1	Protect and maintain current habitat	Protect and enhance riparian vegetation throughout the subreach to maintain channel boundary roughness, terrestrial habitat connectivity, water quality, floodplain roughness, and provide long-term wood recruitment potential. If bank stabilization is needed while vegetation matures it should also reconnect isolated habitat units, provide additional fish cover, and increase channel complexity. Ungulate exclusion may be necessary to re-establish the vegetation.	Maintain/High
2	Reconnect processes	If protection is not necessary or cannot be secured, then enhance riparian vegetation throughout the subreach to maintain channel boundary roughness, terrestrial habitat connectivity, water quality, floodplain roughness, and provide long-term wood recruitment potential. If bank stabilization is needed while vegetation matures it should also reconnect isolated habitat units, provide additional fish cover, and increase channel complexity. Ungulate exclusion may be necessary to re-establish the vegetation.	High

MM-OZ-2 (Outer Zone)

Outer zone MM-OZ-2 is located between RM 49.95 and 49.60 on river right and covers about 10 acres of floodplain. There is one structure that is on a higher surface and does not impact floodplain connectivity. Past riparian vegetation clearing has occurred for agricultural and residential development. The potential actions for this subreach are described in Table 12.

Table 12. Potential actions for MM-OZ-2.

Option	Habitat Action Class	Potential Actions	Reach-scale Rehabilitation Response Potential
1	Protect and maintain current habitat	Protect and enhance riparian vegetation throughout the subreach to maintain channel boundary roughness, terrestrial habitat connectivity, water quality, floodplain roughness, and provide long-term wood recruitment potential. If bank stabilization is needed while vegetation matures it should also reconnect isolated habitat units, provide additional fish cover, and increase channel complexity. Ungulate exclusion may be necessary to re-establish the vegetation.	Maintain/High
2	Reconnect processes	If protection is not necessary or cannot be secured, then enhance riparian vegetation throughout the subreach to maintain channel boundary roughness, terrestrial habitat connectivity, water quality, floodplain roughness, and provide long-term wood recruitment potential. If bank stabilization is needed while vegetation matures it should also reconnect isolated habitat units, provide additional fish cover, and increase channel complexity. Ungulate exclusion may be necessary to re-establish the vegetation.	High

MM-OZ-3 (Outer Zone)

Outer zone MM-OZ-3 is located between RM 49.50 and 48.80 on river left and covers about 26 acres of floodplain. Bear Creek flows into the Barkley canal and is disconnected from the Methow River. The Barkley canal between the headgate and fish screens (about ¾ mile) is an

entrainment hazard for fish and causes stranding and mortality when the canal is turned off in the fall (refer to fish salvage report in Appendix D). About 1,830 linear feet of riprap has been placed along the streambank to protect the Barkley canal from lateral channel migration and capture by the river. This bank protection changes channel hydraulic conditions resulting in increased sediment transport capacity and may result in vertical channel instability (localized scour).

There is about 340 linear feet of spoil piles that minimally impact floodplain connectivity. In addition, there is about 230 linear feet of unimproved road and a bridge crossing that do not appear to disrupt floodplain connectivity. The potential actions for this subreach are described in Table 13.

Anthropogenic features include the Barkley irrigation ditch and appurtenances, about 230 linear feet of unimproved road with a bridge crossing, about 1,830 linear feet of riprap, and about 340 linear feet of spoil piles. Bear Creek has been disconnected from the Methow River and flows into the Barkley ditch.

Table 13. Potential actions for MM-OZ-3.

Option	Habitat Action Class	Potential Actions	Reach-scale Rehabilitation Response Potential
1	Reconnect isolated habitat	Bear Creek flows into the Barkley canal and is disconnected from the Methow River. Reconnecting the Bear Creek watershed would provide additional aquatic habitat during high flow periods and increase ecological processes by transferring energy from the Bear Creek subwatershed to the Methow River that would improve the food web. An alternatives evaluation should be conducted to analyze the feasibility of reconnecting Bear Creek. The Barkley canal from the headgate to the fish screens (about ¾ mile) provides isolated, artificial habitat for salmonids and Pacific lamprey during the irrigation season. However, when the canal is shut off in the fall the isolated habitat is disconnected causing fish stranding and mortality. Alternatives evaluation should be conducted to either either eliminate fish entrainment, stranding and mortality when the canal is turned off in the fall or modifying it so that there is year-round ingress and egress for fish.	High
2	Reconnect processes	This is an important subreach to reconnect terrestrial habitat by planting appropriate vegetation (maximize the extent in the subreach) that will improve energy transfer between the river and riparian corridor, create floodplain roughness, and provide additional streambank stability and long-term wood recruitment potential. Re-establishing the appropriate vegetation should be considered an independent action that is not directly linked to reconnecting Bear Creek or modifying the Barkley canal. Wood placements may be considered to provide baank stability until vegetation matures. If wood placements are used, the placements should provide additional bank roughness, habitat complexity and fish cover, and improve habitat unit connectivity. Ungulate exlusion may be necessary in some areas.	High
3	Reconnect isolated habitat units	Consider placing appropriate roughness elements (such as boulders,large wood, bioengineering treatments, etc.) along lateral bars in lower energy channel segments and along the bank protection to provide resting areas and channel complexity.	Low

Channel Segment RM 49.25 – 48.10

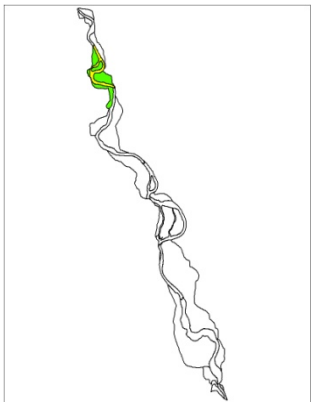

Figure 20. Location of channel segment RM 49.25 - 48.10 within the reach.

Characteristics

Between RM 49.25 and 48.10 (Figure 20), the channel could be transitioning or has been locked in a mode of stasis due to artificial confinement by riprap along much of its length (Figure 21 and Figure 22). Average channel slope is about 0.35 percent based on 2008 thalweg profile data (Reclamation 2010) with an average bankfull width of about 200 feet as measured from the 2006 LiDAR hillshade elevation model, and predominant channel units are runs and riffles with cobbles and gravel substrate. Floodplain connectivity and lateral channel migration have been negatively affected by residential development and associated infrastructure, and bank protection.

The geomorphic potential has been primarily impacted by floodplain development that has resulted in the clearing of riparian vegetation, reduced floodplain connectivity, and restricted lateral channel migration that degrade the physical and ecological processes. An overview of the potential habitat action classes are listed in Table 14. Specific actions for each subreach are addressed in the following sections.

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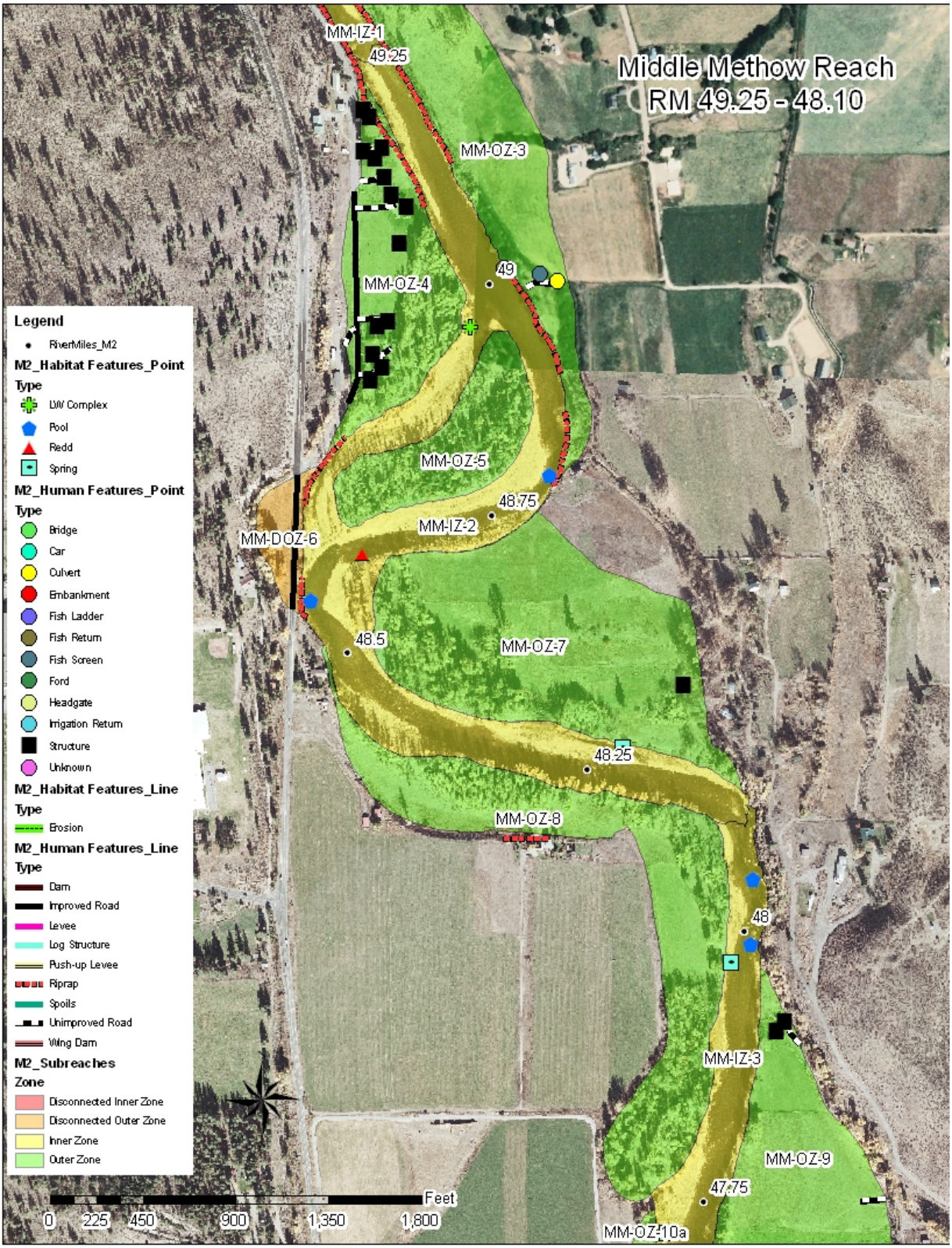

Figure 21. Aerial photograph showing the locations of subreaches and existing natural and anthropogenic features between RM 49.25 and 48.10 (map scale 1:6,500).

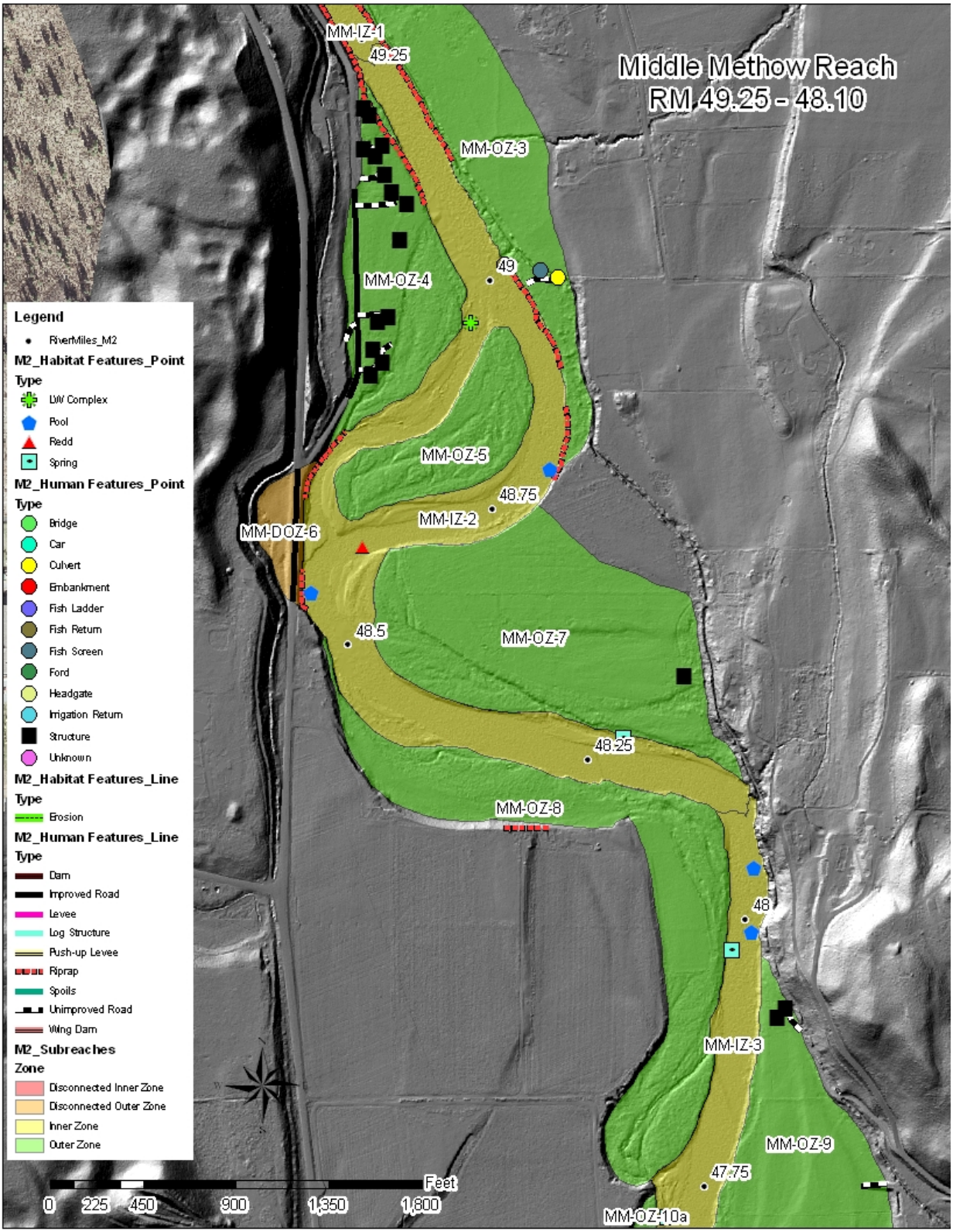

Figure 22. Hillshade elevation model showing the locations of subreaches and existing natural and anthropogenic features between RM 49.25 and 48.10 (map scale 1:6,500).

Table 14. Summary table of subreaches from RM 49.25 to 48.10, anthropogenic impacts and potential habitat action classes.

Parcel	River Mile (RM)	Acreage	Anthropogenic Features	Habitat Action Classes
MM-IZ-2 SUBREACH				
MM-IZ-2 (inner zone)	RM 49.25 – 48.10	36 acres	Bear Creek disconnected from Methow River (refer to MM-OZ-3 for discussion) Riprap (~3,000 ft)	Reconnect isolated habitat Reconnect processes Reconnect isolated habitat units
MM-OZ-4 SUBREACH				
MM-OZ-4 (outer zone)	RM 49.20 - 48.65 (river right)	13 acres	Structure (14) Unimproved roads (~940 ft) Improved roads (~1,020 ft)	Protect and maintain current habitat Reconnect processes
MM-OZ-5 SUBREACH				
MM-OZ-5 (outer zone)	RM 48.95 - 48.60 (island)	9 acres	None	Protect and maintain current habitat
MM-DOZ-6 SUBREACH				
MM-DOZ-6 (disconnected outer zone)	RM 48.60 - 48.55 (river right)	3 acres	Improved road (~640 ft)	Reconnect processes
MM-OZ-7 SUBREACH				
MM-OZ-7 (outer zone)	RM 48.80 - 48.15 (river left)	29 acres	Structure (1)	Protect and maintain current habitat Reconnect processes
MM-OZ-8 SUBREACH				
MM-OZ-8 (outer zone)	RM 48.50 - 47.75	24 acres	Riprap (~230 ft)	Protect and maintain current habitat Reconnect processes Reconnect isolated habitat units

Potential Implementation Actions

The objectives for implementing the proposed actions between RM 49.25 and 48.10 are as follows (refer to Figure 23 and Figure 24):

1. Protecting the fragmented tracts of riparian vegetation and reconnecting these tracts by rehabilitating the cleared areas between them. These actions would provide a long-term cumulative benefit to both the physical and ecological processes.

2. Protecting and enhancing cold water sources (i.e., Gilbertson springs) to the Methow River that moderate water temperatures and provide thermal refugia.

3. Reconnecting floodplain processes by implementing the following actions: (1) remove or modify road embankments that impede overland flows, (2) remove bank protection, where appropriate, to allow lateral channel migration, (3) modify bank protection with roughness elements to retain sediment and possibly elevate the channel bed to improve floodplain connectivity, and (4) strategically place large wood "key" members on bars and large wood at the head of overflow channels that contribute to the creation and maintenance of side channels.

4. Connecting habitat units by implementing the following actions: (1) using appropriate methods to stabilize banks and re-establish vegetation, (2) increasing channel boundary roughness and habitat complexity, and (3) strategically placing large wood to improve fish cover, habitat complexity, and biomass in side channels and alcoves.

Only the actions that have been identified through field observations and local input from the MRC are described. Many other potential actions could be implemented as described in the *Recovery Plan* or that are identified during a future alternatives evaluation.

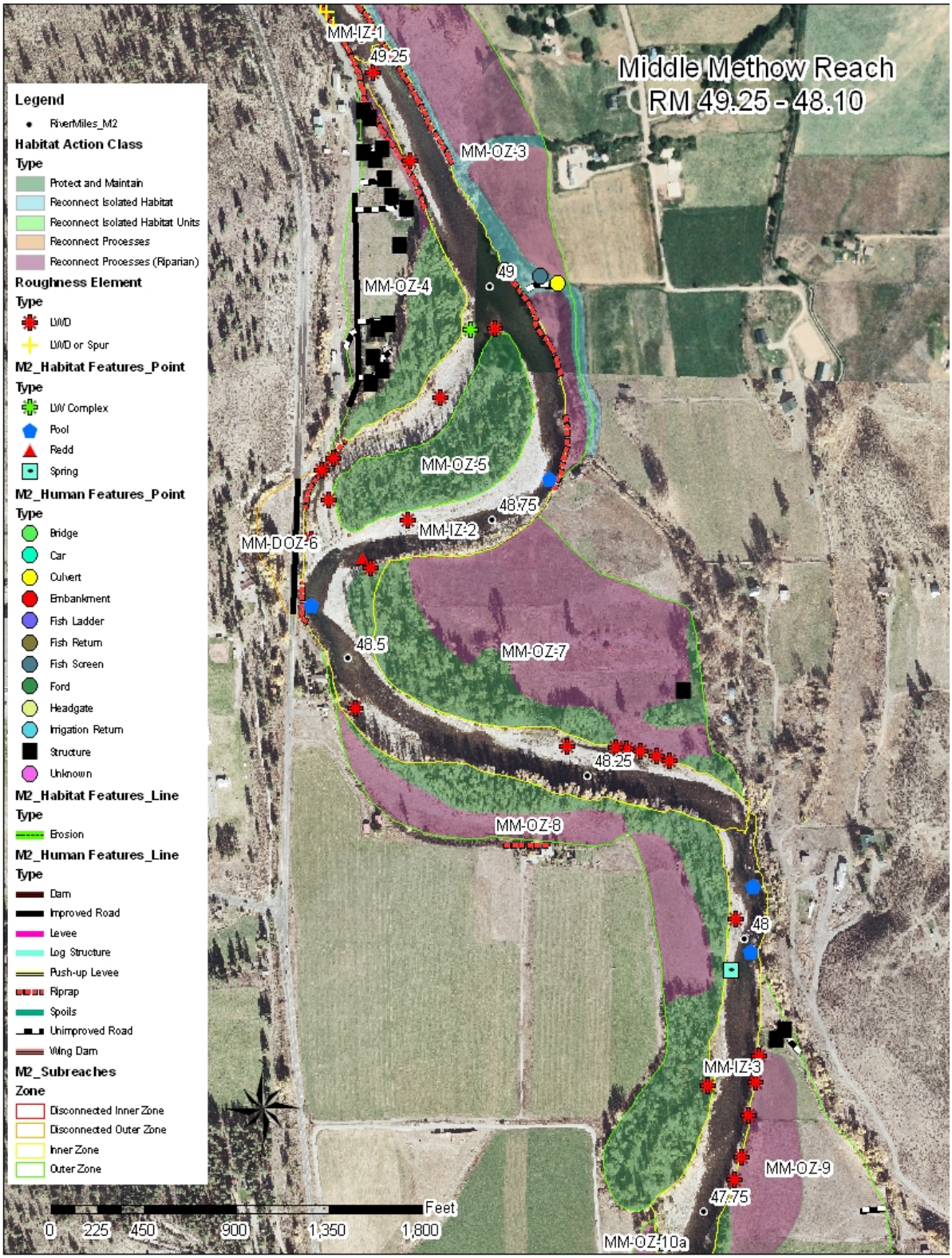

Figure 23. Aerial photograph showing the locations of subreaches, potential implementation actions, and existing natural and anthropogenic features between RM 49.25 and 48.10 (map scale 1:6,500).

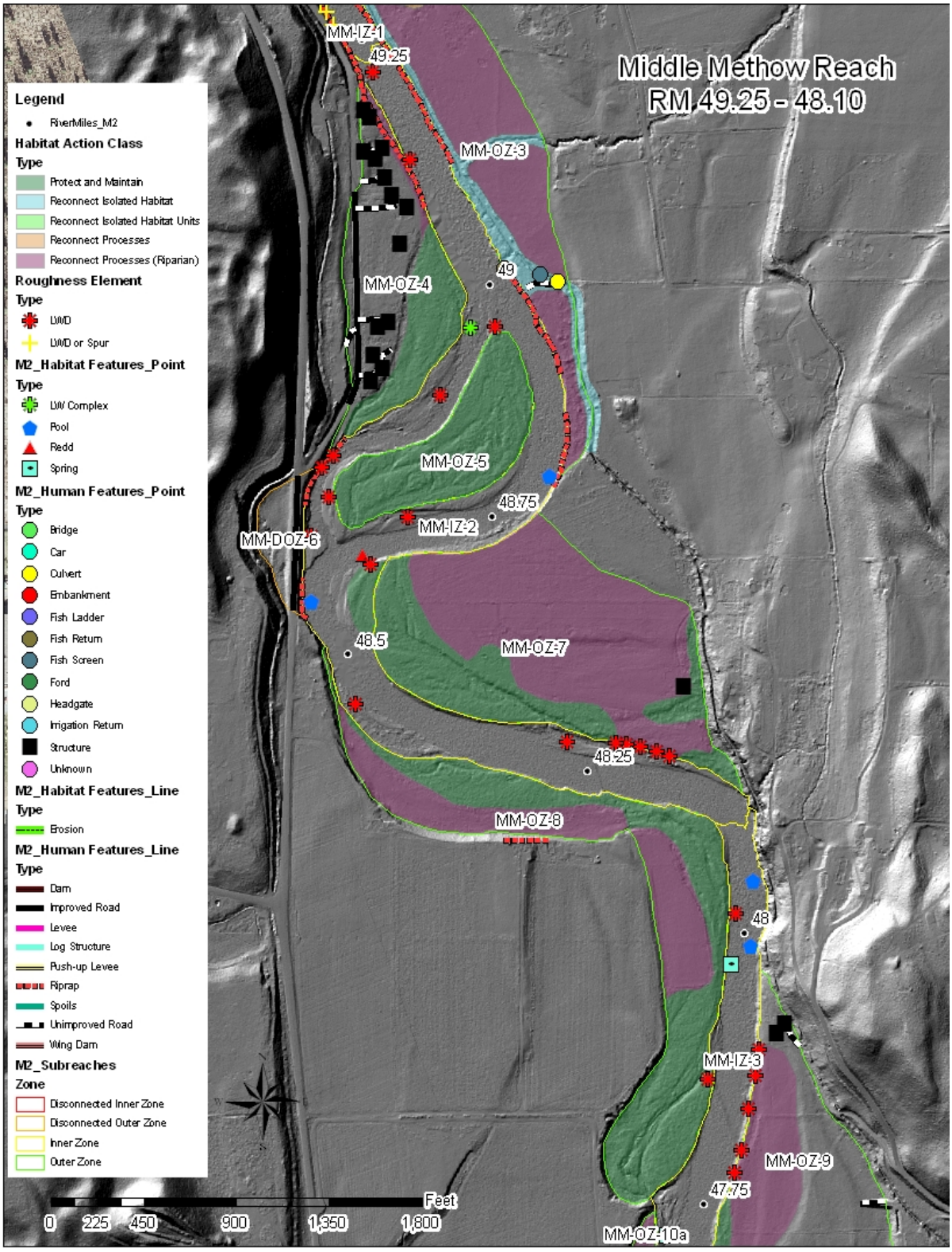

Figure 24. Hillshade elevation model showing the locations of subreaches, potential implementation actions, and exiting natural and anthropogenic features between RM 49.25 and 48.10 (map scale 1:6,500).

MM-IZ-2 (Inner Zone)

Inner zone MM-IZ-2 is located between RM 49.25 and 48.10 covers about 36 acres of the active channel and side channels. The channel is transitioning or has been locked in a mode of stasis due to artificial confinement and restricted lateral channel migration. Bear Creek is disconnected from the Methow River and flows into the Barkley canal (refer to subreach MM-OZ-3 for further discussion). Riprap was placed on river left from RM 49.00 to 48.80, and along river right near RM 48.55. The riprap restricts lateral channel migration and changes channel hydraulic conditions resulting in increased sediment transport capacity and may result in vertical channel instability (localized scour).

There are four side channels within the subreach that are summarized in Table 15. One side channel (SC_48.37_L), known as Gilbertson springs is a cold water source to the Methow River. Side channel (SC_49.00_R), known as the Bird side channel, is a dynamic floodplain-type side channel that provides seasonal off-channel habitat (Figure 25). The potential actions for this subreach are described in Table 16.

Figure 25. View is to the southwest looking downstream at a lateral scour pool forced by riprap along the Bird side channel near RM 48.7. Methow Subbasin, Washington – Bureau of Reclamation photograph by E. Lyon, October 3, 2008.

Table 15. Summary of side channels within MM-IZ-2.

Side Channel Identifier	Total Acres	Side Channel Type	Cold Water Source	Wetted
SC_49.25_R	0.52	Gravel Bar	No	Perennial
SC_49.00_R (Bird side channel)	3.91	Floodplain	No	Ephemeral
SC_48.50_R	0.55	Gravel Bar	No	Ephemeral
SC_48.37_L (Gilbertson springs)	0.68	Gravel Bar	Yes	Perennial

Table 16. Potential actions for MM-IZ-2.

Option	Habitat Action Class	Potential Actions	Reach-scale Rehabilitation Response
1	Protect and maintain current habitat	Protect and enhance riparian buffer zone (minimum of 30 meters recommended in *Monitoring Strategy*) to provide channel boundary roughness, bank stability, and terrestrial habitat connectivity. Wood placements may be necessary to provide bank stability until vegetation matures. If wood placements are used, the placements should provide additional habitat complexity and connectivity. Ungulate exclusion may be necessary in some areas. Protect and enhance Gilbertson springs (SC_48.37_L) which is a cold water source to the Methow River and provides thermal refugia and rearing habitat. Enhance by strategically placing wood along side channel to increase channel diversity, provide fish cover, and increase biomass. Explore the possibility of mechanically expanding the alcove area. Protect and enhance Bird side channel (SC_49.00_R). Enhance by strategically placing wood along side channel to increase channel diversity, provide fish cover, and increase biomass. Explore the possibility of mechanically expanding the alcove area to insure continued fish ingress and egress.	Maintain/High
2	Reconnect processes	Place large wood “key” members on lateral bars to increase hydraulic and sediment transport variability, resulting in more natural or appropriate rates of bedform development, lateral channel migration and possible side channel development in order to alter hydraulic processes to provide diversity of flow regimes within the channel, creating improved migration and resting conditions for fish. Remove bank protection, where appropriate, to allow lateral channel migration, or modify with roughness elements to reduce stream power.	High
3	Reconnect isolated habitat units	Strategically place wood in side channels and alcoves to increase channel diversity, provide fish cover, and increase biomass.	Low

MM-OZ-4 (Outer Zone)

Outer zone MM-OZ-4 is located between RM 49.20 and 48.65 on river right and covers about 13 acres of floodplain. There are fourteen existing structures that currently constrain the extent in which short-term implementation of potential actions to improve floodplain connectivity can occur. There is about 1,020 linear feet of improved road that disconnects a

small area of the floodplain (greater than 5 percent). About 940 linear feet of unimproved roads are present, but do not disrupt floodplain connectivity. About 30 percent of the subreach has intact riparian vegetation. The potential actions for this subreach are described in Table 17.

Table 17. Potential action for MM-OZ-4.

Option	Habitat Action Class	Potential Action	Reach-scale Rehabilitation Response Potential
1	Protect and maintain current habitat	Protect and enhance riparian vegetation to provide floodplain roughness, bank stability, and terrestrial habitat connectivity. Wood placements may be necessary to provide bank stability until vegetation matures in some areas. If wood placements are used, the placements should provide additional habitat complexity and connectivity. Ungulate exclusion may be necessary in some areas.	Maintain/High
2	Reconnect processes	Enhance vegetation throughout subreach to provide floodplain roughness, bank stability, and terrestrial habitat connectivity. Wood placements may be necessary in some areas to provide bank stability until vegetation matures. If wood placements are used, the placements should provide additional habitat complexity and connectivity. Ungulate exclusion may be necessary in some areas.	Moderate

MM-OZ-5 (Outer Zone)

Outer zone MM-OZ-5 is an island (Bird Island) located between RM 48.95 and 48.60 and covers about 9 acres of floodplain. There are no anthropogenic features and the existing riparian vegetation covers most of the island. The potential action for this subreach is described in Table 18.

Table 18. Potential action for MM-OZ-5.

Option	Habitat Action Class	Potential Action	Reach-scale Rehabilitation Response Potential
1	Protect and maintain current habitat	Protect and enhance riparian vegetation to provide floodplain roughness, bank stability, and terrestrial habitat connectivity. Wood placements may be necessary to provide bank stability until vegetation matures in some areas. If wood placements are used, the placements should provide additional habitat complexity and connectivity. Ungulate exclusion may be necessary in some areas.	Maintain/High

MM-DOZ-6 (Disconnected Outer Zone)

Disconnected outer zone MM-DOZ-6 is located between RM 48.60 and 48.55 on river right and covers about 3 acres of floodplain. There is about 650 linear feet of improved road that disconnects the floodplain. The costs versus biological benefits most likely preclude any action occurring in this subreach. As such, the actions for this subreach are described in Table 19.

Table 19. Potential actions for MM-DOZ-6.

Option	Habitat Action Class	Potential Actions	Reach-scale Rehabilitation Response Potential
1	Reconnect processes	Remove, modify or relocate improved road to reconnect floodplain and allow lateral channel migration. If improved road is removed, modified or relocated, plant appropriate vegetation to improve floodplain roughness, terrestrial habitat connectivity, water quality, and provide wood recruitment potential.	Moderate

MM-OZ-7 (Outer Zone)

Outer zone MM-OZ-7 is located between RM 48.80 and 48.15 on river left and covers about 29 acres of floodplain. There is one existing structure that is located on a higher surface and does not disrupt floodplain processes. Past clearing of riparian vegetation has occurred for agriculture development. The potential actions for this subreach are described in Table 20.

Table 20. Potential actions for MM-OZ-7.

Option	Habitat Action Class	Potential Actions	Reach-scale Rehabilitation Response Potential
1	Protect and maintain current habitat	Protect and enhance riparian vegetation to provide floodplain roughness, bank stability, and terrestrial habitat connectivity. Wood placements may be necessary to provide bank stability until vegetation matures in some areas. If wood placements are used, the placements should provide additional habitat complexity and connectivity. Ungulate exclusion may be necessary in some areas.	Maintain/High
2	Reconnect processes	Enhance riparian vegetation to provide floodplain roughness, bank stability, and terrestrial habitat connectivity. Allow for lateral channel migration where appropriate, Wood placements may be necessary to provide bank stability until vegetation matures in some areas. If wood placements are used, the placements should provide additional habitat complexity and connectivity. Ungulate exclusion may be necessary in some areas.	High
3	Reconnect isolated habitat units	Consider wood placements where riparian vegetation has been removed to provide channel boundary roughness, bank stability, and improve habitat unit connectivity. This action should be considered in conjunction with re-establishing a riparian buffer zone.	Low

MM-OZ-8 (Outer Zone)

Outer zone MM-OZ-8 is located between RM 48.50 and 47.75 on river right and covers about 24 acres of floodplain. There is about 230 linear feet of riprap that protects a structure and may impede lateral channel migration. Past riparian vegetation clearing has occurred for agriculture development, but there is a relatively continuous buffer zone along the river.

The subreach contains a floodplain-type side channel (SC_47.90_R), known as the River Rock Reach (3R) side channel, on river right at RM 47.90 (Figure 26: Table 21). The 3R side channel is a cold water source to the Methow River and provides thermal refugia and rearing habitat. The potential actions for this subreach are described in Table 22.

Figure 26. View is to the south looking downstream at a lateral scour pool forced by bedrock along River Rock Reach (3R) side channel along river right near RM 47.6. Methow Subbasin, Washington - Bureau of Reclamation photograph by E. Lyon, October 3, 2008.

Table 21. Summary of side channel within subreach MM-OZ-8.

Side Channel Identifier	Total Acres	Side Channel Type	Cold Water Source	Wetted
SC_47.90_R (3R side channel)	0.99	Floodplain	Yes	Perennial

Table 22. Potential actions for MM-OZ-8.

Option	Habitat Action Class	Potential Actions	Reach-scale Rehabilitation Response Potential
1	Protect and maintain current habitat	Protect and enhance riparian vegetation to provide floodplain roughness, bank stability, and terrestrial habitat connectivity. Wood placements may be necessary to provide bank stability until vegetation matures in some areas. If wood placements are used, the placements should provide additional habitat complexity and connectivity. Ungulate exclusion may be necessary in some areas. Protect and enhance the 3R side channel (SC_47.90_R) that is a cold water source to the Methow River. Enhance by strategically placing wood along side channel to increase channel diversity, provide fish cover, and increase biomass. Explore the possibility of mechanically expanding the alcove area or increasing side channel length.	Maintain/High

Option	Habitat Action Class	Potential Actions	Reach-scale Rehabilitation Response Potential
2	Reconnect processes	Enhance riparian vegetation to provide floodplain roughness, bank stability, and terrestrial habitat connectivity. Wood placements may be necessary to provide bank stability until vegetation matures in some areas. If wood placements are used, the placements should provide additional habitat complexity and connectivity. Ungulate exclusion may be necessary in some areas. Allow lateral channel migration throughout subreach and along adjacent high terrace. An alternatives evaluation would be necessary to address the removal of riprap that protects a structure and/or possible relocation of the structure. Strategic large wood placements that contribute to side channel creation that would improve off-channel habitat for salmonid rearing habitat and refugia. Combined with riparian plantings, this subreach could provide suitable beaver habitat for colonization.	High
3	Reconnect isolated habitat units	Strategically place wood in side channels and alcoves to increase channel diversity, provide fish cover, and increase biomass.	Low

Channel Segment RM 48.10 – 46.25

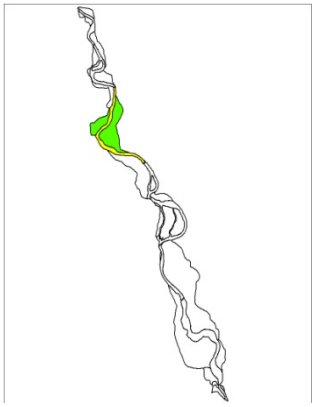

Figure 27. Location of channel segment RM 48.10 - 46.25 within the reach.

Characteristics

Between RM 48.10 and 46.25 (Figure 27), the channel is transitioning or has been locked in a mode of stasis due to confinement by bedrock and glacial terraces in the upstream section, and then the channel is less confined in the lower section and appears to be widening in areas where active bank erosion is occurring (Figure 28 and Figure 29). Average channel slope is about 0.28 percent based on 2008 thalweg profile data (Reclamation 2010) with an average bankfull width of about 220 feet as measured from the 2006 LiDAR hillshade elevation model, and predominant channel units are runs and riffles with cobbles and gravel substrate.

Past riparian vegetation clearing has occurred primarily for agriculture development. Bank erosion is occurring in some areas where the riparian vegetation has been cleared along the

streambank. Residential structures and associated access roads disconnect the floodplain in some areas. Bank protection including "Detroit riprap" (cars), riprap, and other debris limit the lateral channel migration into a glacial terrace near the Winthrop airport.

There are three cold water sources to the Methow River: (1) a cold water upwelling in the channel near RM 47.95 along river right, (2) 3R side channel (SC_47.90_R) near RM 47.70 on river right, and (3) Boesel side channel (SC_46.70_L) near RM 46.50 on river left.

The geomorphic potential has been impacted primarily by floodplain development that has resulted in the clearing of riparian vegetation, restricted lateral channel migration, and reduced floodplain connectivity that degrade the physical and ecological processes. An overview of the potential habitat action classes is listed in Table 23. Specific actions for each subreach are addressed in the following sections.

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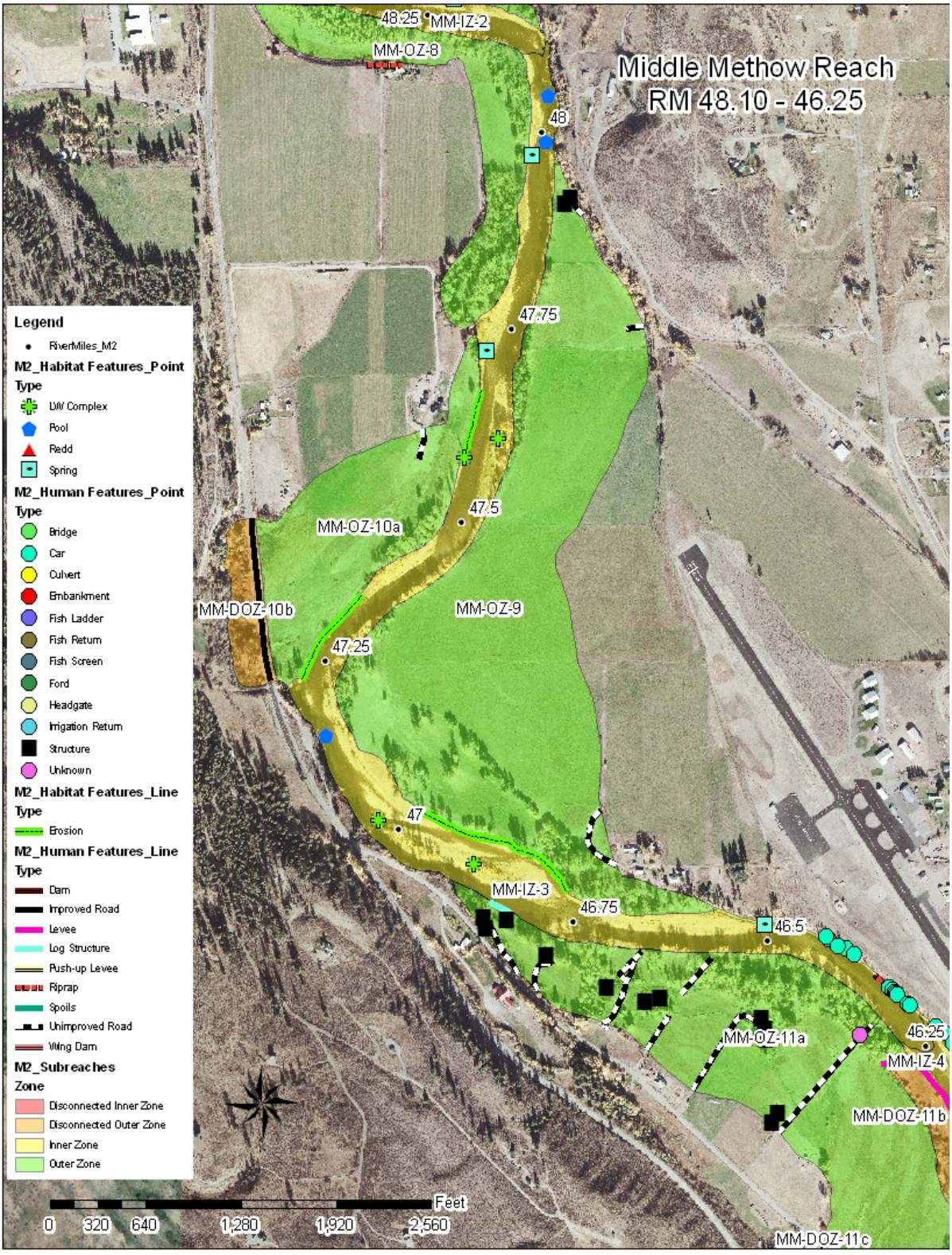

Figure 28. Aerial photograph showing the locations of subreaches and existing natural and anthropogenic features between RM 48.10 and 46.25 (map scale 1:9,000).

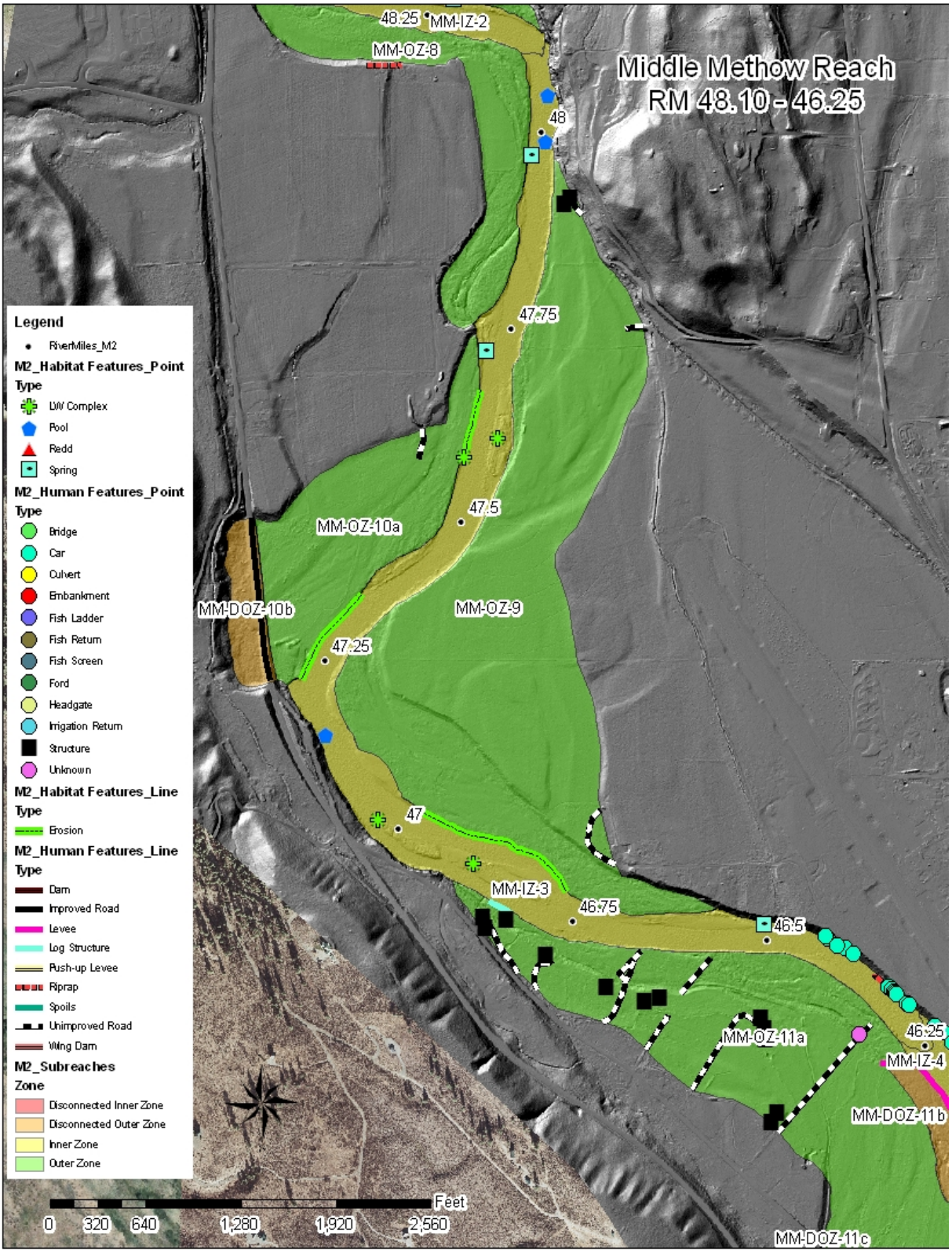

Figure 29. Hillshade elevation model showing the locations of subreaches and existing natural and anthropogenic features between RM 48.10 and 46.25 (map scale 1:9,000).

Table 23. Summary table of subreaches from RM 48.10 to 46.25, anthropogenic impacts and potential habitat action classes.

Parcel	River Mile (RM)	Acreage	Anthropogenic Features	Habitat Action Classes
MM-IZ-3 SUBREACH				
MM-IZ-3 (inner zone)	RM 48.10 - 46.25	56 acres	Cars (13), gabions, and other debris Riprap (~80 ft)	Reconnect processes Reconnect isolated habitat units
MM-OZ-9 SUBREACH				
MM-OZ-9 (outer zone)	RM 48.00 – 46.55 (river left)	99 acres	Floodplain development (agriculture)	Reconnect processes Protect and maintain current habitat Reconnect isolated habitat units
MM-OZ-10 SUBREACH COMPLEX				
MM-OZ-10a (outer zone)	RM 47.75 - 47.20 (river right)	30 acres	Unimproved road (~210 ft)	Reconnect processes Reconnect isolated habitat units
MM-DOZ-10b (disconnected outer zone)	RM 47.35 - 47.20 (river right)	6 acres	Improved road (~1,080 ft)	Reconnect processes

Potential Implementation Actions

The objective for implementing the proposed actions between RM 48.10 and 46.25 are as follows (refer to Figure 30 and Figure 31):

1. Protecting the fragmented tracts of riparian vegetation, and reconnecting these tracts by rehabilitating the cleared areas between them. These actions would provide a long-term cumulative benefit to both the physical and ecological processes.

2. Protecting and enhancing the following cold water sources: (1) upwelling near RM 47.95 in the channel, (2) 3R side channel (SC_47.90_R) near RM 47.70, and (3) Boesel side channel (SC_46.70_L) near RM 46.50.

3. Reconnecting floodplain processes by implementing the following actions: (1) remove bank protection ("Detroit riprap" and other bank protection near Winthrop airport) to allow lateral channel migration into glacial terrace, and (2) strategically placing large wood "key" members on bars and large wood at the head of overflow channels that contribute to side channel formation.

4. Connecting habitat units by implementing the following acitons: (1) using appropriate methods to stabilize banks and re-establish appropriate vegetation, (2) increasing channel boundary roughness and habitat complexity, and (3) strategically placing large wood to improve fish cover, habitat complexity, and biomass in side channels and alcoves.

Only the actions that have been identified through field observations and local input from the MRC are described. Many other potential actions could be implemented as described in the *Recovery Plan* or that are identified during an alternatives evaluation.

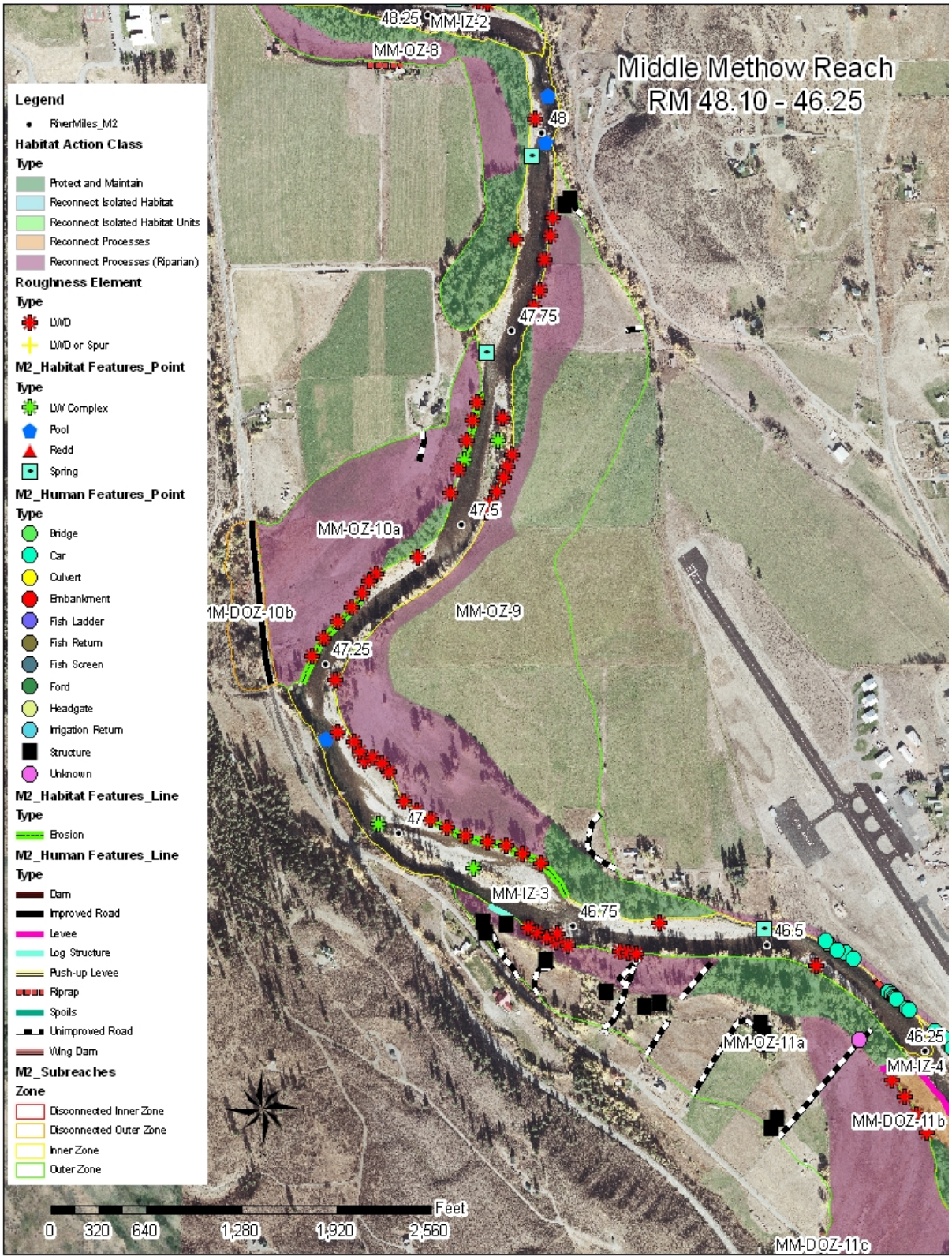

Figure 30. Aerial photograph showing the locations of subreaches, potential implementation actions, and existing natural and anthropogenic features between RM 48.10 and 46.25 (map scale 1:9,000).

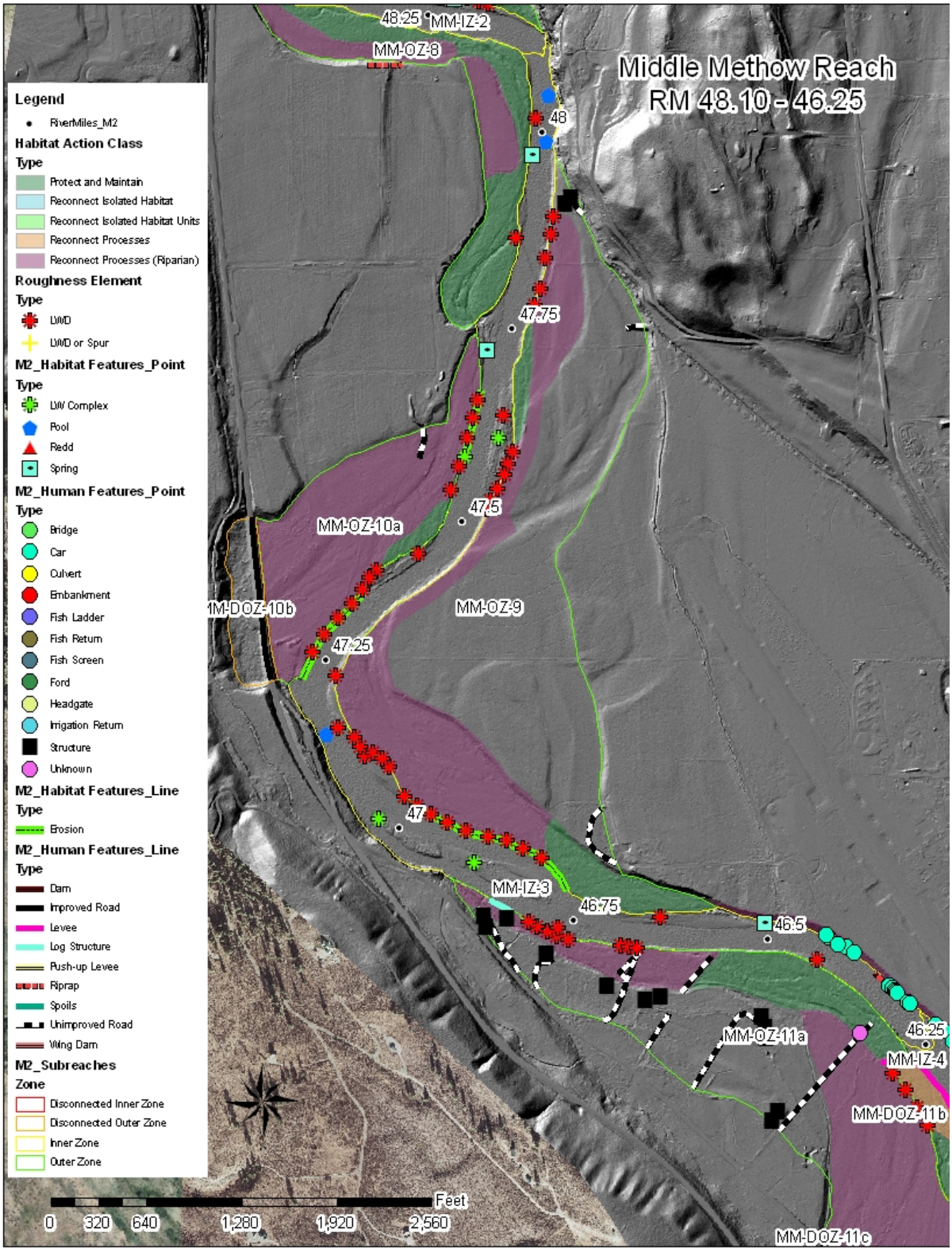

Figure 31. Hillshade elevation model showing the locations of subreaches, potential implementation actions, and existing natural and anthropogenic features between RM 48.10 and 46.25 (map scale 1:9,000).

MM-IZ-3 (Inner Zone)

Inner zone MM-IZ-3 is located between RM 48.10 and 46.25 and covers about 56 acres of the active channel. This subreach is used by Pacific lamprey for rearing. The channel is transitioning by actively widening and eroding the unvegetated streambanks.

Past riparian clearing has occurred along the riparian buffer zone primarily for agriculture development. Active erosion is occurring along cleared banks in several locations including the following: (1) along river right between about RM 47.65 and 47.55, (2) along river right between about RM 47.35 and 47.20, and (3) along river left between about RM 47.00 and 46.80. Lateral channel migration into a glacial terrace that may self armor as it erodes is inhibited by riprap and cars placed along river left between about RM 46.50 and 46.25.

There are two gravel bar type side channels in the subreach which are summarized in Table 24. The Boesel side channel (SC_46.70_L) is a perennial cold water source to the Methow River. The potential actions for this subreach are described in Table 25.

Table 24. Summary of side channnel within MM-IZ-3.

Side Channel Identifier	Total Acres	Side Channel Type	Cold Water Source	Wetted
SC_46.80_R	0.48	Gravel Bar	No	Perennial
SC_46.70_L (Boesel side channel)	0.75	Gravel Bar	Yes	Perennial

Table 25. Potential actions for MM-IZ-3.

Option	Habitat Action Class	Potential Actions	Reach-scale Rehabilitation Response Potential
1	Protect and maintain current habitat	Protect and enhance riparian buffer zone (minimum of 30 meters recommended in *Monitoring Strategy*) to provide channel boundary roughness, bank stability, and terrestrial habitat connectivity. Wood placements may be necessary to provide bank stability until vegetation matures. If wood placements are used, the placements should provide additional habitat complexity and connectivity. Ungulate exclusion may be necessary in some areas. Protect and enhance Boesel side channel (SC_46.70_L) which is a cold water source to the Methow River and provides thermal refugia and rearing habitat. Enhance by strategically placing wood along side channel to increase channel diversity, provide fish cover, and increase biomass. Explore the possibility of mechanically expanding the alcove area. Protect and enhance cold water upwelling along river right near RM 47.95 that provides thermal refugia. Explore enhancement opportunities of constructing an instream structure to provide additional thermal refugia area and fish cover.	Maintain/High

Option	Habitat Action Class	Potential Actions	Reach-scale Rehabilitation Response Potential
2	Reconnect processes	Plant appropriate vegetation along buffer zone (minimum of 30 meters recommended in *Monitoring Strategy*) to provide channel boundary roughness, bank stability, and terrestrial habitat connectivity. Wood placements may be necessary to provide bank stability until vegetation matures. If wood placements are used, the placements should provide additional habitat complexity and connectivity. Ungulate exclusion may be necessary in some areas. Place large wood "key" members on lateral bars to increase hydraulic and sediment transport variability, resulting in more natural or appropriate rates of bedform development, lateral channel migration and possible side channel development in order to alter hydraulic processes to provide diversity of flow regimes within the channel, creating improved migration and resting conditions for fish. Remove bank protection, where appropriate, to allow lateral channel migration, or modify with roughness elements to reduce stream power	High
3	Reconnect isolated habitat units	Strategically place wood in side channels and alcoves to increase channel diversity, provide fish cover, and increase biomass. Consider placing appropriate roughness elements (such as boulders,large wood, bioengineering treatments, etc.) along lateral bars in lower energy channel segments to provide resting areas and channel complexity.	Low

MM-OZ-9 (Outer Zone)

Outer zone MM-OZ-9 is located between RM 48.00 and 46.55 on river left, and covers about 99 acres of floodplain. Past clearing of the riparian vegetation has occurred primarily for agriculture development. There is a narrow, discontinuous riparian buffer. There are two existing structures at the upper end of the subreach that are located on a higher terrace and do not disrupt floodplain econnectivity. The potential actions for this subreach are described in Table 26.

Table 26. Potential actions for MM-OZ-9.

Option	Habitat Action Class	Potential Actions	Reach-scale Rehabilitation Response Potential
1	Protect and maintain current habitat	Protect and enhance riparian vegetation to provide floodplain roughness, bank stability, and terrestrial habitat connectivity. Wood placements may be necessary to provide bank stability until vegetation matures in some areas. If wood placements are used, the placements should provide additional habitat complexity and connectivity. Ungulate exclusion may be necessary in some areas.	Maintain/High

Option	Habitat Action Class	Potential Actions	Reach-scale Rehabilitation Response Potential
2	Reconnect processes	Enhance riparian vegetation to provide floodplain roughness, bank stability, and terrestrial habitat connectivity. Wood placements may be necessary to provide bank stability until vegetation matures in some areas. If wood placements are used, the placements should provide additional habitat complexity and connectivity. Ungulate exclusion may be necessary in some areas. Allow lateral channel migration where appropriate to improve physical processes.	High
3	Reconnect isolated habitat units	Strategically place wood where riparian vegetation has been removed that would provide channel boundary roughness, bank stability, and improve habitat unit connectivity.	Moderate

MM-OZ-10 (Outer Zone) Subreach Complex

Outer zone MM-OZ-10 is located between RM 47.20 and 47.35 on river right and covers about 36 acre of floodplain. The subreach was further divided into two parcels due to anthropogenic features that relate to floodplain connectivity and lateral channel migration. Actions described for parcel MM-OZ-10a should be prioritized over parcel MM-DOZ-10b because they may have a higher reach-scale relative response.

MM-OZ-10a (Outer Zone)

Outer zone MM-OZ-10a is located between RM 47.75 and 47.20 on river right, and covers about 30 acres of floodplain. Past riparian vegetation clearing has occurred primarily for agriculture development. Active erosion is occurring along the banks where vegetation has been cleared. There is about 210 linear feet of unimproved road that do not disrupt floodplain connectivity. The potential actions for the subreach are described in Table 27.

Table 27. Potential actions for MM-OZ-10a.

Option	Habitat Action Class	Potential Actions	Reach-scale Rehabilitation Response Potential
1	Protect and maintain current habitat	Protect and enhance riparian vegetation to provide floodplain roughness, bank stability, and terrestrial habitat connectivity. Wood placements may be necessary to provide bank stability until vegetation matures in some areas. If wood placements are used, the placements should provide additional habitat complexity and connectivity. Ungulate exclusion may be necessary in some areas.	Maintain/High
2	Reconnect processes	Enhance riparian vegetation to provide floodplain roughness, bank stability, and terrestrial habitat connectivity. Wood placements may be necessary to provide bank stability until vegetation matures in some areas. If wood placements are used, the placements should provide additional habitat complexity and connectivity. Ungulate exclusion may be necessary in some areas. Allow lateral channel migration where appropriate to improve physical processes.	High
3	Reconnect isolated habitat units	Strategically place wood where riparian vegetation has been removed that would provide channel boundary roughness, bank stability, and improve habitat unit connectivity.	Moderate

MM-DOZ-10b (Disconnected Outer Zone)

Disconnected outer zone MM-DOZ-10b is located between RM 47.35 and 47.20 on river right, and covers about 6 acres of floodplain. About 1,080 linear feet of improved road disconnect the floodplain and restrict lateral channel migration. The cost versus biological benefit may prohibit actions taken in this parcel. As such, the potential action for this parcel is listed in Table 28.

Table 28. Potential action for MM-DOZ-10b.

Option	Habitat Action Class	Potential Action	Reach-scale Rehabilitation Response Potential
1	Reconnect processes	Remove or modify an improved road that disconnects a historical channel migration area and allow lateral channel migration to improve physical processes.	Low

Channel Segment RM 46.25 – 45.50

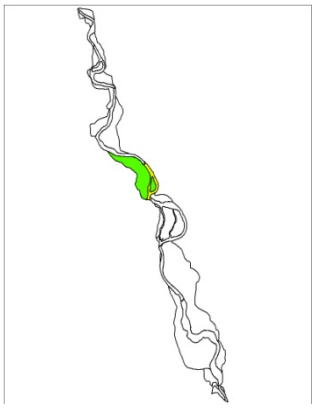

Figure 32. Location of channel segment RM 46.25 - 45.50 within the reach.

Characteristics

Between RM 46.25 and 45.50 (Figure 32), the channel is transitioning due to the removal of Methow Valley Irrigation District's (MVID) diversion dam in late 2008 and potentially from artificial confinement by riprap and levees (Figure 33 and Figure 34). Average channel slope is about 0.32 percent based on 2008 thalweg profile data (Reclamation 2010) with an average bankfull width of about 200 feet as measured from the 2006 LiDAR hillshade elevation model, and the predominant channel units are runs and riffles with cobble and gravel substrate.

A levee between about RM 46.25 and 46.05 on river right disconnects the floodplain and restricts lateral channel migration. An improved road disconnects a wetland area, known as the Plummer side channel (SC_45.60_R). Residential structures and most associated roads are on a higher terrace and do not disrupt floodplain connectivity. There are a couple of unimproved roads on the lower terrace that disrupt overland flow in a small percentage of the subreach (less than 5 percent). Past riparian vegetation clearing was primarily for agriculture development, but now includes residential structures and related infrastructure.

The geomorphic potential has been primarily impacted by restricted lateral channel migration, disconnected floodplain, and clearing of riparian vegetation for agriculture and residential development. Overviews of the potential habitat action classes are listed in Table 29. Specific actions for each subreach are addressed in the following sections.

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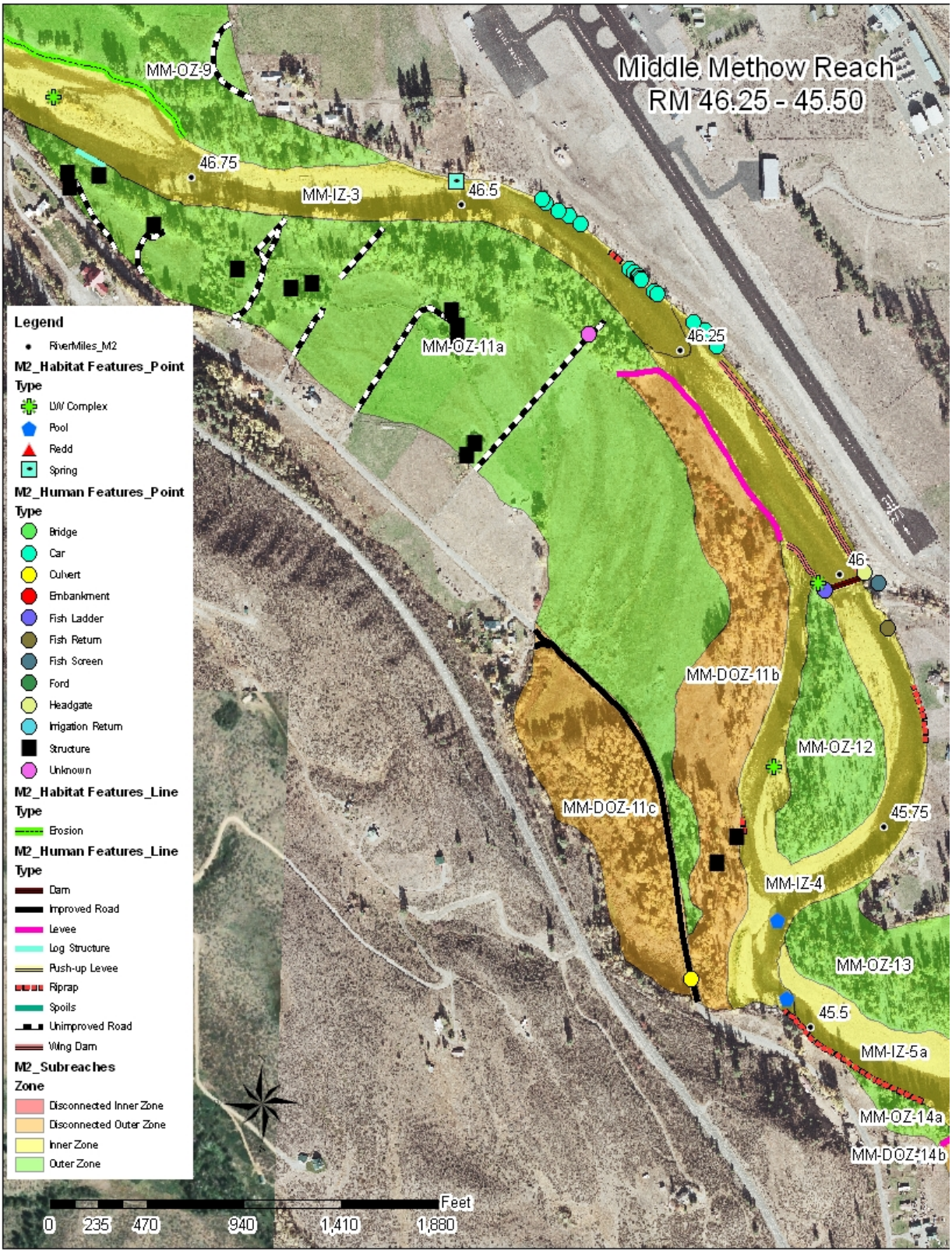

Figure 33. Aerial photograph showing the locations of subreaches and existing natural and anthropogenic features between RM 46.25 and 45.50 (map scale 1:6,500).

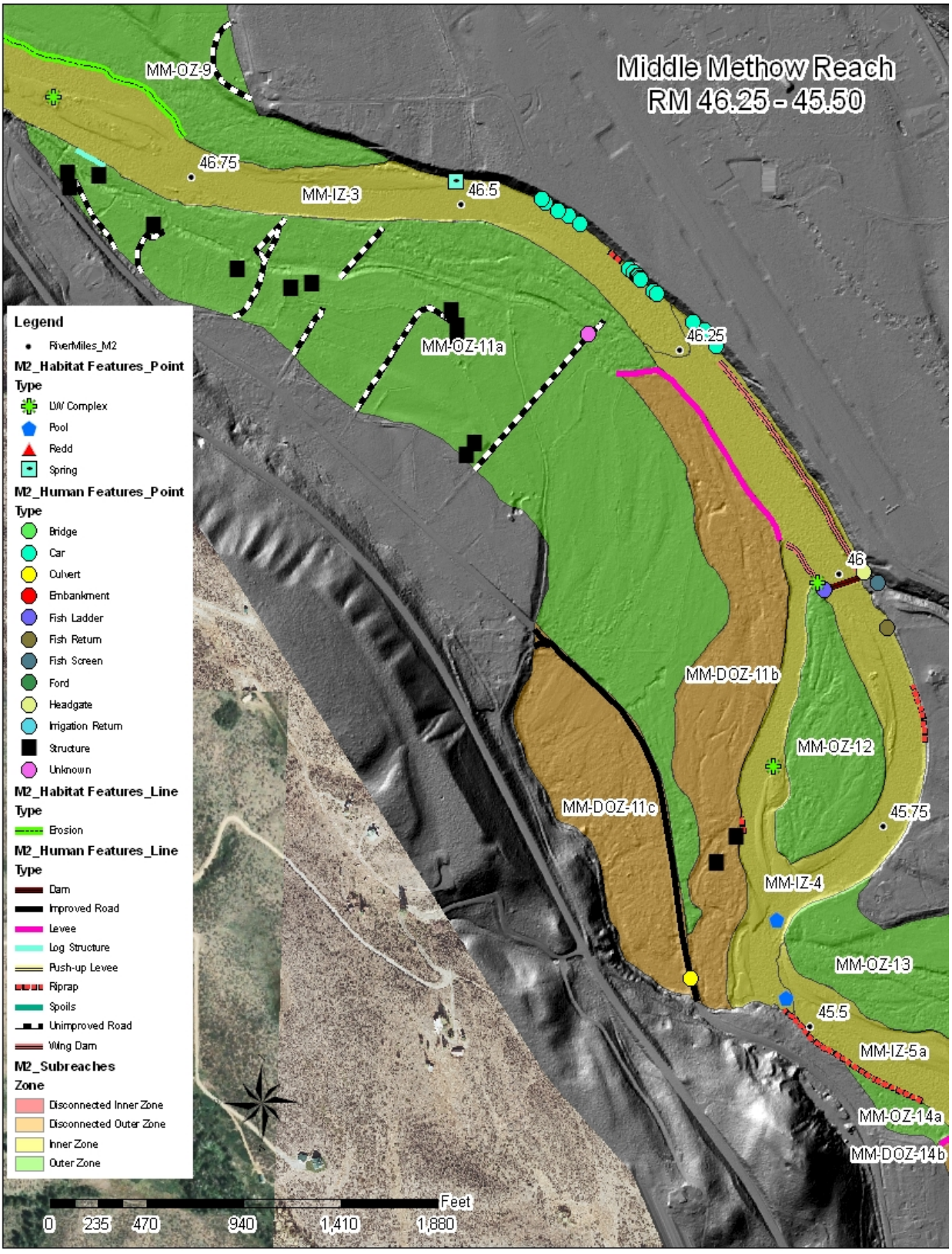

Figure 34. Hillshade elevation model showing the locations of subreaches and existing natural and anthropogenic features between RM 46.25 and 45.50 (map scale 1:6,500).

Table 29. Summary table of subreaches from RM 46.25 to 45.50, anthropogenic impacts and potential habitat action classes.

Parcel	River Mile (RM)	Acreage	Anthropogenic Features	Habitat Action Classes
MM-IZ-4 SUBREACH				
MM-IZ-4 (inner zone)	RM 46.25 – 45.50	26 acres	MVID east diversion dam (note: dam was mostly removed in 2008, new intake structure was constructed and the intake canal was piped in 2009). Levee (~980 ft) Push-up levee (~230 ft) Riprap (~370 ft) Cars (3) and debris	Reconnect processes Reconnect isolated habitat units
MM-OZ-11 SUBREACH COMPLEX				
MM-OZ-11a (outer zone)	RM 46.90 – 45.50 (river right)	72 acres	Structures (12) Unimproved roads (~3,760 ft) Crossing (1)	Protect and maintain current habitat Reconnect processes Reconnect isolated habitat units
MM-DOZ-11b (disconnected outer zone)	RM 46.25 – 45.50 (river right)	20 acres	Levee (~1,220 ft)	Protect and maintain current habitat Reconnect processes Reconnect isolated habitat units
MM-DOZ-11c (disconnected outer zone)	RM 46.00 – 45.50 (river right)	16 acres	Improved road (~2,110 ft)	Protect and maintain current habitat Reconnect isolated habitat Reconnect processes
MM-OZ-12 SUBREACH				
MM-OZ-12 (outer zone)	RM 46.00 - 45.65 (island))	10 acres	Fish ladder (1)	Protect and maintain current habitat Reconnect processes Reconnect isolated habitat units

Potential Implementation Actions

The objective for implementing the proposed actions between RM 46.25 and 45.50 are as follows (refer to Figure 35 and Figure 36):

1. Protecting the fragmented tracts of riparian vegetation, and reconnecting these tracts by rehabilitating the cleared areas between them. These actions would provide a long-term cumulative benefit to both the physical and ecological processes.

2. Protecting and potentially enhancing the beaver activity and population at Plummer side channel (SC_45.60_R).

3. Improve connectivity between the Plummer side channel (SC_45.60_R) and the Methow River (currently there is a small, elevated culvert through road embankment) will not only provide additional habitat to aquatic species, but also creates an avenue for beavers and the transfer of energy that helps drive food web productivity.

4. Reconnecting floodplain processes by implementing the following actions: (1) remove or modify levee and road embankment that disconnect the floodplain processes, (2) remove or modify remaining unimproved roads to improve conveyance of flood waters, (3) remove riprap that restricts lateral channel migration, and (4) strategically place large wood "key" members on bars and large wood at the head of overflow channels to contribute to the creation of side channels.

5. Connect habitat units by implementing the following actions: (1) using appropriate methods to stabilize banks and re-establish appropriate vegetation, (2) increasing channel boundary roughness and habitat complexity, and (3) strategically placing large wood to improve fish cover, habitat complexity, and biomass along and within side channels and alcoves.

Only the actions that have been identified through field observations and local input from the MRC are described. Many other potential actions could be implemented as described in the *Recovery Plan* or that are identified during an alternatives evaluation.

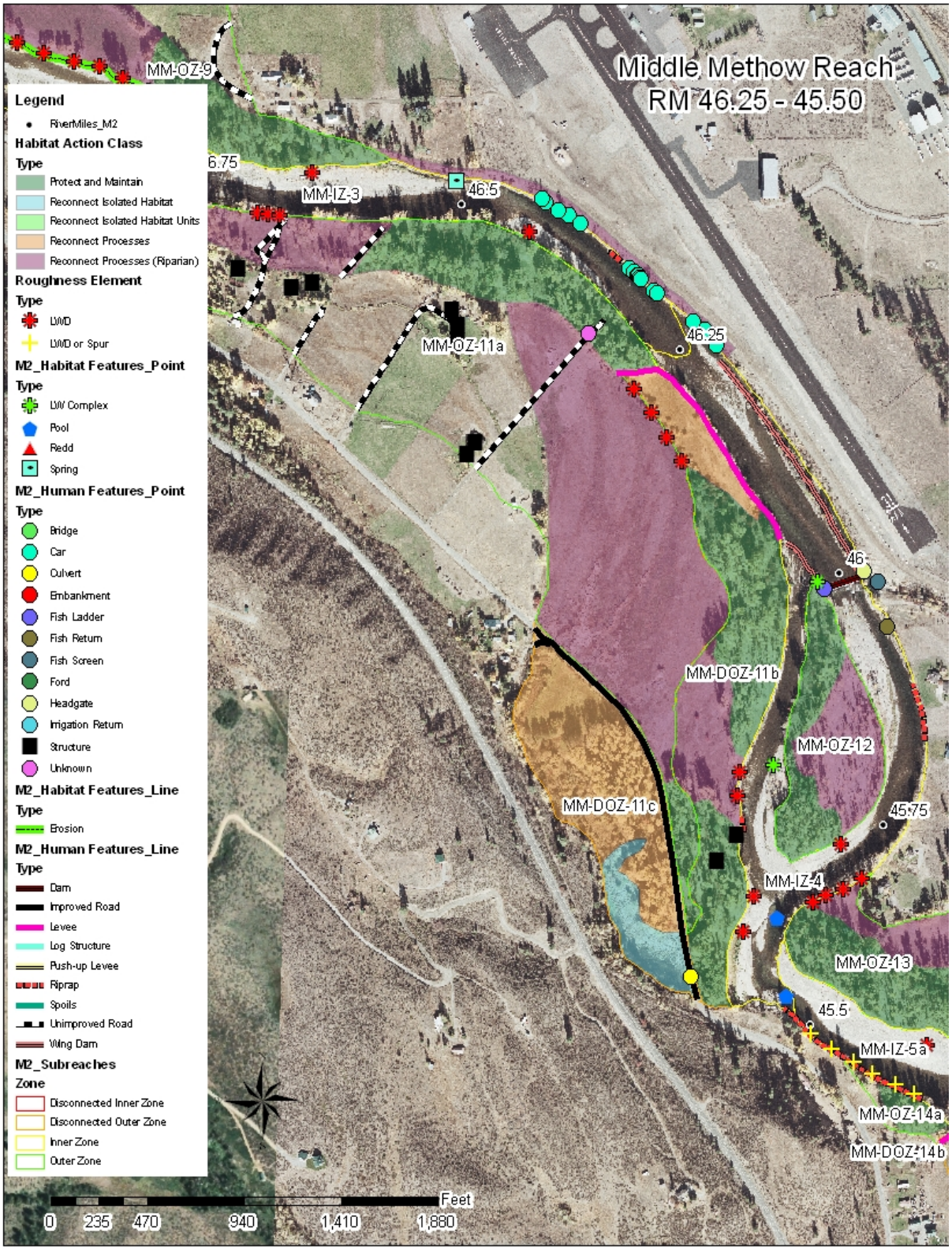

Figure 35. Aerial photograph showing the locations of subreaches, potential implementation actions, and existing natural and anthropogenic features between RM 46.25 and 45.50 (map scale 1:6,500).

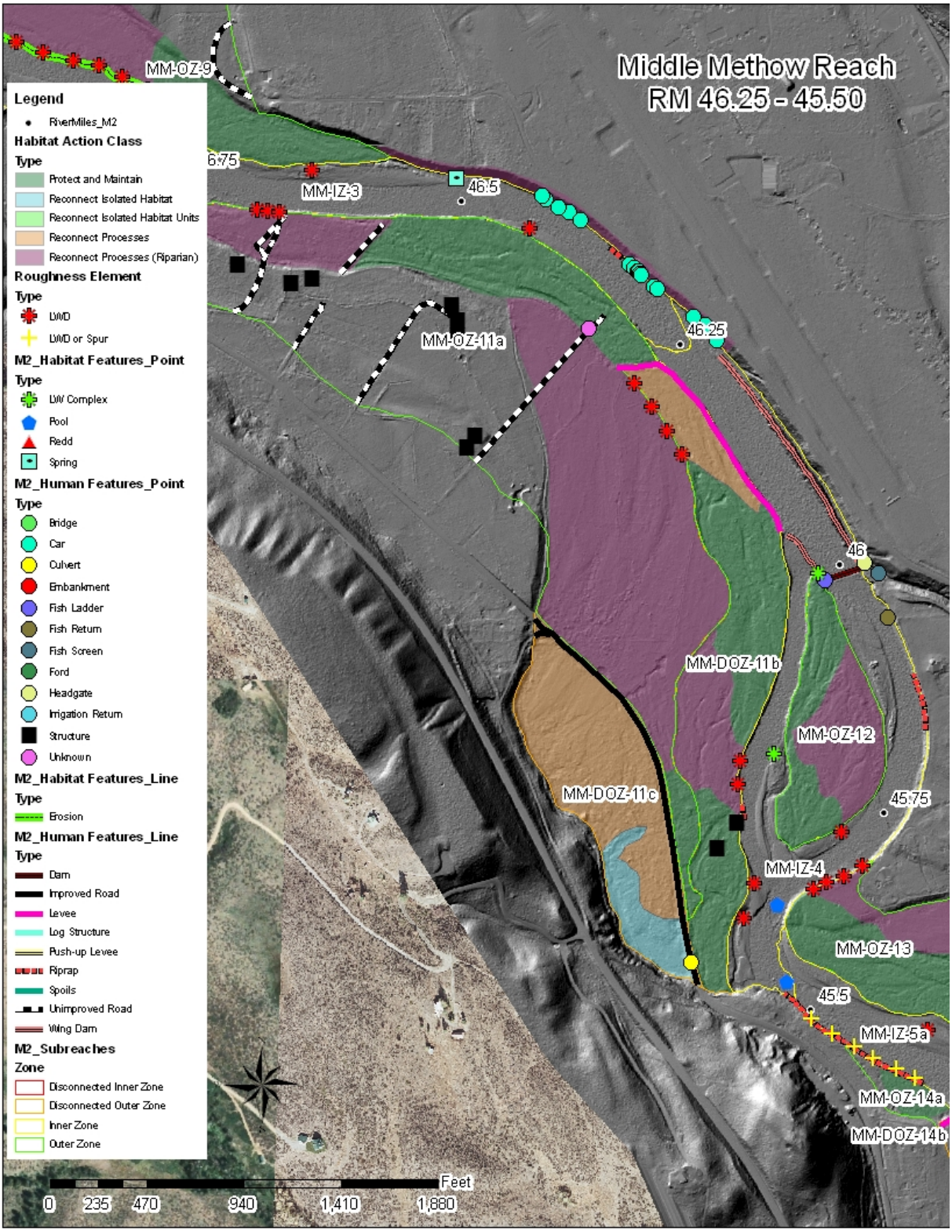

Figure 36. Hillshade elevation model showing locations of subreaches, potential implementation actions, and existing natural and anthropogenic features between RM 46.25 and 45.50 (map scale 1:6,500).

MM-IZ-4 (Inner Zone)

Inner zone MM-IZ-4 is located between RM 46.25 and 45.50, and covers about 26 acres of the active channel. The channel is transitioning as it actively adjusts to the removal of the MVID's east diversion dam in 2008 (Figure 37) and due to artificial confinement by riprap and a levee that restricts channel migration, affects hydraulics, and sediment transport. In addition to salmonid use, Pacific lampreys are using this area for rearing.

The O'Banion levee near RM 46.25 on river right is about 980 feet long and disconnects the floodplain. There is about 370 linear feet of riprap, three cars, and other debris that are restricting lateral channel migration.

There are four side channels in the subreach. A summary of the side channels is provided in Table 30. McNae side channel (SC_46.04_R) has remnants of a push-up levee about 230 feet long at its head that inhibits flows. Another side channel is the MVID intake ditch that has since been piped in 2009. The potential actions for this subreach are described in Table 31.

Figure 37. View is to the west looking across at the Methow Valley Irrigation District's east canal diversion dam that was mostly removed in 2008 near RM 46.0. Methow Subbasin, Washington – Bureau of Reclamation photograph by E. Lyon, October 4, 2008.

Table 30. Sumary of side Channels within MM-IZ-4.

Side Channel Identifier	Total Acres	Side Channel Type	Cold Water Source	Wetted
SC_46.25_L (MVID East intake)	0.70	Artificial	No	Perennial
SC_46.04_R (McNae side channel)	3.51	Floodplain	No	Perennial
SC_45.75_R	0.40	Gravel Bar	No	Ephemeral
SC_45.59_R	0.26	Gravel Bar	No	Ephemeral

Table 31. Potential actions for MM-IZ-4.

Option	Habitat Action Class	Potential Actions	Reach-scale Rehabilitation Response Potential
1	Reconnect isolated habitat	Complete modifications to MVID east diversion dam and appurtenances that provide fish passage and elimanates entrainment. (Note: modifications completed in late 2008 and 2009).	High
2	Reconnect processes	Plant appropriate vegetation and protect riparian buffer zone (minimum of 30 meters recommended in *Monitoring Strategy*) to provide channel boundary roughness, bank stability, and terrestrial habitat connectivity. Wood placements may be necessary to provide bank stability until vegetation matures. If wood placements are used, the placements should provide additional habitat complexity and connectivity. Ungulate exclusion may be necessary in some areas. Place large wood “key” members on lateral bars to increase hydraulic and sediment transport variability, resulting in more natural or appropriate rates of bedform development, lateral channel migration and possible side channel development in order to alter hydraulic processes to provide diversity of flow regimes within the channel, creating improved migration and resting conditions for fish. Explore modifying the push-up levee at the head of McNae side channel (SC_46.04_R) to allow increased flows and strategically place wood to enhance habitat complexity, fish cover, and biomass. Remove riprap, where appropriate, to allow lateral channel migration, or modify with roughness elements to reduce stream powerl.	High
3	Reconnect isolated habitat units	Consider placing appropriate roughness elements (such as boulders,large wood, bioengineering treatments, etc.) along lateral bars in lower energy channel segments to provide resting areas and channel complexity.	Low

MM-OZ-11 Subreach Complex (Outer Zone)

MM-OZ-11 Subreach Complex includes three parcels (MM-OZ-11a, MM-DOZ-11b, and MM-DOZ-11c) due to different complex anthropogenic impacts. The alternative evaluation process should be completed in the context of the entire subreach. Potential actions described for parcel MM-DOZ-11b should be the priority followed by MM-DOZ-11c and MM-OZ-11a based on reach-scale relative response potential.

MM-OZ-11a

Outer zone MM-OZ-11a is located between about RM 46.90 and 45.50 on river right, and covers about 72 acres of floodplain. Past riparian vegetation clearing occurred primarily for agriculture development. There are about 3,760 linear feet of unimproved roads and one overflow channel crossing that do not significantly disrupt floodplain processes. Twelve structures exist that inhibit short-term potential actions. The potential actions for this parcel are described in Table 32.

Table 32. Potential actions for MM-OZ-11a.

Option	Habitat Action Class	Potential Actions	Reach-scale Rehabilitation Response Potential
1	Protect and maintain current habitat	Protect and enhance riparian vegetation to provide floodplain roughness, bank stability, and terrestrial habitat connectivity. Wood placements may be necessary to provide bank stability until vegetation matures in some areas. If wood placements are used, the placements should provide additional habitat complexity and connectivity. Ungulate exclusion may be necessary in some areas.	Very High
2	Reconnect processes	Enhance riparian vegetation to provide floodplain roughness, bank stability, and terrestrial habitat connectivity. Wood placements may be necessary to provide bank stability until vegetation matures in some areas. If wood placements are used, the placements should provide additional habitat complexity and connectivity. Ungulate exclusion may be necessary in some areas. Allow lateral channel migration where appropriate to improve physical processes.	High
3	Reconnect isolated habitat units	Wood placements where riparian vegetation has been removed would provide channel boundary roughness, bank stability, contribute to side channel creation, and increase habitat complexity. This action should be considered in conjunction with re-establishing a riparian buffer zone.	Moderate

MM-DOZ-11b

Disconnected outer zone MM-DOZ-11b is located between RM 46.25 and 45.50 on river right, and covers about 20 acres of floodplain and the lower section of Plummer side channel (SC_45.60_R). A levee, about 1,210 linear feet, disconnects the floodplain and restricts lateral channel migration. Active bank erosion is occurring along the McNae side channel (SC_46.04_R) and there is a small amount of riprap protecting two structures. The structures are partially protected mainstem floods by the levee, but remain at risk from side channel flood flows and lateral channel migration. Past riparian vegetation clearing has occurred primarily for agriculture development. The potential actions for this parcel are described in Table 33.

Table 33. Potential actions for MM-DOZ-11b.

Option	Habitat Action Class	Potential Actions	Reach-scale Rehabilitation Response Potential
1	Protect and maintain current habitat	Protect and enhance riparian vegetation to provide floodplain roughness, bank stability, and terrestrial habitat connectivity. Wood placements may be necessary to provide bank stability until vegetation matures in some areas. If wood placements are used, the placements should provide additional habitat complexity and connectivity. Ungulate exclusion may be necessary in some areas.	Very High
2	Reconnect processes	Reconnect and enhance floodplain connectivity. An alternatives evaluation should be conducted to identify appropriate locations for removing or breaching the levee to re-establish floodplain connectivity. The evaluation should consider the need to protect the MVID diversion and private property. In addition, explore enhancing floodplain connectivity by mechanically modifying disconnected overflow channels. Enhance riparian vegetation to provide floodplain roughness, bank stability, and terrestrial habitat connectivity. Wood placements may be necessary to provide bank stability until vegetation matures in some areas. If wood placements are used, the placements should provide additional habitat complexity and connectivity. Ungulate exclusion may be necessary in some areas.	High
3	Reconnect isolated habitat units	Wood placements where riparian vegetation has been removed would provide channel boundary roughness, bank stability, contribute to side channel creation, and increase habitat complexity. This action should be considered in conjunction with re-establishing a riparian buffer zone.	Low

MM-DOZ-11c

Disconnected outer zone MM-DOZ-11c is located between RM 46.00 and 45.50 on river right, and covers about 16 acres of floodplain and most of Plummer side channel (SC_45.60_R) (Table 34). About 2,110 linear feet of improved road embankment disconnects the floodplain and isolates potential off-channel habitat (Plummer side channel). Beavers activity is occurring in the Plummer side channel area. The potential actions for this parcel are described in Table 35.

Table 34. Summary of side channel within MM-DOZ-11c.

Side Channel Identifier	Total Acres	Side Channel Type	Cold Water Source	Wetted
SC_45.60_R (Plummer side channel)	1.15	Floodplain	No	Perennial

Table 35. Potential actions for MM-DOZ-11c.

Option	Habitat Action Class	Potential Actions	Reach-scale Rehabilitation Response Potential
1	Protect and maintain current habitat	Protect and enhance riparian vegetation to provide floodplain roughness, bank stability, and terrestrial habitat connectivity. Wood placements may be necessary to provide bank stability until vegetation matures in some areas. If wood placements are used, the placements should provide additional habitat complexity and connectivity. Ungulate exclusion may be necessary in some areas. Protect and enhance beaver habitat in the Plummer side channel area (SC_45.60_R). Explore improving the connection between the Plummer side channel and Methow River that will improve both aquatic and terrestrial connectivity.	Maintain/High
2	Reconnect processes	Complete an alternatives evaluation that should explore if the improved road can be removed, relocated or modified to improve connectivity between the Plummer side channel and Methow River, and allow lateral channel migration.	High

MM-OZ-12 (Outer Zone)

Subreach MM-OZ-12 is an island (McNae Island) located between RM 46.00 and 45.65, and covers about 10 acre of floodplain. There is an abandoned fish ladder and riprap at the head of the island that could be acting as "key" members and maintaining the wood complex at head of island. The island is in a very dynamic location along the river where the MVID east diversion dam has been removed and the river is actively adjusting to the channel modification. Riparian vegetation on the island is patchy due to natural flood disturbances. The potential actions for this subreach are described in Table 36.

Table 36. Potential actions for MM-OZ-12.

Option	Habitat Action Class	Potential Actions	Reach-scale Rehabilitation Response Potential
1	Protect and maintain current habitat	Protect and enhance riparian vegetation to provide floodplain roughness, bank stability, and terrestrial habitat connectivity. Wood placements may be necessary to provide bank stability until vegetation matures in some areas. If wood placements are used, the placements should provide additional habitat complexity and connectivity. Ungulate exclusion may be necessary in some areas.	Maintain/High
2	Reconnect processes	Enhance riparian vegetation to provide floodplain roughness, bank stability, and terrestrial habitat connectivity. Wood placements may be necessary to provide bank stability until vegetation matures in some areas. If wood placements are used, the placements should provide additional habitat complexity and connectivity. Ungulate exclusion may be necessary in some areas.	High

Channel Segment RM 45.50 – 44.15

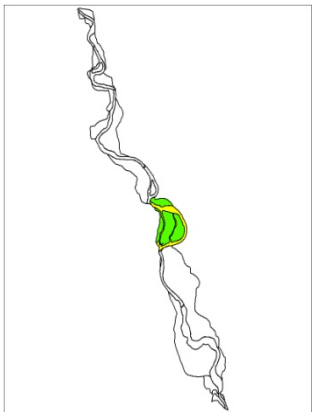

Figure 38. Location of channel segment RM 45.50 - 44.15 within the reach.

Characteristics

Between RM 45.50 and 44.15 (Figure 38), the channel may be transitioning due to artificial confinement that restricts lateral channel migration, hydraulics, and sediment transport (Figure 39 and Figure 40). Average channel slope is about 0.38 percent based on 2008 thalweg profile data (Reclamation 2010) with an average bankfull width of about 200 feet as measured from the 2006 LiDAR hillshade elevation model, and predominant channel units are runs and riffles with gravel and cobbles substrate.

Levees, riprap, and roads reduce floodplain connectivity, restrict lateral channel migration, affect hydraulics, and sediment transport. Past riparian vegetation clearing was primarily for agriculture development, but now some of these areas have residential structures. There is one cold water source to the Methow River along the Habermehl side channel (SC_45.10_R). The geomorphic potential has been primarily affected by the disconnection of floodplains and side channels, restricted lateral channel migration, and riparian vegetation clearing that degrade the physical and ecological processes. An overview of the potential habitat action classes are listed in Table 37. Specific actions for each subreach are addressed in the following sections.

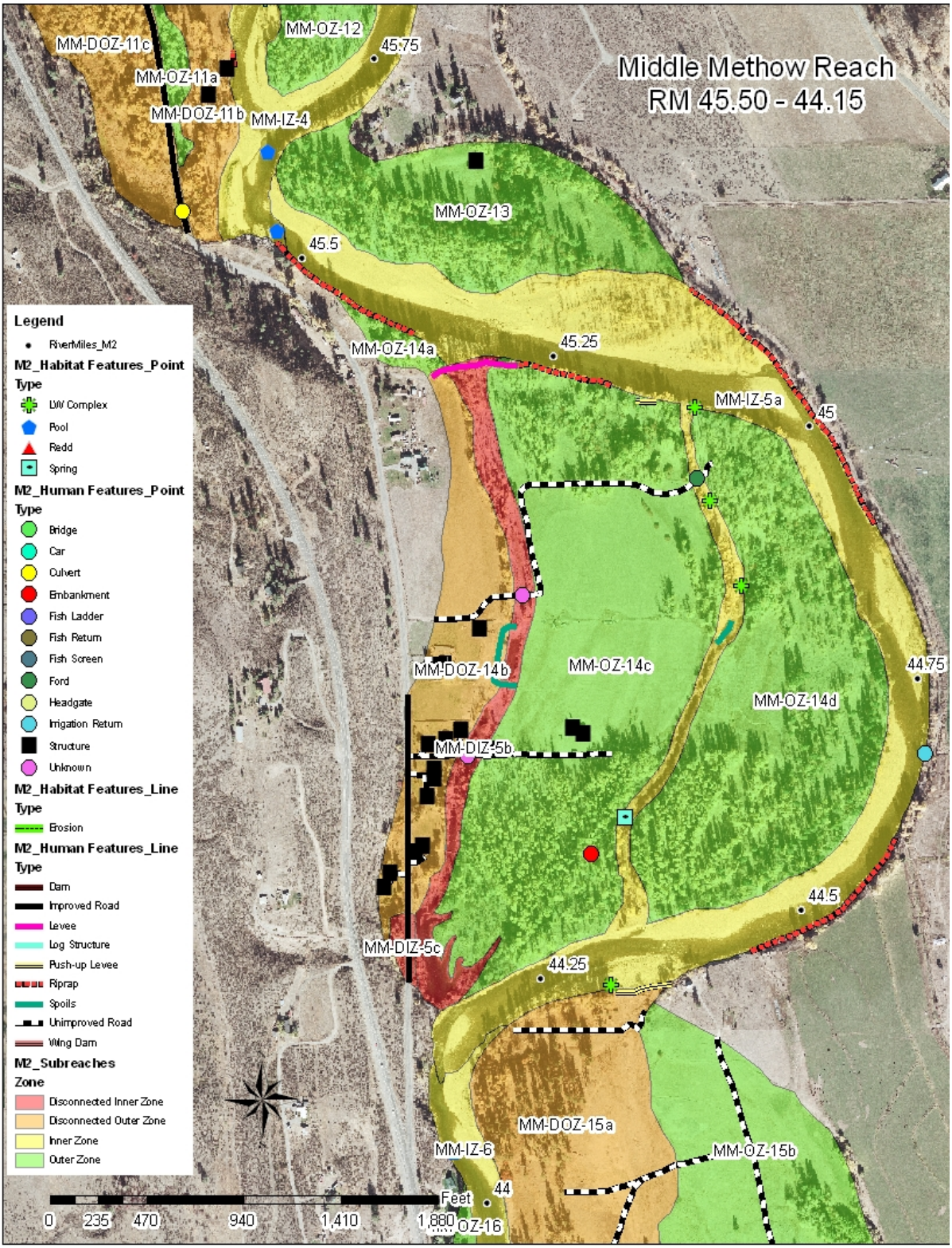

Figure 39. Aerial photograph showing the locations of subreaches and existing natural and anthropogenic features between RM 45.50 and 44.15 (map scale 1:6,500).

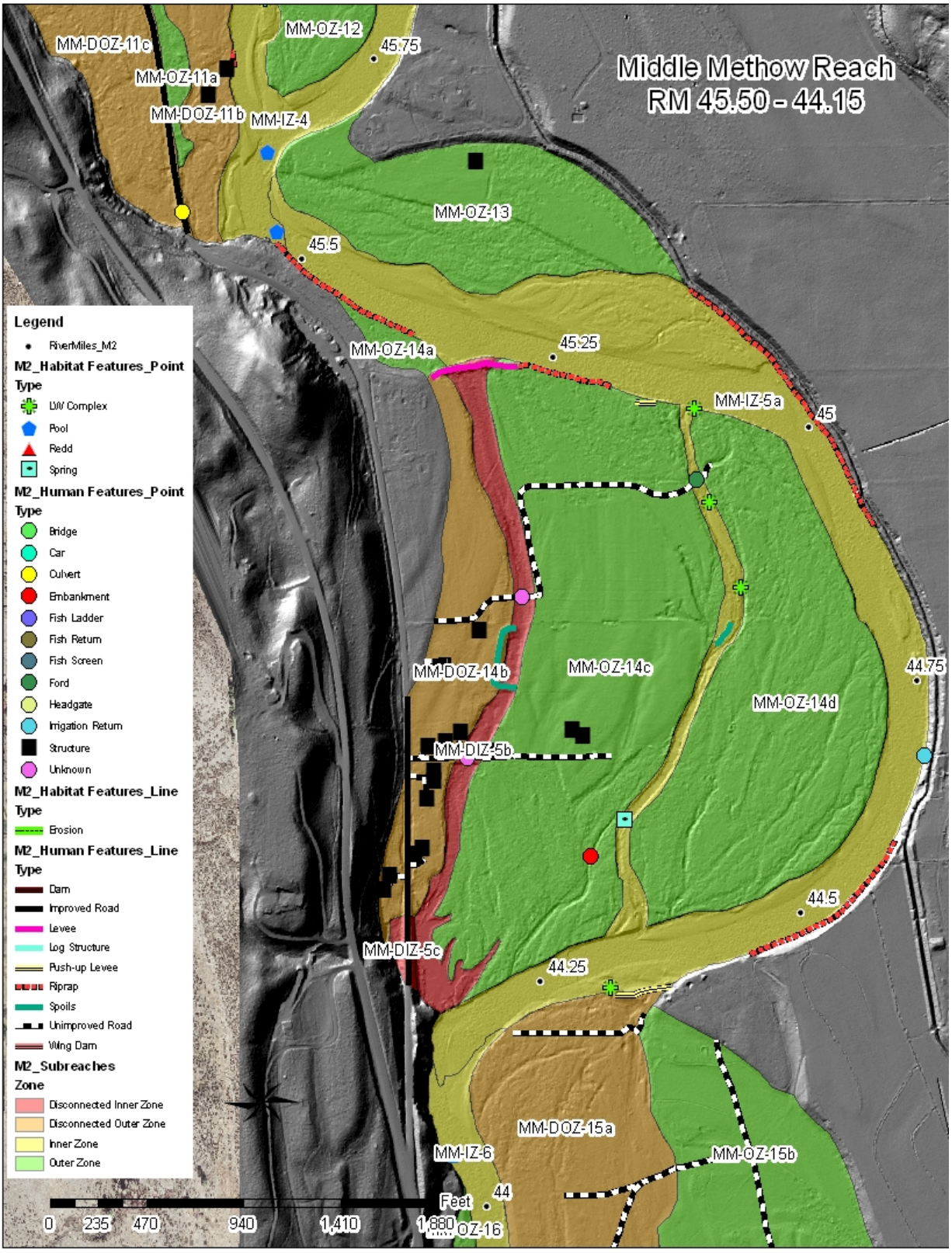

Figure 40. Hillshade elevation model showing the locations of subreaches and existing natural and anthropogenic features between RM 45.50 and 44.15 (map scale 1:6,500).

Table 37. Summary table of subreaches from RM 45.50 to 44.15, anthropogenic impacts and potential habitat action classes.

Parcel	River Mile (RM)	Acreage	Anthropogenic Features	Habitat Action Classes
MM-IZ-5 SUBREACH COMPLEX				
MM-IZ-5a (inner zone)	RM 45.50 - 44.15	52 acres	Riprap (~3,120 ft)	Reconnect processes Reconnect isolated habitat units
MM-DIZ-5b (disconnected inner zone)	RM 45.30 – 44.15 (river right)	8 acres	Levee (~440 ft) Unimproved road (~230 ft) Culvert ? (2) Spoils (~110 ft)	Reconnect isolated habitat Reconnect processes Reconnect isolated habitat
MM-DIZ-5c (disconnected inner zone)	RM 44.30 - 44.20 (river right)	1 acre	Improved road (~330 ft)	Reconnect processes
MM-OZ-13 SUBREACH				
MM-OZ-13 (outer zone)	RM 45.70 – 45.15 (river right)	22 acres	Structure (1)	Protect and maintain current habitat Reconnect processes Reconnect isolated habitat units
MM-OZ-14 SUBREACH COMPLEX				
MM-OZ-14a (outer zone)	RM 45.45 - 45.35 (river right)	2 acres	Riprap (~460 ft)	Reconnect processes Reconnect isolated habitat units
MM-DOZ-14b (disconnected outer zone)	RM 45.35 - 44.25 (river right)	16 acres	Structures (12) Levee (~65 ft) Unimproved roads (~1,330 ft) Improved roads (~1,040 ft) Spoils (~320 ft)	Reconnect processes Reconnect isolated habitat units

Parcel	River Mile (RM)	Acreage	Anthropogenic Features	Habitat Action Classes
MM-OZ-14c (outer zone)	RM 45.30 - 44.20 (river right)	55 acres	Floodplain development (agriculture & residential) Structures (2) Unimproved roads (~2020 ft) Embankment (1)	Protect and maintain current habitat Reconnect processes Reconnect isolated habitat units
MM-OZ-14d (outer zone)	RM 45.10 – 44.35 (river right)	39 acres	Floodplain development (recreational)	Protect and maintain current habitat Reconnect processes Reconnect isolated habitat units

Potential Implementation Actions

The objectives for implementing the proposed actions between RM 45.50 and 44.15 are as follows (refer to Figure 41 and Figure 42):

1. Protecting the fragmented tracts of riparian vegetation and reconnecting these tracts by rehabilitating the cleared areas between them. These actions would provide a long-term cumulative benefit to both the physical and ecological processes.
2. Protecting current beaver activity and population and enhancing areas that provide suitable habitat for beaver colonization.
3. Protecting and enhancing the Habermehl side channel (SC_45.10_R), a cold water source to the Methow River.
4. Reconnecting and enhancing disconnected floodplains and side channels to provide additional habitat, and improve floodplain processes that helps drive food web productivity.
5. Allow lateral channel migration by removing bank protection, or modifying bank protection to increase channel boundary roughness to retain sediment and potentially elevate the channel bed to improve floodplain connectivity. Strategically place large wood "key" members on bars and large wood at the head of overflow channels that contribute to side channel formation.
6. Connecting habitat units by implementing the following actions: (1) using appropriate methods to stabilize banks and re-establish appropriate vegetation, (2) increasing channel boundary roughness and habitat complexity, and (3) strategically placing large wood to improve fish cover, habitat complexity, and biomass in side channels and alcoves.

Only the actions that have been identified through field observations and local input from the MRC are described. Many other potential actions could be implemented as described in the *Recovery Plan* or that are identified during an alternatives evaluation.

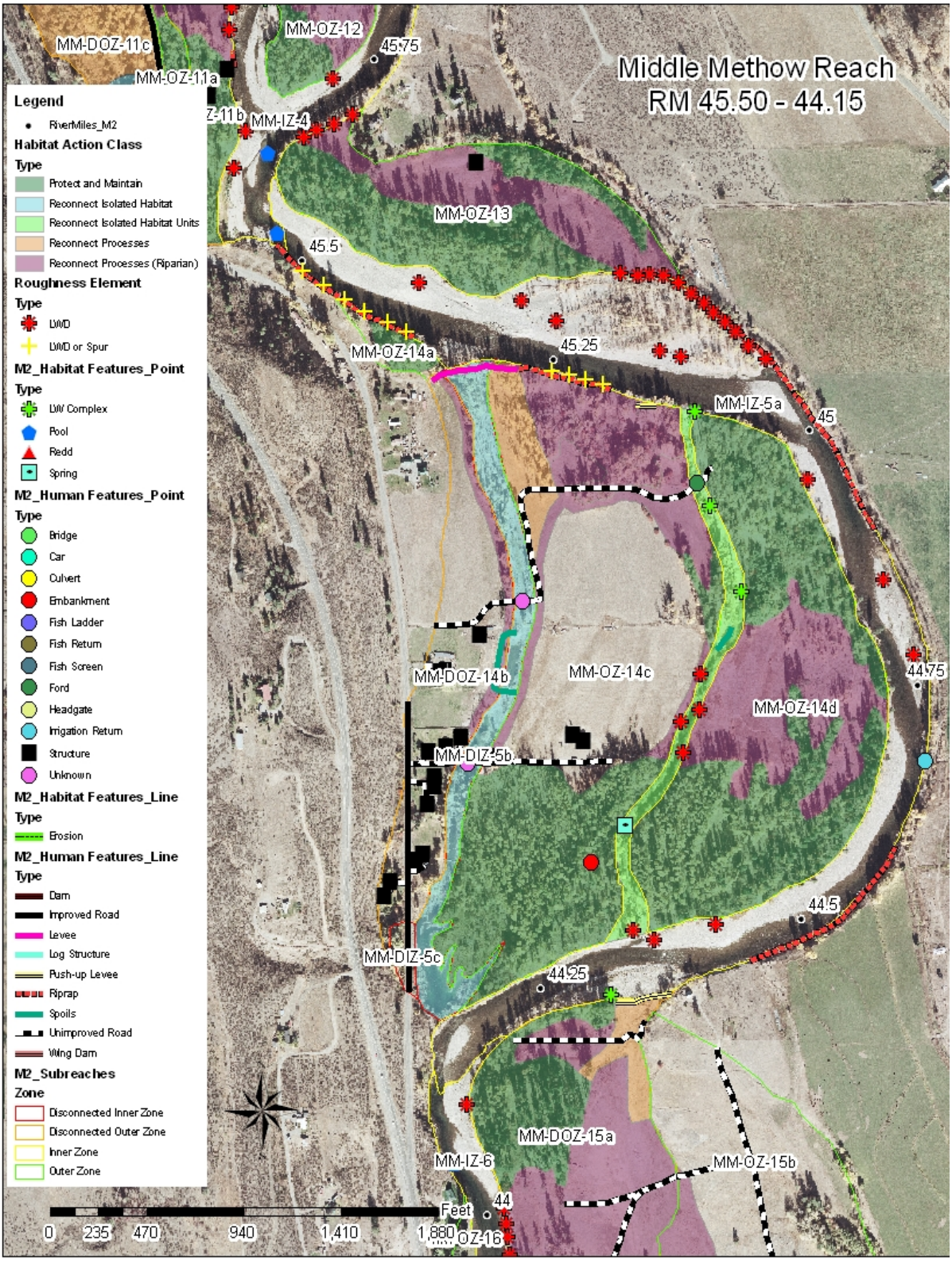

Figure 41. Aerial photograph showing the locations of subreaches, potential implementation actions, and existing natural and anthropogenic features between RM 45.50 and 44.15 (map scale 1:6,500).

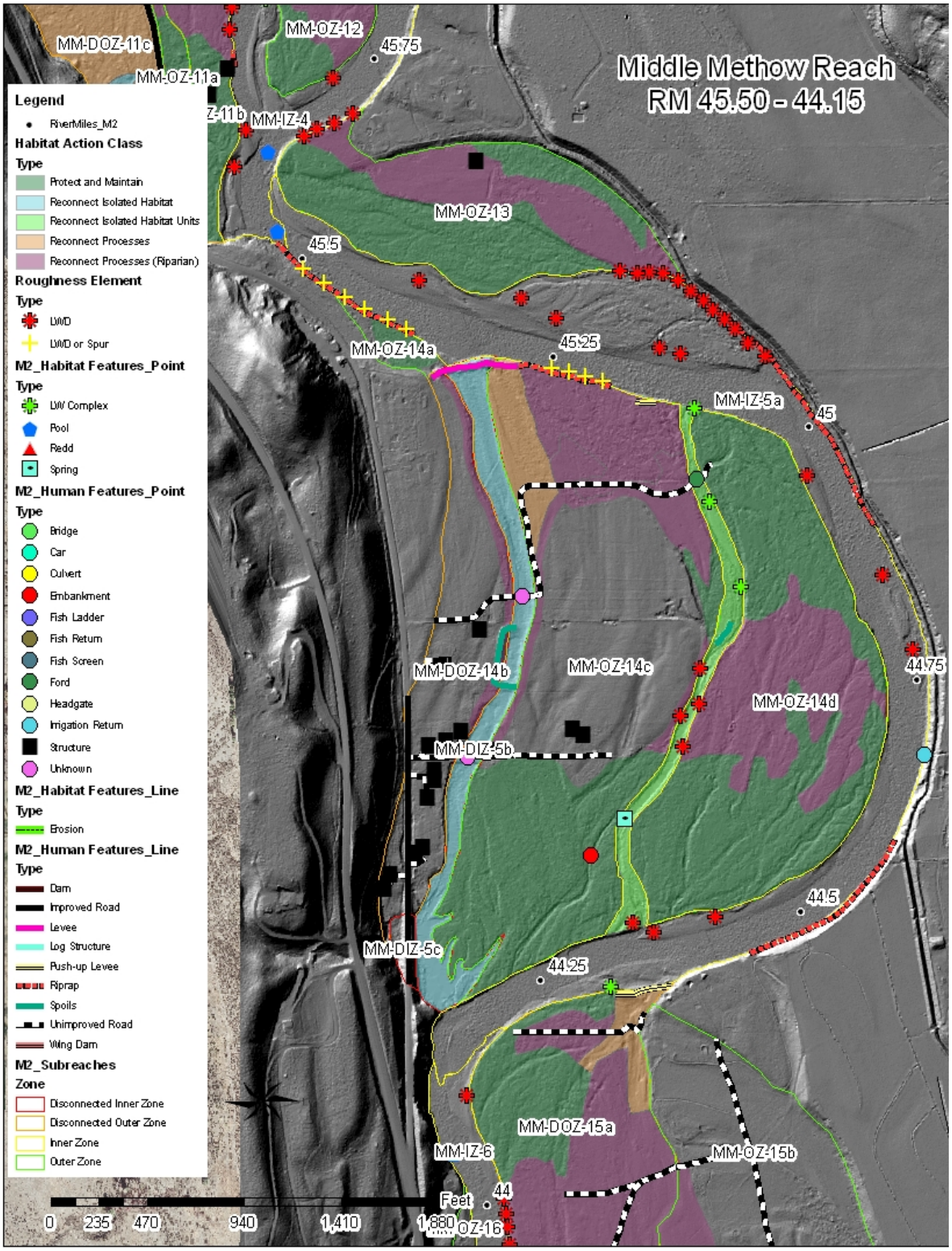

Figure 42. Hillshade elevation model showing the locations of subreaches, potential implementation actions, and existing natural and anthropogenic features between RM 45.50 and 44.15 (map scale 1:6,500).

MM-IZ-5 Subreach Complex (Inner Zone)

MM-IZ-5 Subreach Complex is located between RM 45.50 and 44.10, and covers about 61 acres. The subreach has been divided into three parcels (MM-IZ-5a, MM-DIZ-5b, and MM-DIZ-5c) based on complex anthropogenic impacts. The alternative evaluation process should be completed in the context of the entire subreach. Potential actions described for parcel MM-IZ-5a should be the priority followed by MM-DIZ-11b and MM-DIZ-5c based on reach-scale relative response potential.

MM-IZ-5a

Inner zone MM-IZ-5a is located between RM 45.50 and 44.10, and covers about 52 acres of active channel and side channels. The channel may be transitioning due to artificial confinement by a levee and riprap that disconnects floodplain processes, restricts lateral channel migration, affects hydraulics, and sediment transport (Figure 43).

There is about 4,000 linear feet of riprap bank protection that provides lateral channel stability and may be causing vertical channel instability resulting in localized scour and incision. Areas where the channel may be vertically unstable and sediment transport capacity has increased could be in the process abandoning their floodplain. Hydraulic modeling suggests much of the floodplain does not get activated until about a 10-year flood (Reclamation 2010).

There are three side channels in the parcel, but only the Habermehl side channel (SC_45.10_R) (Figure 44) is a cold water source to the Methow River. The side channels are summarized in Table 38. The potential actions for this parcel are described in Table 39.

Figure 43. View is to the southeast looking downstream from a bedrock outcrop at a lateral scour pool and riprap placed along river right near RM 45.5. Methow Subbasin, Washington – Bureau of Reclamation photograph by E. Lyon, October 6, 2008.

Figure 44. View is to the south looking downstream along Habermehl side channel (SC_45.10_R) where groundwater maintains the flow in the lower section near RM 44.7. Methow Subbasin, Washington - Bureau of Reclamation photograph by E. Lyon, October 6, 2008.

Table 38. Summary of side channels within MM-IZ-5a.

Side Channel Identifier	Total Acres	Side Channel Type	Cold Water Source	Wetted
SC_45.30_L	1.24	Floodplain	No	Ephemeral
SC_45.10_R (Habermehl side channel)	4.74	Floodplain	Yes	Ephemeral
SC_44.90_L	0.55	Gravel Bar	No	Perennial

Table 39. Potential actions for MM-IZ-5a.

Option	Habitat Action Class	Potential Actions	Reach-scale Rehabilitation Response Potential
1	Protect and maintain current habitat	Protect and enhance riparian buffer zone (minimum of 30 meters recommended in *Monitoring Strategy*) to provide channel boundary roughness, bank stability, and terrestrial habitat connectivity. Wood placements may be necessary to provide bank stability until vegetation matures. If wood placements are used, the placements should provide additional habitat complexity and connectivity. Ungulate exclusion may be necessary in some areas. Protect and enhance the Habermehl side channel (SC_45.10_R) that is a cold water source to the river. Plant appropriate vegetation to provide shading and improve terrestrial habitat connectivity. Strategically place wood to maintain or improve side channel development and provide complexity, cover, and increase biomass. During the alternatives evalulation, explore mechanically enhancing the side channel and constructing an alcove at downstream end.	Maintain/High

Option	Habitat Action Class	Potential Actions	Reach-scale Rehabilitation Response Potential
2	Reconnect processes	Place large wood "key" members on lateral bars to increase hydraulic and sediment transport variability, resulting in more natural or appropriate rates of bedform development, lateral channel migration and possible side channel development in order to alter hydraulic processes to provide diversity of flow regimes within the channel, creating improved migration and resting conditions for fish. Remove riprap, where appropriate, to allow lateral channel migration, or modify with appriate roughness elements to reduce stream power.	High
3	Reconnect isolated habitat units	Consider placing appropriate roughness elements (such as boulders, large wood, bioengineering treatments, etc.) along lateral bars in lower energy channel segments to provide resting areas and channel complexity.	Low

MM-DIZ-5b

Disconnected inner zone MM-DIZ-5b is located between RM 45.30 and 44.15 on river right, and covers about 8 acres. There is about 440 linear feet of levee at the upstream end that disconnects the side channel (SC_45.30_R) known as the Habermehl west side channel. The downstream end of the side channel remains connected to the river (Table 40). The wetlands in the downstream area are being utilized by juvenile spring Chinook salmon for rearing, and there has been some beaver activity. Much of the riparian buffer zone along the side channel has been cleared for agriculture and residential development. There are two road crossings with elevated culverts placed through the embankments. The potential actions for this parcel are described in Table 41.

Table 40. Summary of side channel within MM-DIZ-5b.

Side Channel Identifier	Total Acres	Side Channel Type	Cold Water Source	Wetted
SC_45.30_R (Habermehl west side channel)	8.38	Floodplain	No	Perennial (downstream section)

Table 41. Potential actions for MM-DIZ-5b.

Option	Habitat Action Class	Potential Actions	Reach-scale Rehabilitation Response Potential
1	Reconnect processes	Remove or modify the levee at the head of the Habermehl west side channel (SC_45.30_R) to improve surface water connectivity. Alternatives evaluation should be conducted to identify appropriate measures that could be feasible to provide flow through the side channel, and the need to protect beaver activity and private property. Enhance the Habermehl west side channel (SC_45.30_R) by planting appropriate vegetation to provide shading and improve terrestrial habitat connectivity.	High

Option	Habitat Action Class	Potential Actions	Reach-scale Rehabilitation Response Potential
		Strategically place wood to maintain or improve side channel development and provide complexity, cover, and increase biomass. During the alternatives evalulation, explore mechanically enhancing the side channel and analyze how these actions would impact the current beaver population in the downstream section of the side channel.	
2	Reconnect isolated habitat units	The downstream end of the side channel remains connected to the river. Explore alternatives to increase the wetland area upstream, and improve habitat units throughout using wood placements.	High

MM-DIZ-5c

Disconnected inner zone MM-DIZ-5c is located between RM 44.30 and 44.20 on river right, and covers about 1 acre. There is about 300 linear feet of improved road that disconnects a historic channel path from the river. Potential actions for the area are most likely cost prohibitive with limited biological benefit. As such, a potential action for this parcel is described in Table 42.

Table 42. Potential action for MM-DIZ-5c.

Option	Habitat Action Class	Potential Actions	Reach-scale Rehabilitation Response Potential
1	Reconnect processes	Explore alternatives to remove or relocate improved road, or modifying road embankment with appropriate roughness elements to reduce stream power.	Low

MM-OZ-13 (Outer Zone)

Outer zone MM-OZ-13 is located between RM 45.70 and 45.15 on river left and covers about 22 acres of floodplain. There is one structure on a higher terrace that does not disrupt floodplain processes. Past riparian vegetation clearing has occurred primarily for agriculture development. Much of the riparian buffer zone is intact, but the floodplain has patches of vegetation. The potential actions for this subreach are described in Table 43.

Table 43. Potential actions for MM-OZ-13.

Option	Habitat Action Class	Potential Actions	Reach-scale Rehabilitation Response Potential
1	Protect and maintain current habitat	Protect and enhance riparian vegetation to provide floodplain roughness, bank stability, and terrestrial habitat connectivity. Wood placements may be necessary to provide bank stability until vegetation matures in some areas. If wood placements are used, the placements should provide additional habitat complexity and connectivity. Ungulate exclusion may be necessary in some areas.	Maintain/High

Option	Habitat Action Class	Potential Actions	Reach-scale Rehabilitation Response Potential
2	Reconnect processes	Enhance riparian vegetation to provide floodplain roughness, bank stability, and terrestrial habitat connectivity. Wood placements may be necessary to provide bank stability until vegetation matures in some areas. If wood placements are used, the placements should provide additional habitat complexity and connectivity. Ungulate exclusion may be necessary in some areas. Allow lateral channel migration, where appropriate, to improve physical processes. Alternatives evaluation should include anaylysis of the potential risk to structure.	High
3	Reconnect isolated habitat units	Wood placements where riparian vegetation has been removed would provide channel boundary roughness, bank stability, and increase aquatic habitat complexity. This action should be considered in conjunction with re-establishing a riparian buffer zone.	Moderate

MM-OZ-14 Subreach Complex (Outer Zone)

MM-OZ-14 Subreach Complex is located between RM 45.45 and 44.15 on river right, and covers about 73 acres. The subreach has been divided into four parcels (MM-OZ-14a, MM-DOZ-14b, MM-OZ-14c, and MM-OZ-14d) based on complex anthropogenic impacts. The alternative evaluation process should be completed in the context of the entire subreach. Potential actions described for parcel MM-OZ-14d should be the priority followed by MM-OZ-14c, MM-OZ-14a, and MM-DOZ-14b based on reach-scale relative response potential. Potential actions are described for each parcel in the following sections.

MM-OZ-14a (Outer Zone)

Outer zone MM-OZ-14a is located between RM 45.45 and 45.35 on river right, and covers about 2 acres of floodplain. There is about 460 linear feet of riprap that restricts lateral channel migration, affects hydraulics, and sediment transport. Bedrock outcrops along the river directly upstream and provides a lateral channel control which suggests the potential for lateral channel migration is be minimal. The riparian vegetation is mostly intact, but here are small cleared areas.. The potential action for this parcel is described in Table 44.

Table 44. Potential action for MM-OZ-14a.

Option	Habitat Action Class	Potential Action	Reach-scale Rehabilitation Response Potential
1	Protect and maintain current habitat	Protect and enhance riparian vegetation to provide floodplain roughness, bank stability, and terrestrial habitat connectivity.	Maintain/High
2	Reconnect processes	Remove riprap, where appropriate, to allow lateral channel migration or modify with appropriate roughness elements to reduce stream power.	Moderate

MM-DOZ-14b

Disconnected outer zone MM-DOZ-14b is located between RM 45.35 and 44.25 on river right, and covers about 16 acres of floodplain. There are twelve residential structures that currently limit the extent of potential actions. A levee (about 65 linear feet) provides protection for the structures from flood damage. About 2,370 linear feet of roads and about 320 linear feet of spoil piles disrupt floodplain connectivity. The potential actions for this parcel are described in Table 45.

Table 45. Potential actions for MM-DOZ-14b.

Option	Habitat Action Class	Potential Actions	Reach-scale Rehabilitation Response Potential
1	Protect and maintain current habitat	Protect and enhance riparian vegetation to provide floodplain roughness, bank stability, and terrestrial habitat connectivity. Ungulate exclusion may be necessary in some areas.	Maintain/High
2	Reconnect processes	Remove or modify the levee and riprap improve floodplain connectivity and allow lateral channel migration. Alternatives evaluation should be conducted to identify appropriate measures and the need to protect private property.	Moderate

MM-OZ-14c

Outer zone MM-OZ-14c is located between RM 45.30 and 44.20 on river right, and covers about 55 acres of the floodplain. There are two residential structures in the parcel that were constructed on a higher terrace that do not appear to have been inundated during the 1948 flood and do not disrupt floodplain connectivity. There is about 2,020 linear feet of unimproved roads that are not raised and do not disrupt floodplain connectivity. An embankment was constructed across a side channel (SC_44.35_R) that restricts flood flows and negatively impacts side channel evolution. Riprap was placed at the upstream end of the parcel that restricts lateral channel migration, affects hydraulics, and sediment transport. The potential actions for this parcel are described in Table 46.

Table 46. Potential actions for MM-OZ-14c.

Option	Habitat Action Class	Potential Actions	Reach-scale Rehabilitation Response Potential
1	Protect and maintain current habitat	Protect and enhance riparian vegetation to provide floodplain roughness, bank stability, and terrestrial habitat connectivity. Ungulate exclusion may be necessary in some areas.	Maintain/High

Option	Habitat Action Class	Potential Actions	Reach-scale Rehabilitation Response Potential
2	Reconnect processes	Allow lateral channel migration, where appropriate, to improve physical processes. Alternatives evaluation may need to be conducted to insure structures are protected. Enhance vegetation to provide floodplain roughness, bank stability, and terrestrial habitat connectivity. Ungulate exclusion may be necessary in some areas. Remove riprap, where appropriate, to allow lateral channel migration, or modify with appropriate roughness elements to reduce stream power. Remove embankment in side channel SC_44.35_R to improve side channel evolution.	High

MM-OZ-14d

Outer zone MM-OZ-14d is located between RM 45.10 and 44.35 on river right, and covers about 39 acres of the floodplain. There are no permanent structures that limit the extent of potential actions. Past riparian vegetation clearing occurred primarily for agriculture development. The riparian buffer zone is mostly intact. The potential actions for this parcel are described in Table 47.

Table 47. Potential actions for MM-OZ-14d.

Option	Habitat Action Class	Potential Actions	Reach-scale Rehabilitation Response Potential
1	Protect and maintain current habitat	Protect and enhance riparian vegetation to provide floodplain roughness, bank stability, and terrestrial habitat connectivity. Ungulate exclusion may be necessary in some areas.	Maintain/High
2	Reconnect processes	Allow lateral channel migration to improve physical processes. Enhance vegetation to provide floodplain roughness, bank stability, and terrestrial habitat connectivity. Ungulate exclusion may be necessary in some areas. Explore possible locations for large wood placements at the head of overflow channels that could contribute to side channel evolution.	High

Channel Segment RM 44.15 – 43.10

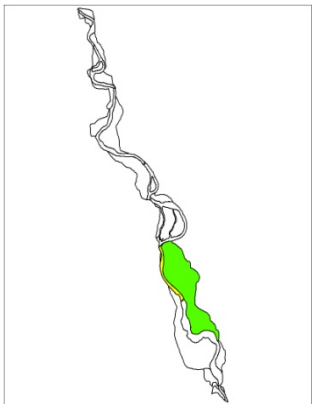

Figure 45. Location of channel segment RM 44.15 - 43.10 within the reach.

Characteristics

Between RM 44.15 and 43.10 (Figure 45), the channel is in transition because the river has been artificially confined by riprap (Figure 46 and Figure 47). Average channel slope is about 0.18 percent based on 2008 thalweg profile data (Reclamation 2010) with an average bankfull width of about 200 feet as measured from the 2006 LiDAR hillshade elevation model, and the predominant channel units are runs and riffles with cobbles and gravel substrate.

Bank protection placed along the east side of an improved road does not necessarily restrict lateral channel migration because bedrock is exposed in areas on the west side. However, the riprap does not affect hydraulics and sediment transport. There is a push-up levee that disconnects the floodplain. Past riparian vegetation clearing has occurred primarily for agriculture development, but some areas are not occupied by residential structures. The structures and associated roads disrupt floodplain connectivity in some locations.

The geomorphic potential has been primarily impacted by floodplain development, reduced floodplain connectivity, and clearing of riparian vegetation for development that degrade the physical and ecological processes. An overview of the potential habitat action classes are listed in Table 48. Specific actions for each subreach are addressed in the following sections.

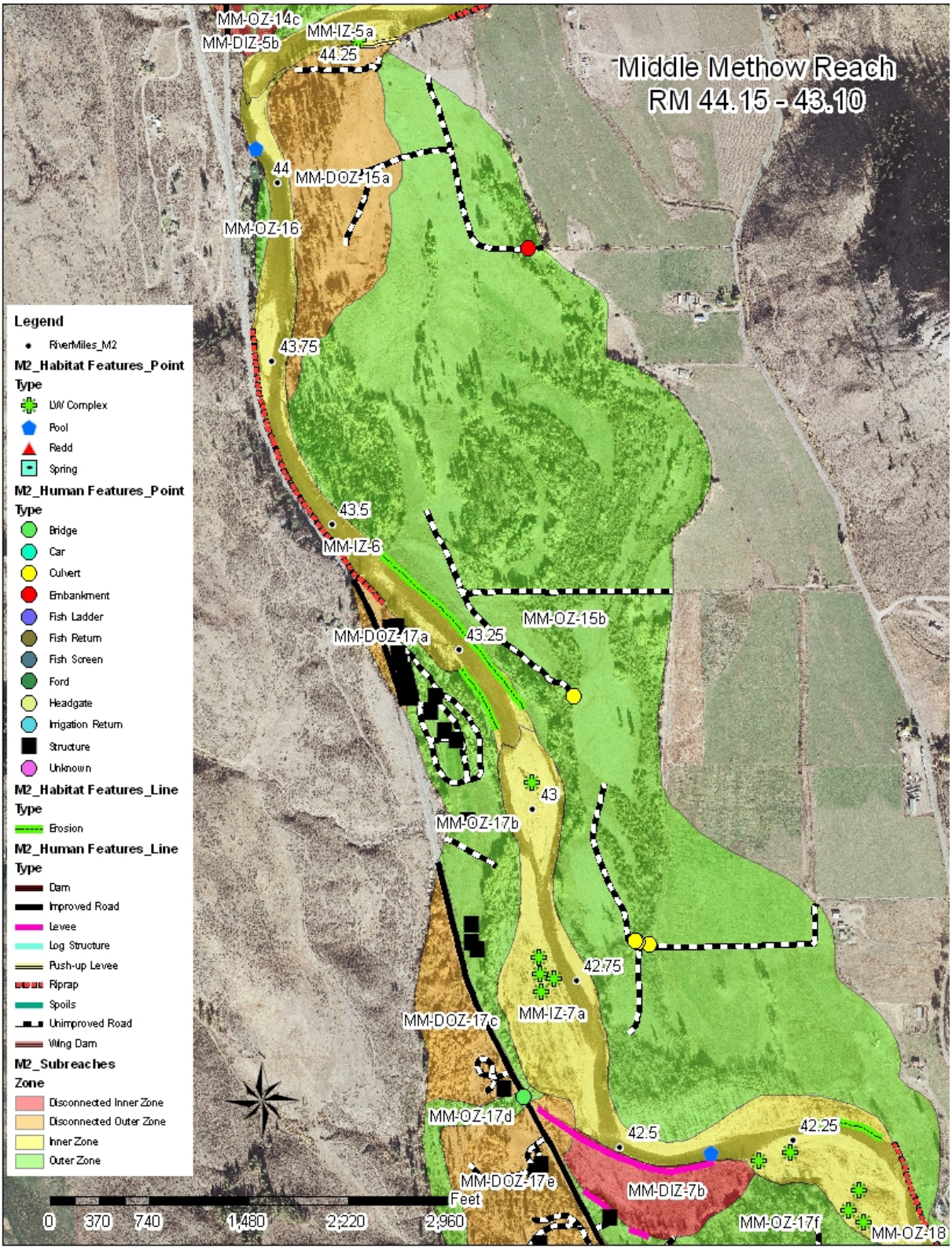

Figure 46. Aerial photograph showing the locations of subreaches and existing natural and anthropogenic features between RM 44.15 and 43.10 (map scale 1:10,000).

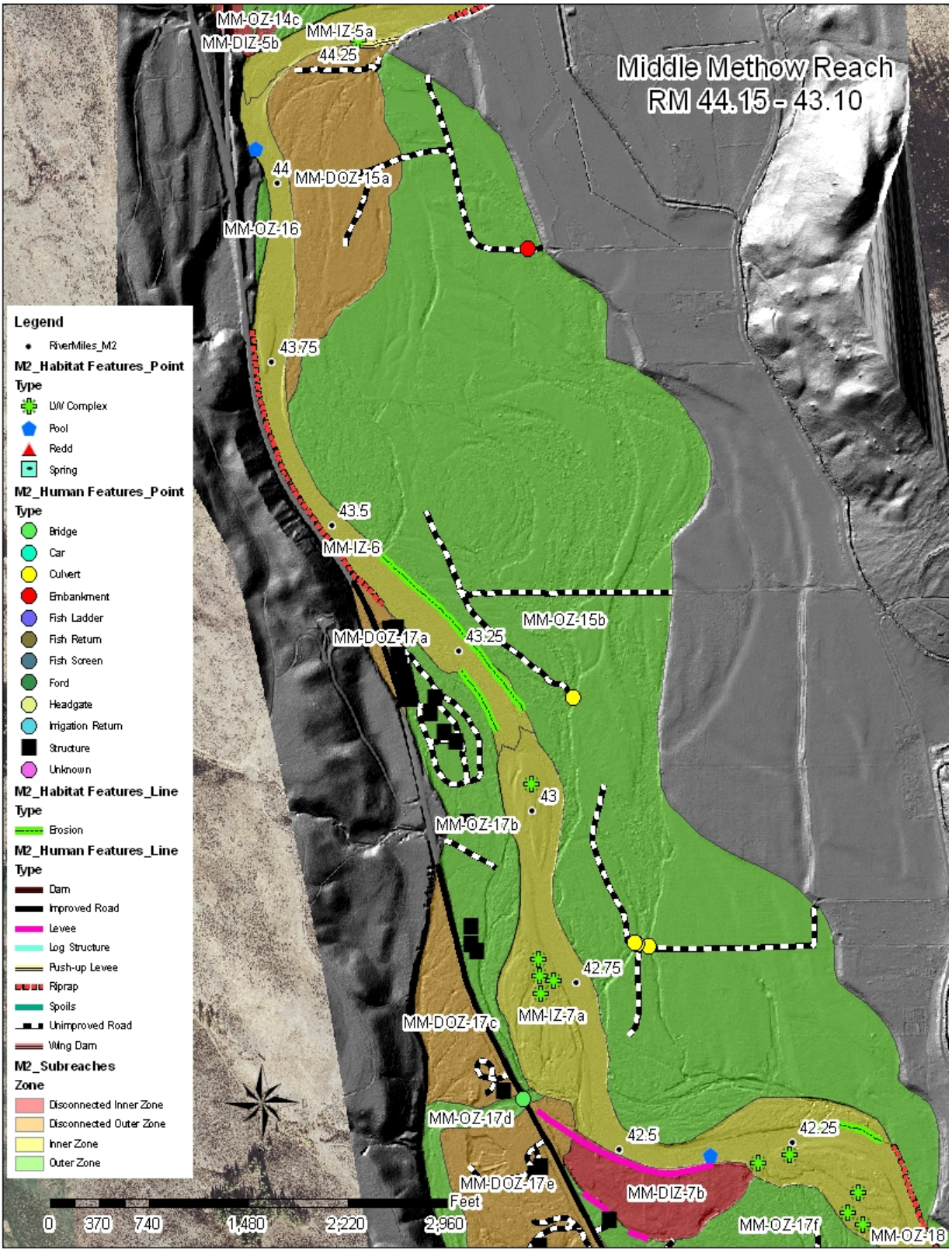

Figure 47. Hillshade elevation model showing the locations of subreaches and existing natural and anthropogenic features between RM 44.15 and 43.10 (map scale 1:10,000).

Table 48. Summary table of subreaches from RM 44.15 to 43.10, anthropogenic impacts and potential habitat action classes.

Parcel	River Mile (RM)	Acreage	Anthropogenic Features	Habitat Action Classes
MM-IZ-6 SUBREACH				
MM-IZ-6 (inner zone)	RM 44.10 - 43.10	29 acres	Riprap (~2,330 ft)	Reconnect processes Reconnect isolated habitat units
MM-OZ-15 SUBREACH COMPLEX				
MM-DOZ-15a (disconnected outer zone)	RM 44.35-43.70 (river left)	35 acres	Push-up levee (~280 ft) Unimproved roads (~1,990 ft)	Protect and maintain current habitat Reconnect processes Reconnect isolated habitat units
MM-OZ-15b (outer zone)	RM 44.35-42.00 (river left)	305 acres	Unimproved roads (~9,260 ft) Culvert (4) Embankment (1)	Protect and maintain current habitat Reconnect processes Reconnect isolated habitat units
MM-OZ-16 SUBREACH				
MM-OZ-16 (outer zone)	RM 44.00-43.85 (river right)	1 acre	Floodplain development (residential)	Reconnect processes

Potential Implementation Actions

The objectives for implementing the proposed actions between RM 44.15 and 43.10 are as follows (refer to Figure 48 and Figure 49):

1. Protecting the fragmented tracts of riparian vegetation and reconnecting these tracts by rehabilitating the cleared areas between them. These actions would provide a long-term cumulative benefit to both the physical and ecological processes.

2. Reconnecting floodplain processes by implementing the following actions: (1) removing a push-up levee to improve floodplain connectivity, (2) modifying bank protection to improve channel boundary roughness to reduce stream power and potentially elevate the channel bed for improved floodplain connectivity, and (3) strategically place large wood "key" members on bars and large wood at the head of overflow channels that contribute to side channel formation.

3. Connecting habitat units by implementing the following actions: (1) using appropriate methods to stabilize banks and re-establish appropriate vegetation, (2) increasing channel boundary roughness and habitat complexity, and (3) strategically placing large wood to improve fish cover, habitat complexity, and biomass in side channels.

Only the actions that have been identified through field observations and local input from the MRC are described. Many other potential actions could be implemented as described in the *Recovery Plan* or that are identified during an alternatives evaluation.

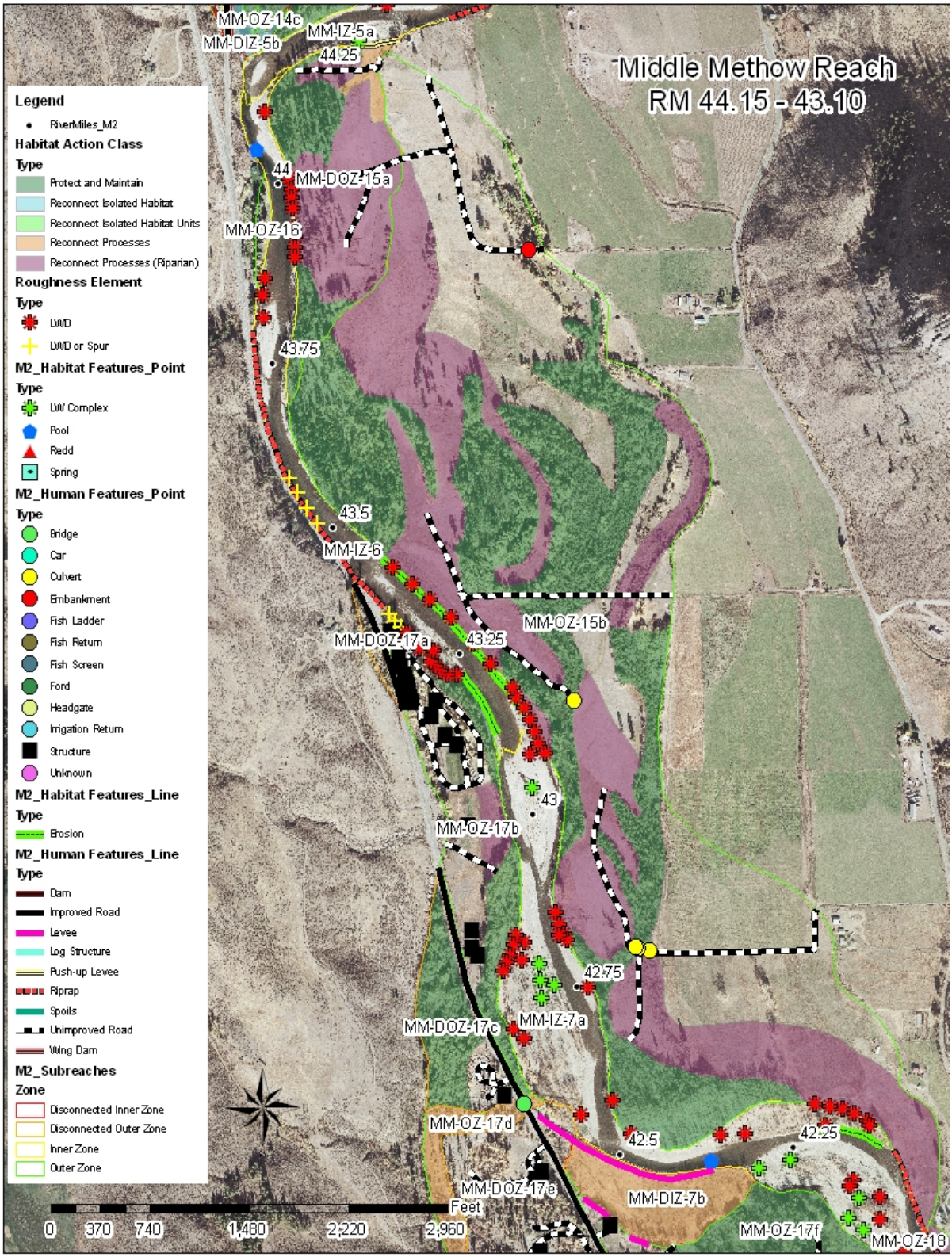

Figure 48. Aerial photograph showing the locations of subreaches, potential implementation actions, and existing natural and anthropogenic features between RM 44.15 and 43.10 (map scale 1:10,000).

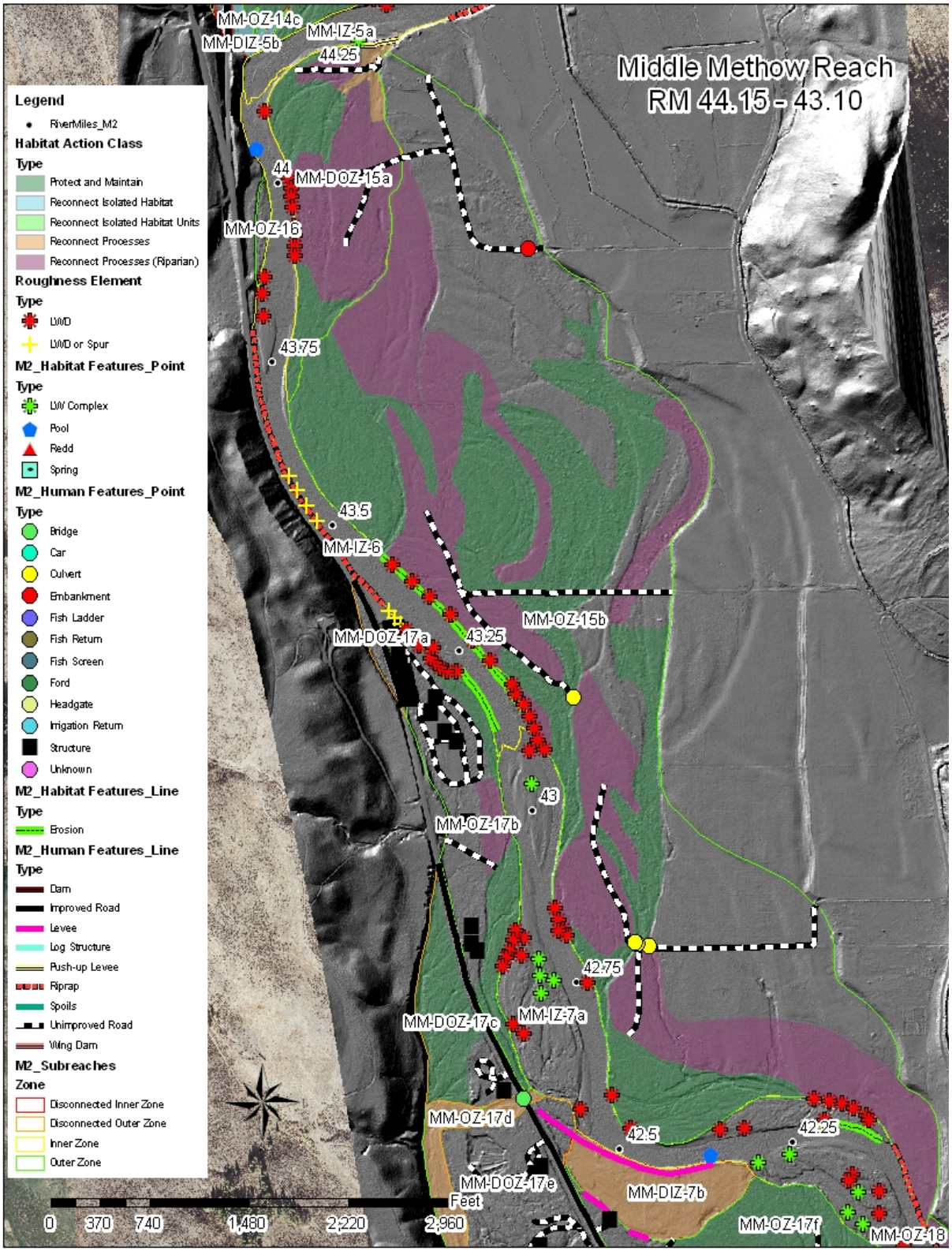

Figure 49. Hillshade elevation model showing the locations of subreaches, potential implementation actions, and existing natural and anthropogenic features between RM 44.15 and 43.10 (map scale 1:10,000).

MM-IZ-6 (Inner Zone)

Inner zone MM-IZ-6 is located between RM 44.10 and 43.10, and covers about 29 acres of the active channel (Table 49). The channel could be transitioning or has been locked in a mode of stasis due to artificial confinement by riprap restricts lateral channel migration, affects hydraulics, and sediment transport. There is about 2,330 linear feet of riprap placed along river right between RM 43.75 and RM 43.40 that restricts lateral channel migration and may be causing vertical channel instability resulting in localized scour or incision. Some channel sections could be in the process of abandoning their floodplain. Hydraulic modeling suggests much of the floodplain does not get activated until about a 10-year flood (Reclamation 2010).

There is active erosion along river left between RM 43.50 and RM 43.10 where the riparian vegetation has been cleared for agriculture (Figure 49). Livestock do have access to this section of the channel and are most likely exacerbating the erosion problem. The potential actions for this subreach are described in Table 50.

Figure 50. View is to the southeast looking downstream at a split flow near RM 43.4. Note the bank erosion occurring along river left where the vegetation has been disturbed. Methow Subbasin, Washington – Bureau of Reclamation photograph by E. Lyon, October 4, 2008.

Table 49. Summary of side channel within MM-IZ-6.

Side Channel Identifier	Total Acres	Side Channel Type	Cold Water Source	Wetted
SC_43.85_R	0.78	Gravel Bar	No	Perennial

Table 50. Potential actions for MM-IZ-6.

Option	Habitat Action Class	Potential Actions	Reach-scale Rehabilitation Response Potential
1	Protect and maintain current habitat	Plant appropriate vegetation and protect riparian buffer zone (minimum of 30 meters recommended in *Monitoring Strategy*) to provide channel boundary roughness, bank stability, and terrestrial habitat connectivity. Wood placements may be necessary to provide bank stability until vegetation matures. If wood placements are used, the placements should provide additional habitat complexity and connectivity. Ungulate exclusion may be necessary in some areas.	Maintain/High
2	Reconnect processes	Enhance riparian buffer zone (minimum of 30 meters recommended in *Monitoring Strategy*) to provide channel boundary roughness, bank stability, and terrestrial habitat connectivity. Wood placements may be necessary to provide bank stability until vegetation matures. If wood placements are used, the placements should provide additional habitat complexity and connectivity. Ungulate exclusion may be necessary in some areas. Place large wood "key" members on lateral bars to increase hydraulic and sediment transport variability, resulting in more natural or appropriate rates of bedform development, lateral channel migration and possible side channel development in order to alter hydraulic processes to provide diversity of flow regimes within the channel, creating improved migration and resting conditions for fish. Remove riprap, where appropriate, to allow lateral channel migration, or modify with roughness elements to reduce stream.	High
3	Reconnect isolated habitat units	Consider placing appropriate roughness elements (such as boulders,large wood, bioengineering treatments, etc.) along lateral bars in lower energy channel segments to provide resting areas and channel complexity.	Low

MM-OZ-15 Subreach Complex (Outer Zone)

MM-OZ-15 Subreach Complex is located between RM 44.35 and 42.00 on river left and covers about 340 acres. The subreach has been divided into two parcels (MM-DOZ-15a and MM-OZ-15b) based on complex anthropogenic impacts. The alternative evaluation process should be completed in the context of the entire subreach. Potential actions described for parcel MM-OZ-15b should be the priority followed by MM-DOZ-15a based on reach-scale relative response potential. Potential actions are described for each parcel in the following sections.

MM-DOZ-15a

Disconnected outer zone MM-DOZ-15a is located between RM 44.35 and 43.70 on river left and covers about 35 acres of the floodplain. There is about 280 linear feet of push-up levee that disconnects the floodplain and side channel (SC_44.30_L). Table 51 contains a summary of the side channel. There are about 1,990 linear feet of unimproved roads that are not raised and do not disrupt floodplain connectivity. Past riparian vegetation clearing has occurred primarily for agriculture development. The potential actions for this parcel are described in Table 52.

Table 51. Summary of side channel within MM-DOZ-15a.

Side Channel Identifier	Total Acres	Side Channel Type	Cold Water Source	Wetted
SC_44.30_L	0.86	Floodplain	No	Ephemeral

Table 52. Potential actions for MM-DOZ-15a.

Option	Habitat Action Class	Potential Actions	Reach-scale Rehabilitation Response Potential
1	Protect and maintain current habitat	Protect and enhance riparian vegetation to provide floodplain roughness, bank stability, and terrestrial habitat connectivity. Wood placements may be necessary to provide bank stability until vegetation matures in some areas. If wood placements are used, the placements should provide additional habitat complexity and connectivity. Ungulate exclusion may be necessary in some areas.	Maintain/High
2	Reconnect processes	Remove or modify push-up levee at head of historic overflow channel to allow floodplain connectivity and side channel formation. Enhance riparian vegetation to provide floodplain roughness, bank stability, and terrestrial habitat connectivity. Wood placements may be necessary to provide bank stability until vegetation matures in some areas. If wood placements are used, the placements should provide additional habitat complexity and connectivity. Ungulate exclusion may be necessary in some areas. Allow lateral channel migration, where appropriate, to improve physical processes. Alternatives evaluation should include anaylysis of the potential risk to structure.	High
3	Reconnect isolated habitat units	Wood placements where riparian vegetation has been removed would provide channel boundary roughness, bank stability, and increase aquatic habitat complexity. This action should be considered in conjunction with re-establishing a riparian buffer zone.	Moderate

MM-OZ-15b

Outer zone MM-OZ-15b is located between RM 44.35 and 42.00 on river left and covers about 305 acres of the floodplain. There is one side channel (SC_42.90_L) in the parcel that is summarized in Table 53. There are about 9,260 linear feet of unimproved roads that are not raised and do not disrupt floodplain processes except where they cross overflow channels. Of these crossings, four have culverts and one is an embankment. Past riparian vegetation clearing has occurred primarily for agriculture development. Active erosion is occurring along river left between RM 43.50 and RM 43.10 where the riparian vegetation has been cleared and livestock are accessing the river and exacerbating the erosion problem. The potential actions for this parcel are described in Table 54.

Table 53. Summary of side channel within MM-OZ-15b.

Side Channel Identifier	Total Acres	Side Channel Type	Cold Water Source	Wetted
SC_42.90_L	0.86	Floodplain	No	Ephemeral

Table 54. Potential actions for MM-OZ-15b.

Option	Habitat Action Class	Potential Actions	Reach-scale Rehabilitation Response Potential
1	Protect and maintain current habitat	Protect and enhance riparian vegetation to provide floodplain roughness, bank stability, and terrestrial habitat connectivity. Wood placements may be necessary to provide bank stability until vegetation matures in some areas. If wood placements are used, the placements should provide additional habitat complexity and connectivity. Ungulate exclusion may be necessary in some areas.	Maintain
2	Reconnect processes	Enhance riparian vegetation to provide floodplain roughness, bank stability, and terrestrial habitat connectivity. Also plant appropriate vegetation to establish a 10-meter buffer zone along all waterways on floodplain to provide shading. Wood placements may be necessary to provide bank stability until vegetation matures in some areas. If wood placements are used, the placements should provide additional habitat complexity and connectivity. Ungulate exclusion may be necessary in some areas. Allow lateral channel migration, where appropriate, to improve physical processes. Alternatives evaluation should include anaylysis of the potential risk to structure.	High
3	Reconnect isolated habitat units	Wood placements where riparian vegetation has been removed would provide bank stability, channel boundary roughness, increase habitat unit connectivity, and increase aquatic habitat complexity. This action should be considered in conjunction with re-establishing a riparian buffer zone.	Moderate

MM-OZ-16

Outer zone MM-OZ-16 is located between RM 44.00 and 43.85 on river right, and covers about 1 acre of floodplain. The subreach is residential property that has no structures within the floodplain. Some riparian vegetation clearing has occurred. The potential action for this subreach is described in Table 55.

Table 55. Potential action for MM-OZ-16.

Option	Habitat Action Class	Potential Action	Reach-scale Rehabilitation Response Potential
1	Reconnect processes	Enhance riparian vegetation to provide floodplain roughness, bank stability, and terrestrial habitat connectivity.	Low

Channel Segment RM 43.10 – 41.15

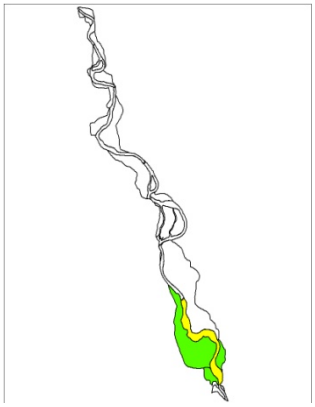

Figure 51. Location of channel segment RM 43.10 - 41.15 within the reach.

Characteristics

Between RM 43.10 and 41.15 (Figure 51), the channel could be transitioning or has been locked in a mode of stasis due to artificial confinement by levees and riprap that disconnect floodplain processes and restricts lateral channel migration which affects the hydraulics and sediment transport (Figure 52 and Figure 53). Average channel slope is about 0.35 percent based on 2008 thalweg profile data (Reclamation 2010) with an average bankfull width of about 250 feet as measured from the 2006 LiDAR hillshade elevation model. Predominant channel units are runs and riffles with cobbles and gravel substrate.

There is a levee reinforced with riprap that disconnects a historic channel path and restricts channel migration. An improved road embankment disconnects large tracts of floodplain and structures disrupt floodplain connectivity. Riparian vegetation clearing for residential development has been occurring. Riprap along the levee on river right and along the left bank

from about RM 42.60 to 41.90 restricts lateral channel migration that may result in increased transport capacity and localized incision. In addition, the bank protection placements may be focusing the steam power downstream resulting in active bank erosion.

The geomorphic potential has been primarily impacted by disconnecting the floodplain and historic channel path, and the restricted lateral channel migration that degrade the physical and ecological processes. An overview of the potential action classes are listed in Table 56. Specific actions for each subreach are addressed in the following sections.

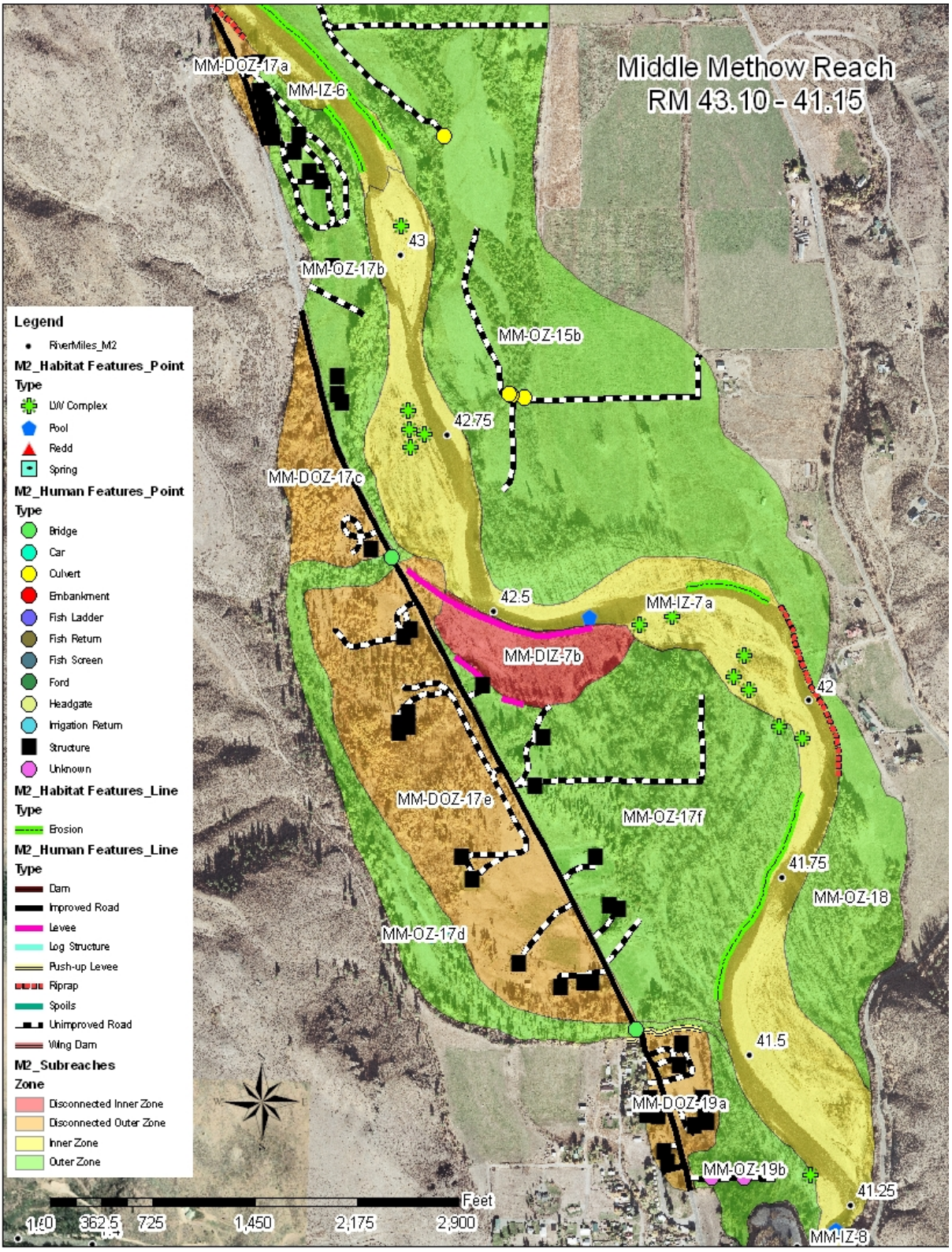

Figure 52. Aerial photograph showing the locations of subreaches and existing natural and anthropogenic features between RM 43.10 and 41.15 (map scale 1:9,500).

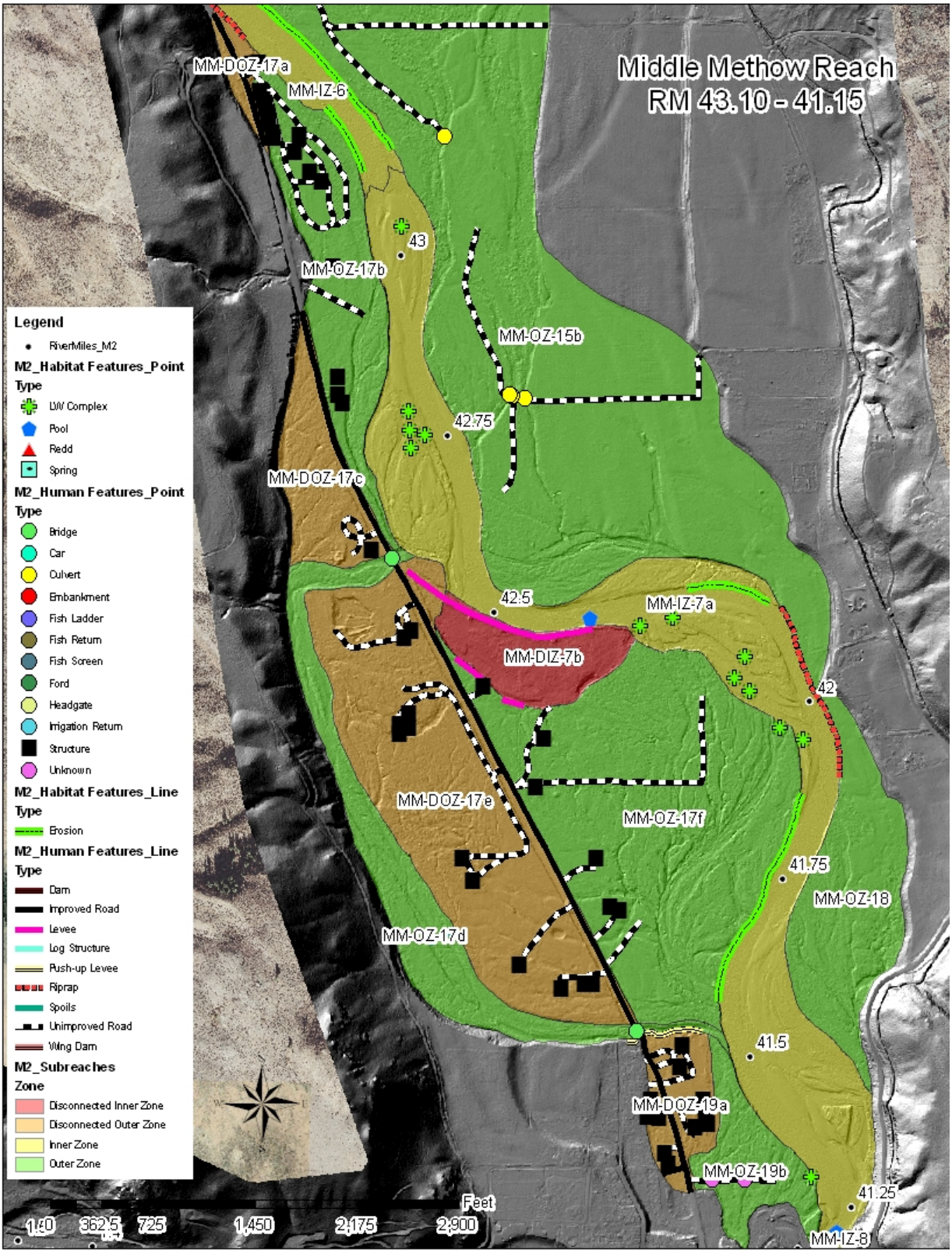

Figure 53. Hillshade elevation model showing the locations of subreaches and existing natural and anthropogenic features between RM 43.10 and 41.15 (map scale 1:9,500).

Table 56. Summary table of subreaches from RM 43.10 to 41.15, anthropogenic impacts and potential habitat action classes.

Parcel	River Mile (RM)	Acreage	Anthropogenic Features	Habitat Action Classes
MM-IZ-7 SUBREACH COMPLEX				
MM-IZ-7a (inner zone)	RM 43.10-41.15	96 acres	Riprap (~1,290 ft)	Reconnect processes Reconnect isolated habitat units
MM-DIZ-7b (disconnected inner zone)	RM 42.55-42.30 (river right)	14 acres	Primary levee (~1,110 ft) Secondary levees (~410 ft)	Reconnect isolated habitat Reconnect processes Reconnect isolated habitat units
MM-OZ-17 SUBREACH COMPLEX				
MM-DOZ-17a (disconnected outer zone)	RM 43.30-43.20 (river right)	3 acres	Improved road (~1,000 ft) Unimproved road (~130 ft) Structures (2)	Reconnect processes
MM-OZ-17b (outer zone)	RM 43.30-42.60 (river right)	30 acres	Structure (16) Unimproved road (~4,100 ft)	Protect and maintain current habitat Reconnect processes Reconnect isolated habitat units
MM-DOZ-17c (disconnected outer zone)	RM 42.90-42.60 (river right)	16 acres	Improved road (~1,810 ft) Unimproved road (~680 ft) Structure (1)	Reconnect processes Protect and maintain current habitat
MM-OZ-17d (outer zone)	RM 42.60-41.55 (river right)	27 acres	Bridges (2)	Reconnect processes Reconnect isolated habitat units

Parcel	River Mile (RM)	Acreage	Anthropogenic Features	Habitat Action Classes
MM-DOZ-17e (disconnected outer zone)	RM 42.60-41.55 (river right)	70 acres	Improved road (~3,570 ft) Unimproved road (~4,880 ft) Structure (12)	Reconnect processes
MM-OZ-17f (outer zone)	RM 42.50-41.55 (river right)	84 acres	Unimproved road (~3,630 ft) Structure (6)	Protect and maintain current habitat Reconnect processes Reconnect isolated habitat units
MM-OZ-18 SUBREACH				
MM-OZ-18 (outer zone)	RM 42.00-41.40 (river left)	29 acres	Floodplain development (agriculture)	Protect and maintain current habitat Reconnect processes Reconnect isolated habitat units
MM-OZ-19 SUBREACH COMPLEX				
MM-DOZ-19a (disconnected outer zone)	RM 41.55-41.30 (river right)	11 acres	Floodplain development (residential) Push-up levee (~440 ft) Improved road (~1,150 ft) Structure (11) Unimproved road (~1,430 ft)	Reconnect processes
MM-OZ-19b (outer zone)	RM 41.55-41.20 (river right)	13 acres	Unimproved road (~610 ft) Crossings (2)	Protect and maintain current habitat Reconnect processes Reconnect isolated habitat units

Potential Implementation Actions

The objectives for implementing the proposed actions between RM 43.10 and 41.15 are as follows (refer to Figure 54 and Figure 55):

1. Protecting the fragmented tracts of riparian vegetation and reconnecting these tracts by rehabilitating the cleared areas between them. These actions would provide a long-term cumulative benefit to both the physical and ecological processes.

2. Protecting current beaver activities and enhancing suitable habitat for re-colonization.

3. Reconnecting historic channel path that has been disconnected by a levee to allow lateral channel migration and improve floodplain connectivity.

4. Improve the connection between the Doran side channel (SC_42.65_R) by either providing surface flow, if feasible, or excavating the downstream end to connect to groundwater.

5. Reconnect floodplain processes by implementing the following actions: (1) remove or modify roads that disrupt floodplain connectivity, (2) remove bank protection, where appropriate, to allow lateral channel migration or modify bank protection to increase channel boundary roughness to potentially retain sediment and elevate the channel bed, and (3) strategically place large wood "key" members on bars and large wood at the head of overflow channels that contribute to side channel formation.

6. Connecting habitat units by implementing the following actions: (1) using appropriate method to stabilize banks and re-establish appropriate vegetation, (2) increase channel boundary roughness and habitat complexity, and (3) strategically placing large wood to improve fish cover, habitat complexity, and biomass in side channels and alcoves.

Only the actions that have been identified through field observations and local input from the MRC are described. Many other potential actions could be implemented as described in the *Recovery Plan* or that are identified during an alternatives evaluation.

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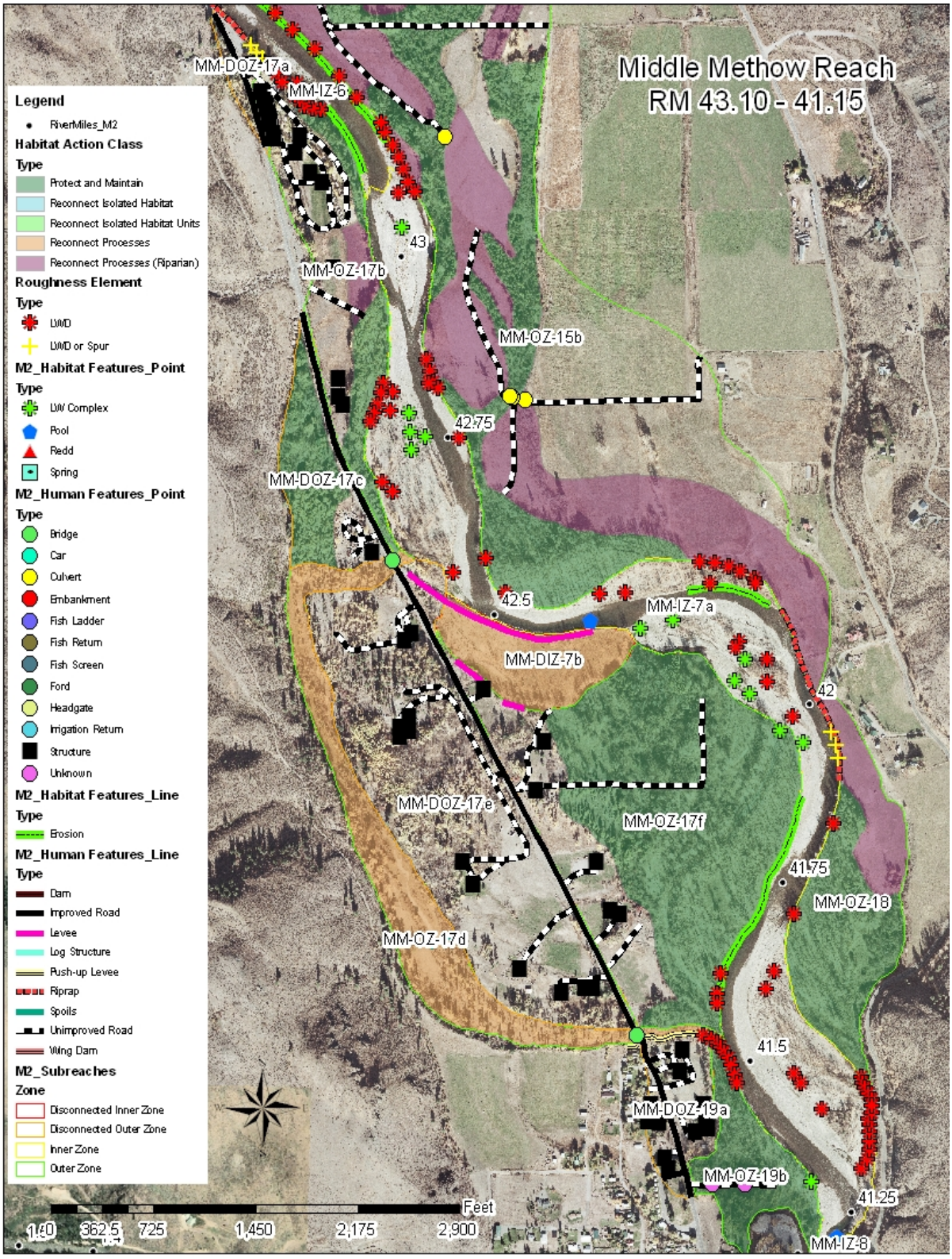

Figure 54. Aerial photograph showing the locations of subreaches, potential implementation actions, and existing natural and anthropogenic features between RM 43.10 and 41.15 (map scale 1:9,500).

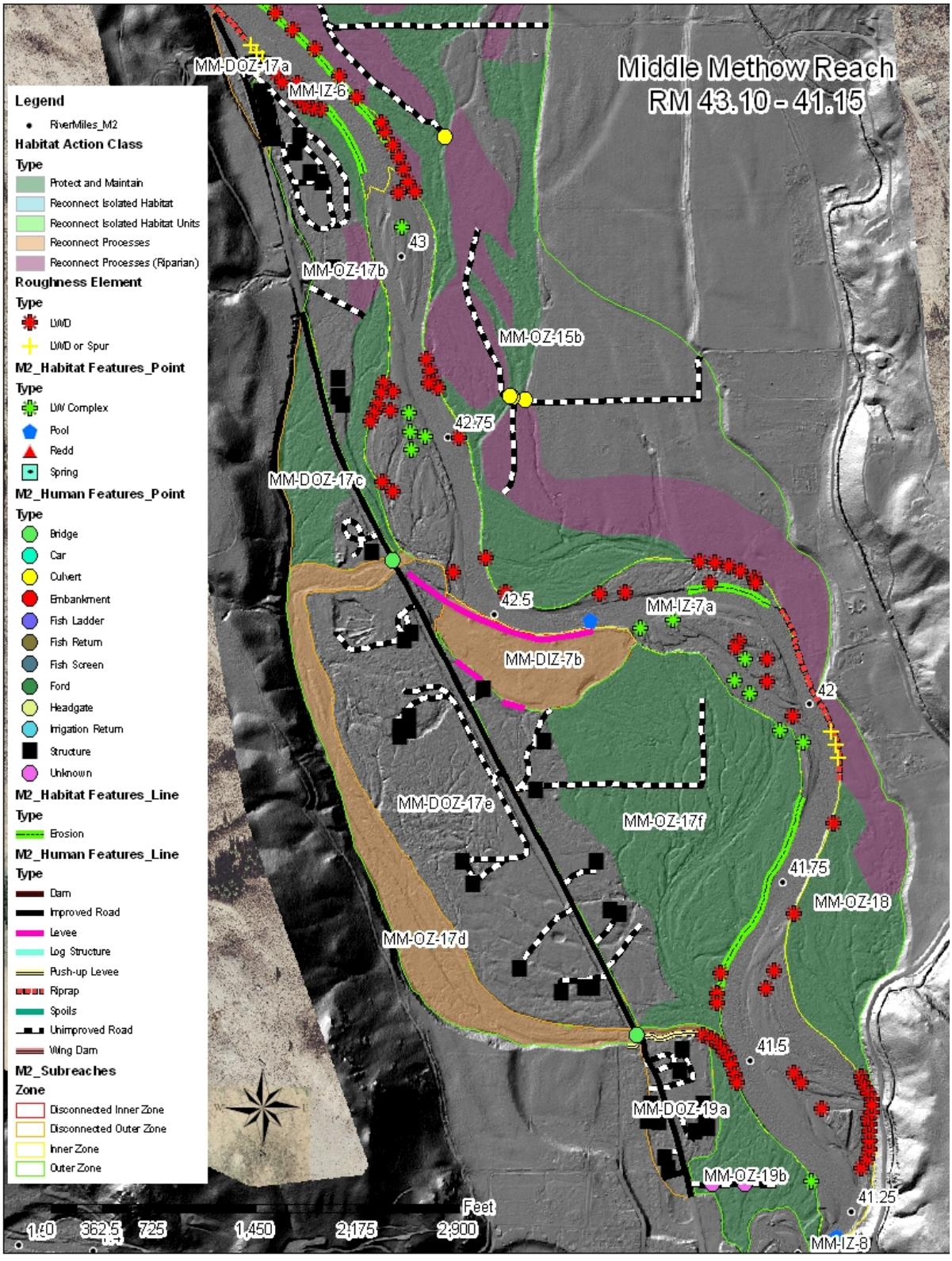

Figure 55. Hillshade elevation model showing the locations of subreaches, potential implementation actions, and existing natural and anthropogenic features between RM 43.10 and 41.15 (map scale 1:9,500).

MM-IZ-7 Subreach Complex (Inner Zone)

MM-IZ-7 subreach complex is located between RM 43.10 to 41.15 on river right and covers about 110 acres. The subreach has been divided into two parcels (MM-IZ-7a and MM-DIZ-7b) based on anthropogenic impacts. The alternative evaluation process should be completed in the context of the entire subreach. Parcel sequencing is not necessary as proposed actions in each parcel are independent, but intrinsically linked by physical processes. Potential actions are described for each parcel in the following sections.

MM-IZ-7a (Inner Zone)

Inner zone MM-IZ-7a is located between RM 43.10 and 41.15, and covers about 96 acres of the active channel and side channels. The channel could be transitioning or has been locked in a mode of stasis due to artificial confinement by levees and riprap that disconnect floodplain processes and restricts lateral channel migration which affects the hydraulics and sediment transport.

There are about 1,100 linear feet of levee placed along river right between RM 42.50 and 42.35, and about 1,300 linear feet of riprap placed along river left between RM 42.15 and 41.85. The levee and bank protection restrict lateral channel migration that may be causing channel bed scour that could result in localized channel incision and floodplain abandonment.

Six side channels are within the parcel that covers about 11 acres (Table 57), the highest concentration in the reach. The hydraulic model suggests that many of these side channels do not become activated during channel forming flows (Reclamation 2010).

Table 57. Summary of side channels within MM-IZ-7a.

Side Channel Identifier	Total Acres	Side Channel Type	Cold Water Source	Wetted
SC_43.10_L	2.26	Gravel Bar	No	Perennial
SC_42.85_R	1.42	Floodplain	No	Ephemeral
SC_42.61_R	0.32	Gravel Bar	No	Ephemeral
SC_42.60_R	0.32	Gravel Bar	No	Perennial
SC_42.30_R	5.02	Floodplain	No	Ephemeral
SC_41.40_L	1.77	Floodplain	No	Ephemeral
SC_41.35_L	0.34	Gravel Bar	No	Perennial

Active erosion is occurring along river left between RM 41.85 and 41.70, and along river right between RM 41.65 and 41.45 downstream of the bank protection (levee and riprap). The bank protection is hydraulically smooth and may be focusing the stream power downstream (Figure 56). The potential actions for this parcel are described in Table 58.

Figure 56 . View is to the southwest looking downstream at a run near RM 41.6. Note the bank erosion along river right. Methow Subbasin, Washington – Bureau of Reclamation photograph by E. Lyon, October 5, 2008.

Table 58. Potential actions for MM-IZ-7a.

Option	Habitat Action Class	Potential Actions	Reach-scale Rehabilitation Response Potential
1	Protect and maintain current habitat	Plant appropriate vegetation and protect riparian buffer zone (minimum of 30 meters recommended in *Monitoring Strategy*) to provide channel boundary roughness, bank stability, and terrestrial habitat connectivity. Wood placements may be necessary to provide bank stability until vegetation matures. If wood placements are used, the placements should provide additional habitat complexity and connectivity. Ungulate exclusion may be necessary in some areas.	Maintain/High
2	Reconnect processes	Enhance riparian buffer zone (minimum of 30 meters recommended in *Monitoring Strategy*) to provide channel boundary roughness, bank stability, and terrestrial habitat connectivity. Wood placements may be necessary to provide bank stability until vegetation matures. If wood placements are used, the placements should provide additional habitat complexity and connectivity. Ungulate exclusion may be necessary in some areas. Place large wood "key" members on lateral bars to increase hydraulic and sediment transport variability, resulting in more natural or appropriate rates of bedform development, lateral channel migration and possible side channel	High

Option	Habitat Action Class	Potential Actions	Reach-scale Rehabilitation Response Potential
		development in order to alter hydraulic processes to provide diversity of flow regimes within the channel, creating improved migration and resting conditions for fish. Remove riprap, where appropriate, to allow lateral channel migration. Where riprap cannot be removed, modify the riprap with roughness elements to reduce stream power.	
3	Reconnect isolated habitat units	Consider placing appropriate roughness elements (such as boulders,large wood, bioengineering treatments, etc.) along lateral bars in lower energy channel segments to provide resting areas and channel complexity.	Low

MM-DIZ-7b (Disconnected Inner Zone)

Disconnected inner zone MM-DIZ-7b is located between RM 42.55 and 42.30 and covers about 14 acres. There are about 1,300 linear feet of levee on river right between RM 42.50 and 42.35 that disconnect a historic channel path and some wetland areas (Figure 57; also see cover photograph). The downstream section of the levee is actively eroding. Based on anecdotal accounts, fill was placed behind the levee. Riparian vegetation clearing had occurred primarily for commercial or agriculture development. The potential actions for this parcel are described in Table 59.

Figure 57. View is to the east looking downstream at a run developed along levee placed on river right near RM 42.5. Note the downstream end of the riprap is failing. Methow Subbasin, Washington – Bureau of Reclamation photograph by E. Lyon, October 5, 2008.

Table 59. Potential actions for MM-DIZ-7b.

Option	Habitat Action Class	Potential Actions	Reach-scale Rehabilitation Response Potential
1	Reconnect processes	Explore alternatives to remove or modify levee to reconnect historic channel path and allow lateral channel migration; or to construct a side channel to provide off-channel habitat, and create suitable habitat for beaver colonization. Enhance riparian vegetation to provide floodplain roughness, bank stability, and terrestrial habitat connectivity. Also plant appropriate vegetation to establish a 10-meter buffer zone along all waterways on floodplain to provide shading. Wood placements may be necessary to provide bank stability until vegetation matures in some areas. If wood placements are used, the placements should provide additional habitat complexity and connectivity. Ungulate exclusion may be necessary in some areas. Explore strategically placing large wood to increase hydraulic and sediment transport variability, resulting in more natural or appropriate rates of bedform development, lateral channel migration and possible side channel development in order to alter hydraulic processes to provide diversity of flow regimes within the channel, creating improved migration and resting conditions for fish.	Very High

MM-OZ-17 Subreach Complex (Outer Zone)

MM-OZ-17 subreach complex is located between RM 43.30 to 43.20 on river right and covers about 230 acres. The subreach has been divided into six parcels (MM-DOZ-17a, MM-OZ-17b, MM-DOZ-17c, MM-OZ-17d, MM-DOZ-17e, and MM-OZ-17f) based on complex anthropogenic impacts. There are commercial and residential structures that limit the extent of short-term potential actions. Parcel sequencing for implementation of potential actions based on reach-scale rehabilitation response potential are as follows: (1) MM-OZ-17f where there are few residential structures and mostly intact riparian vegetation, (2) MM-OZ-17d along the Doran side channel (SC_42.65_R), (3) MM-OZ-17b where there are some residential structures and intact tracts of riparian vegetation, (4) MM-DOZ-17c if the upstream reconnection of the Doran side channel is chosen as a preferred alternative, otherwise the parcel is completely disconnected by an improved road that is unlikely to be relocated in the near future, (5) MM-DOZ-17e where infrastructure and residential development make short-term implementation unlikely, and (6) MM-OZ-17a where infrastructure make short-term implementation unlikely and cost versus biological benefit may be prohibitive. The alternative evaluation process should be completed in the context of the entire subreach. Potential actions are described for each parcel in the following sections.

MM-DOZ-17a

Disconnected outer zone MM-DOZ-17a is located between RM 43.30 and 43.20 on river right, and covers about 3 acres of the floodplain. There are two structures, about 1,300 linear feet of roads, and fill material. The area has been cleared for residential and commercial development. There are road embankments and fill material that disconnect floodplain processes. The riprap placed along the improved road does not necessarily restrict lateral

channel migration because of bedrock, but the riprap is hydraulically smooth and does not sufficiently dissipate stream power. The biological benefit versus cost is most likely prohibitive in this parcel. As such, a potential action for this parcel is described in Table 60.

Table 60. Potential action for MM-DOZ-17a.

Option	Habitat Action Class	Potential Action	Reach-scale Rehabilitation Response Potential
1	Reconnect processes	Removal of riprap is unlikely due to structures and infrastructure, and would only provide limited lateral channel migration due to bedrock. Explore alternatives to modify riprap with roughness elements (large wood or rock spurs) to reduce stream power.	Low

MM-OZ-17b

Outer zone MM-OZ-17b is located between RM 43.30 and 42.60 on river right, and covers about 30 acres of the floodplain. There are sixteen residential structures and about 4,100 linear feet of unimproved roads that do not appear to be raised. Past clearing of riparian vegetation occurred primarily due to agriculture development, but now includes residential and commercial structures. There are tracts of intact riparian vegetation that provide channel boundary roughness and terrestrial habitat connectivity. There is one side channel (SC_42.90_R) that is summarized in Table 61. The potential actions for this parcel are described in Table 62.

Table 61. Summary of side channel within MM-OZ-17b.

Side Channel Identifier	Total Acres	Side Channel Type	Cold Water Source	Wetted
SC_42.90_R	0.77	Floodplain	No	Ephemeral

Table 62. Potential actions for MM-OZ-17b.

Option	Habitat Action Class	Potential Actions	Reach-scale Rehabilitation Response Potential
1	Protect and maintain current habitat	Protect and enhance riparian vegetation to provide floodplain roughness, bank stability, and terrestrial habitat connectivity. Wood placements may be necessary to provide bank stability until vegetation matures in some areas. If wood placements are used, the placements should provide additional habitat complexity and connectivity. Ungulate exclusion may be necessary in some areas.	Maintain/High

Option	Habitat Action Class	Potential Actions	Reach-scale Rehabilitation Response Potential
2	Reconnect processes	In an alternatives evaluation, explore possiblities to allow lateral channel migration to improve physical processes. Structures are present in the parcel that will need to be protected which limits the available area for lateral channel migration. Enhance riparian vegetation to provide floodplain roughness, bank stability, and terrestrial habitat connectivity. Wood placements may be necessary to provide bank stability until vegetation matures in some areas. If wood placements are used, the placements should provide additional habitat complexity and connectivity. Ungulate exclusion may be necessary in some areas.	High

MM-DOZ-17c

Disconnected outer zone MM-DOZ-17c is located between RM 42.90 and 42.60 on river right, and covers about 16 acres of the floodplain. There is one residential structure with associated unimproved access roads, and about 1,810 linear feet of improved road that disconnects floodplain connectivity and provides flood protection for the structure. A small portion of the parcel has been cleared of riparian vegetation for residential and commercial development.

There is a potential to reconnect surface water flows from side channel SC_42.90_R to the Doran side channel (SC_42.65_R) through the road embankment and improve floodplain connectivity. The current location of the upstream bridge in MM-OZ-17d along the Doran side channel (SC_42.65_R) is perpendicular to flows and deposition is filling in the side channel at that location. The potential action for this parcel is described in Table 63.

Table 63. Potential action for MM-DOZ-17c.

Option	Habitat Action Class	Potential Action	Reach-scale Rehabilitation Response Potential
1	Reconnect processes	Explore alternatives to reconnect Doran side channel (SC_42.65_R) to side channel (SC_42.90_R) that approaches road at an appropriate angle. The risk of channel avulsion and potential hazards to property owners needs to be evaluated. If an alternative to reconnect the side channel in this location is identified, then this parcel should be protected to maintain riparian vegetation. Otherwise, no protection is necessary as this area is dosconnected by a road embankment.	High

MM-OZ-17d

Outer zone MM-OZ-17d is located between RM 42.60 and 41.55 on river right, and covers about 27 acres along the Doran side channel (SC_42.65_R). The side channel is summarized in Table 64. There are two bridges along the improved road that maintain surface flow

connection during high flood stages. Residential and commercial development has occurred along the length of the side channel. The location of the upstream bridge is perpendicular to flows and deposition is filling in the side channel at that location. Re-alignment of the side channel to connect to side channel SC_42.90_R could improve flow connectivity and reduce the depositional problem. The downstream end of the side channel is only inundated during flood stages and there is a potential to create an alcove that is connected to groundwater that could be colonized by beavers and provide overwintering/rearing habitat and high water refugia. Streambanks upstream and downstream near the outlet side channel are actively eroding. The potential actions for this parcel are described in Table 65.

Table 64. Summary of side channel within MM-OZ-17d.

Side Channel Identifier	Total Acres	Side Channel Type	Cold Water Source	Wetted
SC_42.90_R	0.77	Floodplain	No	Ephemeral

Table 65. Potential actions for MM-OZ-17d.

Option	Habitat Action Class	Potential Actions	Reach-scale Rehabilitation ResponsePotential
1	Reconnect processes	Explore alternatives to reconnect Doran side channel (SC_42.65_R) to side channel SC_42.90_R that approaches the improved road grade at the appropriate angle to provide surface water flow. The risk of channel avulsion and potential hazards to property owners needs to be evaluated. If the above reconnection is found not to be feasible, then explore alternatives to improve downstream connection with river and possible construction of off-channel habitat that is connected to groundwater source and could provide suitable habitat for beaver colonization.	Very High
2	Reconnect isolated habitat units	Should a preferred alternative be chosen to reconnect either the upstream end and/or downstream end of the side channel, then strategic wood placements should be evaluated to improve bank stability to protect structures, increase habitat unit connectivity, and improve habitat complexity and biomass.	Moderate

MM-DOZ-17e

Disconnected outer zone MM-DOZ-17e is located between RM 42.60 and 41.55 on river right, and covers about 70 acres of the floodplain. There are twelve residential structures and about 4,880 linear feet of associated unimproved roads most of which are not raised. There is about 3,570 linear feet of improved road embankment that disconnects the floodplain and provides flood protection for the structures. Riparian vegetation clearing has occurred primarily for commercial and residential development. Existing infrastructure and residential structures limit any short-term potential actions, and the biological benefits versus cost may be prohibitive. As such, the potential actions for this parcel are described in Table 66.

Table 66. Potential actions for MM-DOZ-17e.

Option	Habitat Action Class	Potential Actions	Reach-scale Rehabilitation Response Potential
1	Protect and maintain current habitat	Protect intact riparian vegetation along Doran side channel (SC_42.65_R) to maintain riparian buffer zone which provides channel boundary roughness, bank stability, shading, and terrestrial habitat connectivity.	Maintain
2	Reconnect processes	Plant appropriate vegetation to improve riparian buffer zone along Doran side channel. Removal or relocation of the improved road and structures could be considered to improve floodplain connectivity and allow lateral channel migration. However, this action does not appear to be feasible in the near future.	Moderate

MM-OZ-17f

Outer zone MM-OZ-17f is located between RM 42.50 and 41.55 on river right, and covers about 84 acres of floodplain and side channels. There are six residential structures on a higher terrace that do not disrupt floodplain connectivity and about 3,630 linear feet of associated unimproved roads that have minimal floodplain disruption. Riparian vegetation clearing has occurred primarily for residential development. There is an extensive intact tract of riparian vegetation in the floodplain and several developing overflow channels. There are two active side channels that are summarized in Table 67. Much of the floodplain is disconnected due to an upstream levee in parcel MM-DIZ-7b that, if removed, would increase floodplain connectivity. The potential actions for this parcel are described in Table 68.

Table 67. Summary of side channels within MM-OZ-17f.

Side Channel Identifier	Total Acres	Side Channel Type	Cold Water Source	Wetted
SC_42.00_R	4.54	Floodplain	No	Ephemeral
SC_42.65_R	3.98	Floodplain	No	Ephemeral

Table 68. Potential actions for MM-OZ-17f.

Option	Habitat Action Class	Potential Actions	Reach-scale Rehabilitation Response Potential
1	Protect and maintain current habitat	Protect and enhance riparian vegetation to provide floodplain roughness, bank stability, and terrestrial habitat connectivity. Wood placements may be necessary to provide bank stability until vegetation matures in some areas. If wood placements are used, the placements should provide additional habitat complexity and connectivity. Ungulate exclusion may be necessary in some areas.	Maintain/High

Option	Habitat Action Class	Potential Actions	Reach-scale Rehabilitation Response Potential
2	Reconnect processes	Allow lateral channel migration to improve physical and ecological processes. Structures are present that will need to be considered in an alternatives evaluation. Explore possible locations for wood placements at the head of overflow channels that could contribute to the possible formation of side channels.	High

MM-OZ-18 (Outer Zone)

Outer zone MM-OZ-18 is located between RM 42.00 and 41.40 on river left, and covers about 29 acres of floodplain. There are no anthropogenic features in the parcel. Past riparian vegetation clearing has occurred primarily for agriculture development. Much of the parcel contains intact tracts of riparian vegetation. One side channel (SC_41.70_L), locally known as the Anderson side channel, is present near RM 41.5 on river left (Figure 58) and is summarized in Table 69. The potential actions for this parcel are described in Table 70.

Figure 58. View is to the south looking downstream along Anderson side channel at a historic beaver dam or embankment near RM 41.5 on river left. Methow Subbasin, Washington – Bureau of Reclamation photograph by E. Lyon, October 5, 2008.

Table 69. Summary of side channels within MM-OZ-18.

Side Channel Identifier	Total Acres	Side Channel Type	Cold Water Source	Wetted
SC_41.70_L	0.60	Floodplain	No	Perennial

Table 70. Potential actions for MM-OZ-18.

Option	Habitat Action Class	Potential Actions	Reach-scale Rehabilitation Response Potential
1	Protect and maintain current habitat	Protect and enhance riparian vegetation to provide floodplain roughness, bank stability, and terrestrial habitat connectivity. Wood placements may be necessary to provide bank stability until vegetation matures in some areas. If wood placements are used, the placements should provide additional habitat complexity and connectivity. Ungulate exclusion may be necessary in some areas.	Maintain/High
2	Reconnect processes	Allow lateral channel migration to improve physical and ecological processes. Enhance riparian vegetation to provide floodplain roughness, bank stability, and terrestrial habitat connectivity. Wood placements may be necessary to provide bank stability until vegetation matures in some areas. If wood placements are used, the placements should provide additional habitat complexity and connectivity. Ungulate exclusion may be necessary in some areas. Explore possible locations for wood placements at the head of overflow channels that could contribute to the possible formation of side channels.	High
3	Reconnect isolated habitat units	Wood placements where riparian vegetation has been removed would provide bank stability, channel boundary roughness, increase habitat unit connectivity, and increase habitat complexity. This action should be considered in conjunction with re-establishing a riparian buffer zone.	Low

MM-OZ-19 Subreach Complex (Outer Zone)

MM-OZ-19 subreach complex is located between RM 41.55 to 41.20 on river right, and covers about 24 acres. The subreach has been divided into two parcels (MM-DOZ-19a and MM-OZ-19b) based on complex anthropogenic impacts. There are commercial and residential structures that limit the extent of short-term potential actions. Parcel sequencing for implementation of potential actions is MM-OZ-19b and then MM-DOZ-19a based on reach-scale rehabilitation response potential. The alternative evaluation process should be completed in the context of the entire subreach. Potential actions are described for each parcel in the following sections.

MM-DOZ-19a

Disconnected outer zone MM-DOZ-19a is located between RM 41.55 and 41.30 on river right, and covers about 11 acres of the floodplain. There are eleven commercial and residential structures and about 2,580 linear feet of associated roads that limit the extent of short-term potential actions. A push-up levee, about 440 feet long, disconnects the floodplain.

Riparian vegetation clearing has occurred for residential and commercial development. The biological benefits versus cost may be prohibitive in this parcel due to structures and associated infrastructure. As such, the potential action for this parcel is described in Table 71.

Table 71. Potential action for MM-DOZ-19a.

Option	Habitat Action Class	Potential Action	Reach-scale Rehabilitation Response Potential
1	Reconnect processes	An alternatives evaluation on the removal of the push-up levee and structures in the parcel could be considered to improve floodplain connectivity and allow lateral channel migration. However, this action does not appear to be feasible in the near future.	Low

MM-OZ-19b

Outer zone MM-OZ-19b is located between RM 41.55 and 41.20 on river right, and covers about 13 acres of floodplain. There are about 610 linear feet of unimproved roads that are not raised and do not disrupt floodplain connectivity. Two overflow channel crossings appear to have embankments that may create minimal floodplain disruption. Riparian vegetation is mostly intact. There is one side channel (SC_41.25_R) that is summarized in Table 72. The potential actions for this parcel are described in Table 73.

Table 72. Summary of side channel within MM-OZ-19b.

Side Channel Identifier	Total Acres	Side Channel Type	Cold Water Source	Wetted
SC_41.25_R	0.30	Floodplain	No	Ephemeral

Table 73. Potential actions for MM-OZ-19b.

Option	Habitat Action Class	Potential Actions	Reach-scale Rehabilitation Response Potential
1	Protect and maintain current habitat	Protect and enhance riparian vegetation to provide floodplain roughness, bank stability, and terrestrial habitat connectivity. Wood placements may be necessary to provide bank stability until vegetation matures in some areas. If wood placements are used, the placements should provide additional habitat complexity and connectivity. Ungulate exclusion may be necessary in some areas.	Maintain/High
2	Reconnect processes	Allow lateral channel migration to improve physical and ecological processes. Remove or modify unimproved roads and crossings that disrupt floodplain processes and side channel formation. Explore possible locations for wood placements at the head of overflow channels that could contribute to the possible formation of side channels.	High

Channel Segment RM 41.15 – 40.85

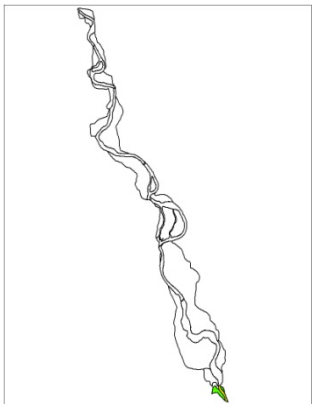

Figure 59. Location of channel segment RM 41.15 - 40.85 within the reach.

Characteristics

Between RM 41.15 and 40.85 (Figure 59), the river is transitioning because the floodplain becomes more confined between bedrock and the Twisp River alluvial fan, and there is an influx of sediment and stream flow from the Twisp River (Figure 60 and Figure 61). Average channel slope is about 0.18 percent based on 2008 thalweg profile data (Reclamation 2010) with an average bankfull width is about 190 feet as measured from the 2006 LiDAR hillshade elevation model. The predominant channel units are runs and riffles with cobbles and gravel substrate.

Riprap restricts lateral channel migration at the mouth of the Twisp River and on river left between RM 41.00 and 40.90. A levee disconnects the Twisp River from its floodplain, but does not necessarily disconnect the Methow River. Past riparian vegetation clearing has occurred primarily for residential and commercial development.

The geomorphic potential has been primarily impacted by floodplain development that has resulted in the clearing of riparian vegetation and restricted lateral channel migration that degrade the physical and ecological processes. An overview of the potential habitat action classes are listed in Table 74. Specific actions for each subreach are addressed in the following sections.

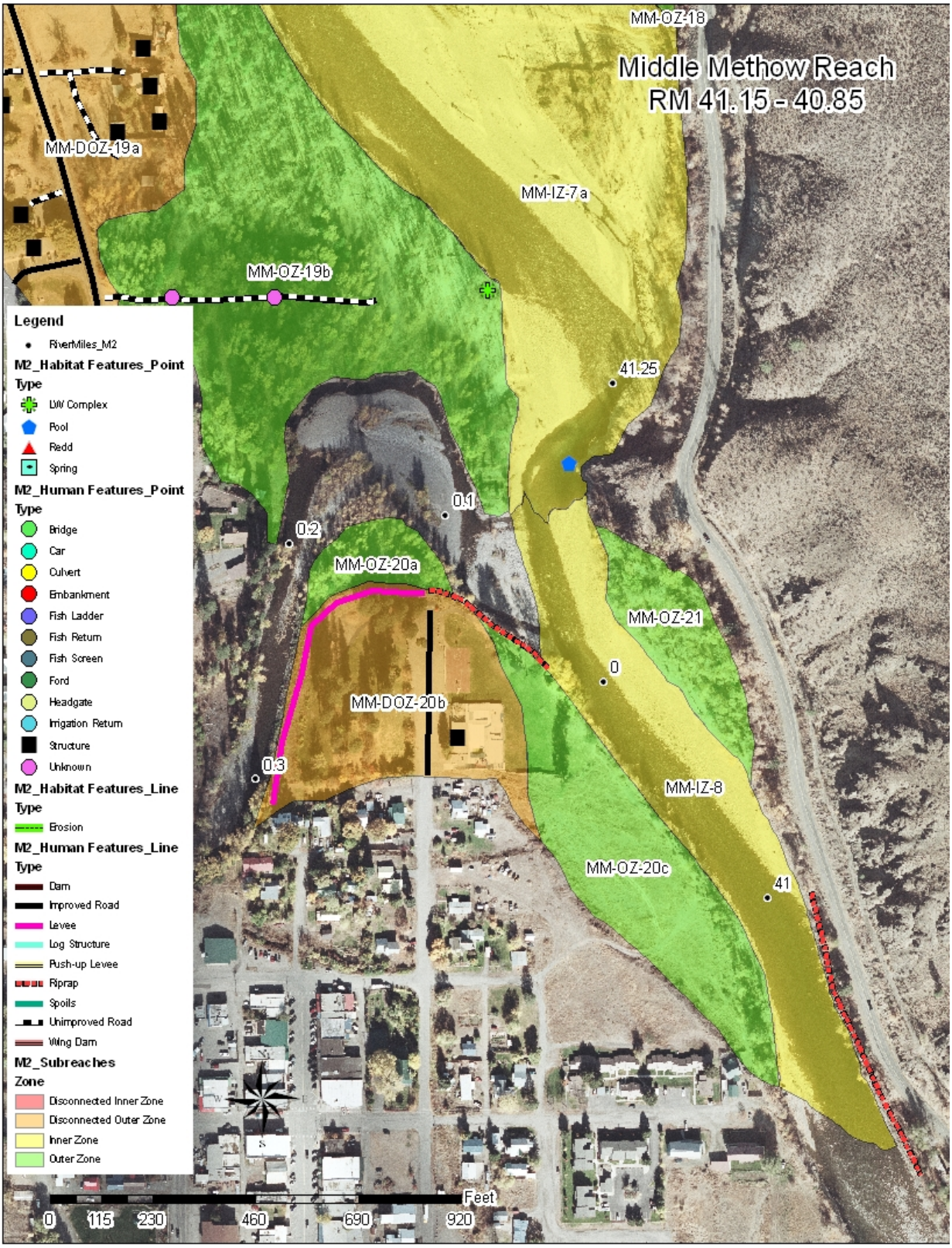

Figure 60. Aerial photograph showing the locations of subreaches and existing natural and anthropogenic features between RM 41.15 and 40.85 (map scale 1:3,000).

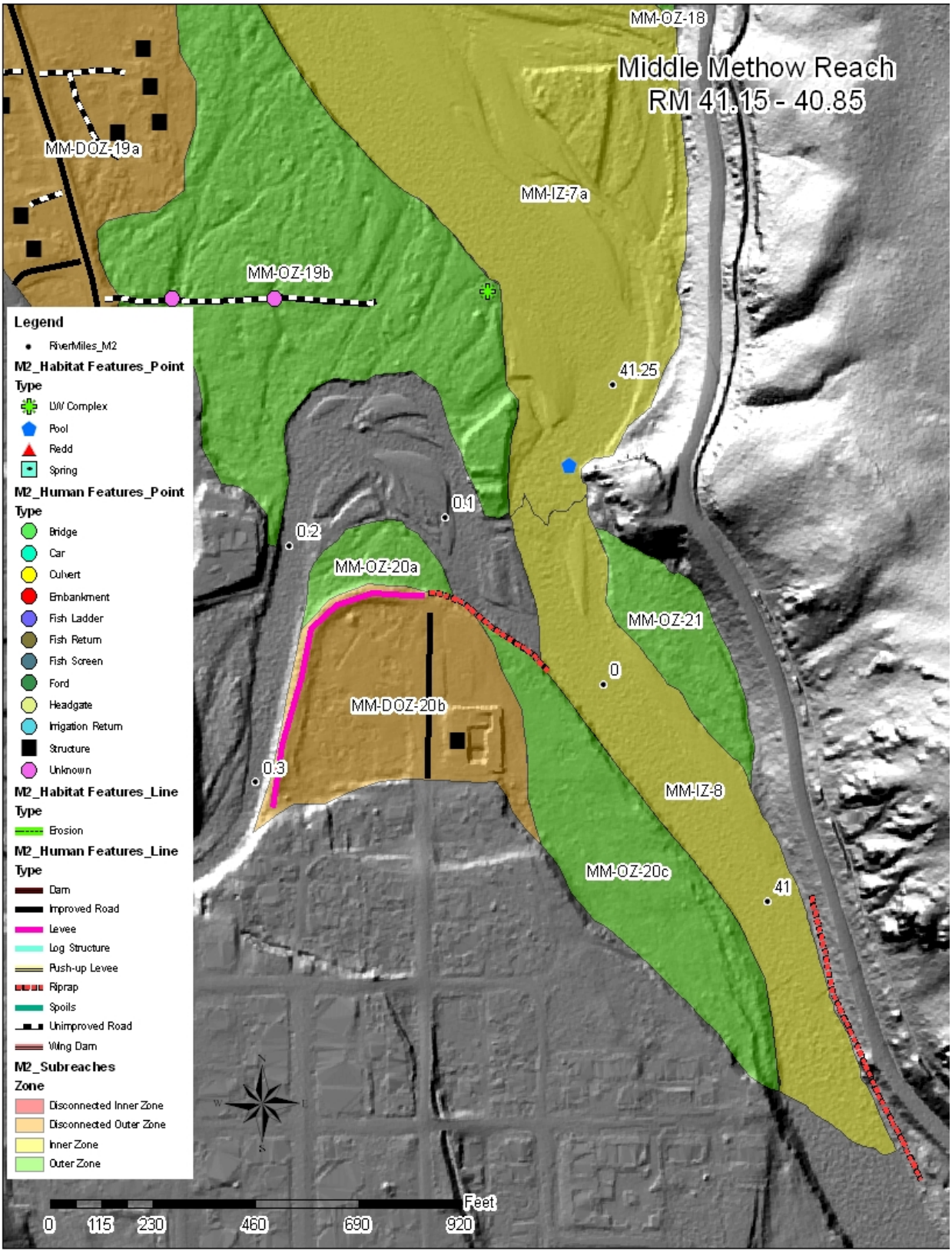

Figure 61. Hillshade elevation model showing the locations of subreaches and existing natural and anthropogenic features between RM 41.15 and 40.85 (map scale 1:3,000).

Table 74. Summary table of subreaches from RM 41.15 to 40.85, anthropogenic impacts and potential habitat action classes.

Parcel	River Mile (RM)	Acreage	Anthropogenic Features	Habitat Action Classes
MM-IZ-8 SUBREACH				
MM-IZ-8 (inner zone)	RM 41.15-40.85	6 acres	Riprap (~670 ft)	Reconnect processes Reconnect isolated habitat units
MM-OZ-20 SUBREACH COMPLEX				
MM-OZ-20a (outer zone)	RM 41.15 (river right)	1 acre	Recreation	Protect and maintain current habitat
MM-DOZ-20b (disconnected outer zone)	RM 41.15-41.10 (river right)	5 acres	Structure (1) Improved road (~370 ft)	Reconnect processes
MM-OZ-20c (outer zone)	RM 41.15-40.85 (river right)	5 acres	Floodplain development (commercial)	Reconnect processes Reconnect isolated habitat units
MM-OZ-21 SUBREACH				
MM-OZ-21 (outer zone)	RM 41.20-41.05 (river left)	2 acres	None	Protect and maintain current habitat

Potential Implementation Actions

The objective for implementing the proposed actions between RM 41.15 and 40.85 are as follows (refer to Figure 62 and Figure 63):

1. Protecting the fragmented tracts of riparian vegetation and reconnecting these tracts by rehabilitating the cleared areas between them. These actions would provide a long-term cumulative benefit to both the physical and ecological processes.

2. Reconnecting floodplain processes by implementing the following actions: (1) removing bank protection to allow lateral channel migration or modifying the bank protection to provide increased channel boundary roughness to reduce stream power, and (2) strategically place large wood "key" members on bars and large wood at the head of overflow channels that contribute to side channel formation.

3. Connecting habitat units by implementing the following actions: (1) using appropriate methods to stabilize banks and re-establish appropriate vegetation, (2) increasing channel boundary roughness and habitat complexity, and (3) strategically placing large wood to improve fish cover, habitat complexity, and biomass in side channels.

Only the actions that have been identified through field observations and local input from the MRC are described. Many other potential actions could be implemented as described in the *Recovery Plan* or that are identified during an alternatives evaluation.

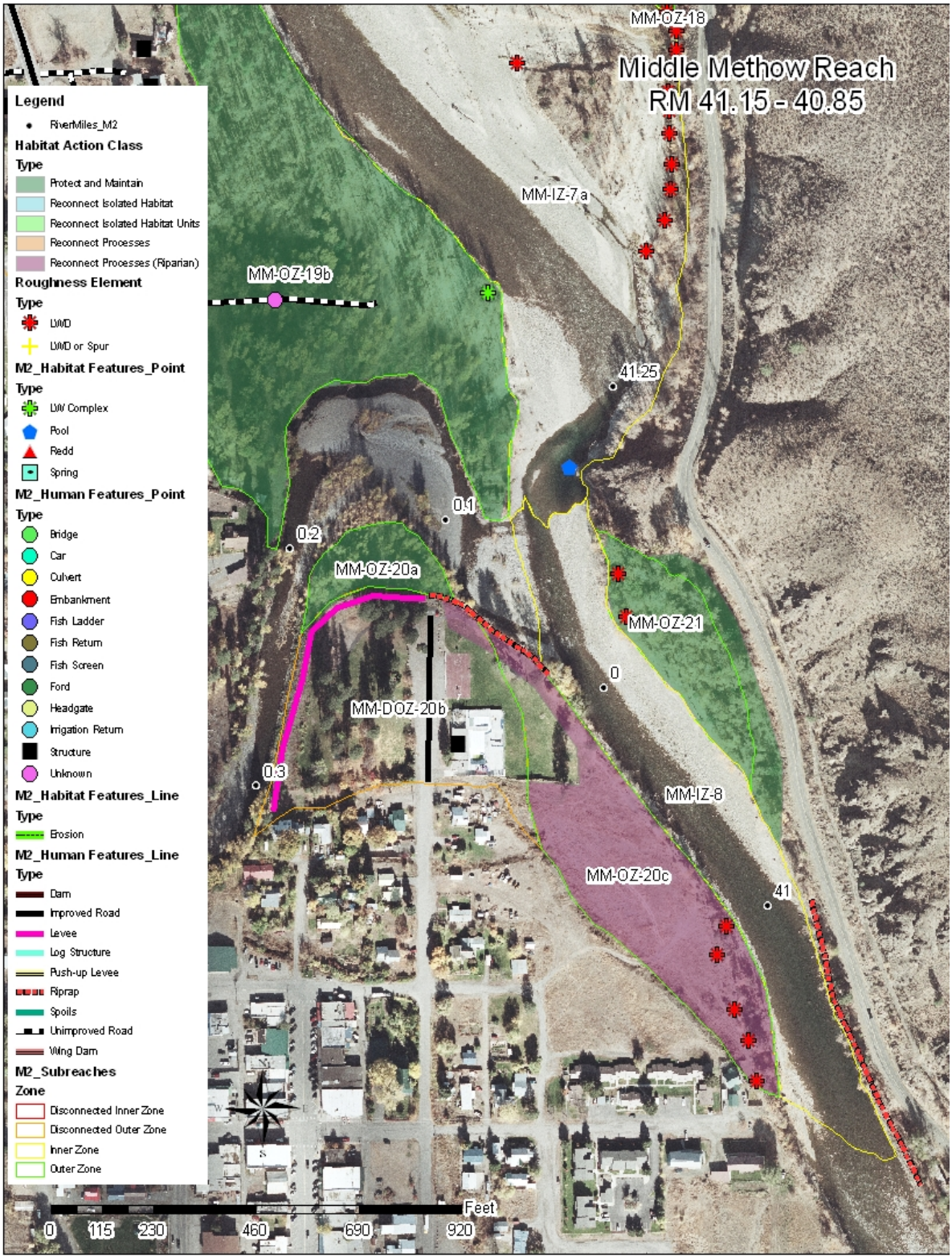

Figure 62. Aerial photograph showing the locations of subreaches, potential implementation actions, and existing natural and anthropogenic features between RM 41.15 and 40.85 (map scale 1:3,000).

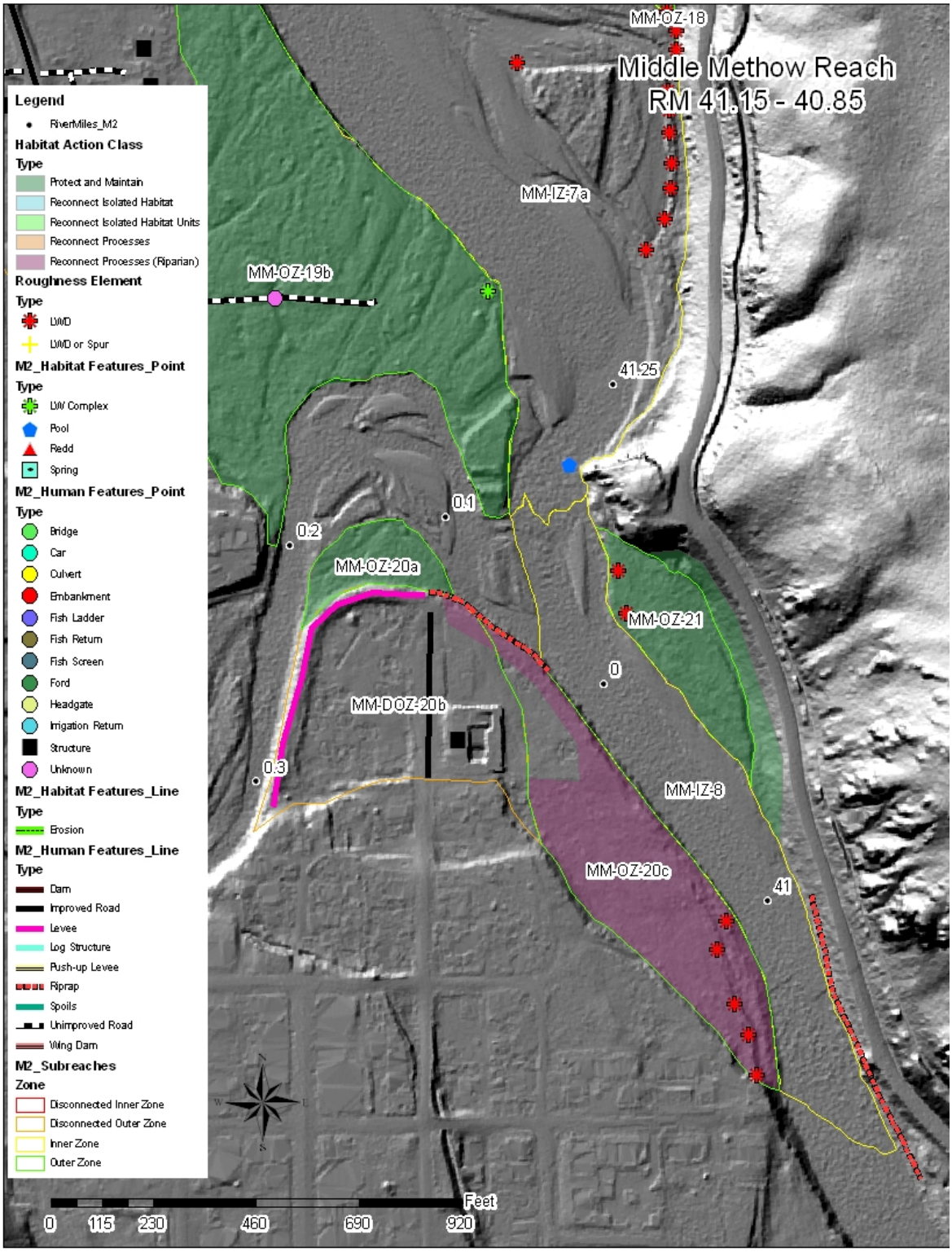

Figure 63. Hillshade elevation model showing the locations of subreaches, potential implementation actions, and existingnatural and anthropogenic features between RM 41.15 and 40.85 (map scale 1:3,000).

MM-IZ-8 (Inner Zone)

Inner zone MM-IZ-8 is located between RM 41.15 and 40.85, and covers about 6 acres of the active channel. The river is transitioning because the floodplain becomes more confined between bedrock and the Twisp River alluvial fan, and there is an influx of sediment and stream flow from the Twisp River. Anthropogenic features include riprap at the mouth of the Twisp River and on river left between RM 41.00 and 40.90 that restrict lateral channel migration, affects hydraulics, and sediment transport. Much of the riparian buffer zone has been cleared for residential and commercial development. The potential actions for this subreach are described in Table 75.

Table 75. Potential actions for MM-IZ-8.

Option	Habitat Action Class	Potential Actions	Reach-scale Rehabilitation Response Potential
1	Protect and maintain current habitat	Plant appropriate vegetation and protect riparian buffer zone (minimum of 30 meters recommended in *Monitoring Strategy*) to provide channel boundary roughness, bank stability, and terrestrial habitat connectivity. Wood placements may be necessary to provide bank stability until vegetation matures. If wood placements are used, the placements should provide additional habitat complexity and connectivity. Ungulate exclusion may be necessary in some areas.	Maintain
2	Reconnect processes	Enhance riparian buffer zone (minimum of 30 meters recommended in *Monitoring Strategy*) to provide channel boundary roughness, bank stability, and terrestrial habitat connectivity. Wood placements may be necessary to provide bank stability until vegetation matures. If wood placements are used, the placements should provide additional habitat complexity and connectivity. Ungulate exclusion may be necessary in some areas. Remove riprap, where appropriate, to allow lateral channel migration. Where riprap cannot be removed, modify the riprap with roughness elements to reduce stream power.	High
3	Reconnect isolated habitat units	Consider placing appropriate roughness elements (such as boulders,large wood, bioengineering treatments, etc.) along lateral bars in lower energy channel segments to provide resting areas and channel complexity.	Low

MM-OZ-20 Subreach Complex (Outer Zone)

MM-OZ-20 subreach complex is located between RM 41.15 and 40.85 on river right and covers 11 acres. The subreach has been divided into three parcels (MM-OZ-20a, MM-DOZ-20b, and MM-OZ-20c) based on complex anthropogenic impacts. There are commercial and residential structures that limit the extent of short-term potential actions. Based on reach-scale rehabilitation response potential, parcel sequencing for implementation of potential actions are as follows: (1) MM-OZ-20a, (2) MM-OZ-20c, and (3) MM-DOZ-20b. The alternative evaluation process should be completed in the context of the entire subreach. Potential actions are described for each parcel in the following sections.

MM-OZ-20a

Outer zone MM-OZ-20a is located about RM 41.15 on river right at the mouth of Twisp River, and covers about 1 acre of floodplain. Recreationists are the primary anthropogenic impacts. There are intact tracts of riparian vegetation and a functional floodplain. Small dams are built across channels by recreationists during low flow periods that create potential fish passage barriers. The potential actions for this parcel are described in Table 76.

Table 76. Potential actions for MM-OZ-20a.

Option	Habitat Action Class	Potential Actions	Reach-scale Rehabilitation Response Potential
1	Protect and maintain current habitat	Protect and enhance riparian vegetation to provide floodplain roughness, bank stability, and terrestrial habitat connectivity. Wood placements may be necessary to provide bank stability until vegetation matures in some areas. If wood placements are used, the placements should provide additional habitat complexity and connectivity. Ungulate exclusion may be necessary in some areas. This is a potential public outreach opportunity as many people use this area for recreation. Informational signs about salmon recovery efforts (i.e. Middle Methow rehabilitation efforts) and fish passage (i.e. recreational dams) could be deployed in this parcel.	Maintain/High
2	Reconnect processes	Allow lateral channel migration to improve physical and ecological processes. Explore possible locations for wood placements at the head of overflow channels that could contribute to the possible formation of side channels.	Moderate

MM-DOZ-20b

Disconnected outer zone MM-DOZ-20b is located between RM 41.15 and 41.10 on river right at the mouth of Twisp River, and covers about 5 acres of floodplain. A levee disconnects the floodplain and riprap restricts lateral channel migration along the confluence of the Twisp and Methow Rivers. The levee provides flood protection for one commercial structure and about 370 linear feet of improved roads. The commercial structure and infrastructure limit the extent of short-term potential actions. As such, the potential action for this parcel is described in Table 77.

Table 77. Potential action for MM-DOZ-20b.

Option	Habitat Action Class	Potential Action	Reach-scale Rehabilitation Response Potential
1	Reconnect processes	An alternatives evaluation could be conducted on the removal of levee and structures to improve floodplain connectivity and allow lateral channel migration. However, this action does not appear to be feasible in the near future.	Low

MM-OZ-20c

Outer zone MM-OZ-20c is located between RM 41.15 and 40.85 on river right, and covers about 5 acres of floodplain. There are no anthropogenic features present within this parcel. Past clearing of riparian vegetation has occurred primarily for commercial or residential development. The potential actions for this parcel are described in Table 78.

Table 78. Potential actions for MM-OZ-20c.

Option	Habitat Action Class	Potential Actions	Reach-scale Rehabilitation Response Potential
1	Protect and maintain current habitat	Protect and enhance riparian vegetation to provide floodplain roughness, bank stability, and terrestrial habitat connectivity. Wood placements may be necessary to provide bank stability until vegetation matures in some areas. If wood placements are used, the placements should provide additional habitat complexity and connectivity. Ungulate exclusion may be necessary in some areas.	Maintain/High
2	Reconnect processes	Allow lateral channel migration to improve physical and ecological processes. Plant appropriate vegetation to improve floodplain roughness, terrestrial habitat connectivity, water quality, and provide wood recruitment potential. Wood placements may be necessary to provide bank stability and reduce the risk of avulsion in the cleared areas until the vegetation matures. Ungulate exclusion may be necessary. This is a potential public outreach opportunity as a walking path could be extended to this parcel. Informational signs about salmon recovery efforts (i.e. Middle Methow rehabilitation efforts) and riparian rehabilitation could be deployed along the path. Explore possible locations for wood placements at the head of overflow channels that could contribute to the possible formation of side channels. Remove riprap, where appropriate, to allow lateral channel migration. If riprap removal is not feasible, then explore alternatives to modify riprap with roughness elements to reduce stream power.	High
3	Reconnect isolated habitat units	Wood placements where riparian vegetation has been removed would provide bank stability, channel boundary roughness, increase habitat unit connectivity, and increase habitat complexity. This action should be considered in conjunction with re-establishing a riparian buffer zone.	Low

MM-OZ-21 (Outer Zone)

Outer zone MM-OZ-21 is located between RM 41.20 and 41.05 on river left, and covers about 2 acres of floodplain. There are no anthropogenic features impacting processes. The riparian vegetation is essentially intact. The potential action for this subreach is described in Table 79.

Table 79. Potential action for MM-OZ-21.

Option	Habitat Action Class	Potential Action	Reach-scale Rehabilitation Response Potential
1	Protect and maintain current habitat	Protect and enhance riparian vegetation to provide floodplain roughness, bank stability, and terrestrial habitat connectivity. Wood placements may be necessary to provide bank stability until vegetation matures in some areas. If wood placements are used, the placements should provide additional habitat complexity and connectivity. Ungulate exclusion may be necessary in some areas.	Maintain/High
2	Reconnect processes	Allow lateral channel migration to improve physical and ecological processes. Explore possible locations for wood placements at the head of overflow channels that could contribute to the possible formation of side channels.	High

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SUMMARY AND CONCLUSIONS

The Middle Methow reach, located between RM 50.0 and 41.0 on the Methow River, is within a 6th field Hydrologic Unit Code (HUC) watershed (#170200080605). The reach is characterized as moderately confined (RM 50.0-47.0), unconfined (RM 47.0-41.3) and confined (RM 41.3-41.0) based on valley constraints. Typically, moderately confined and unconfined geomorphic reaches have flatter slopes and a complex network of channels that result in a high degree of interaction between the active channel and its floodplain. In its pre-disturbance state, the Methow River maintained dynamic equilibrium by actively migrating laterally across its floodplain within the moderately confined and unconfined channel segments.

Field surveys and evaluations were conducted in the Middle Methow reach during the 2008 and 2009 field seasons to determine the condition of the hydrologic, geomorphic, and biotic regimes. The 2008/2009 river condition provides an environmental baseline for comparisons with future assessments to establish a time series and integration with monitoring activities. The general and specific indicators were organized in a reach-based ecosystem indicator (REI) table for analysis (Appendix A). Based on available data, the general indicators at the watershed spatial scale were interpreted to be in an **At Risk Condition**: effective drainage network and watershed road density; flow/hydrology; water quality; and habitat access. The disturbance regime (natural/human) general indicator was interpreted to be in an **Adequate Condition**. All general indicators at the reach spatial scale were interpreted to be in an **At Risk Condition**: water quality; habitat access; habitat quality; channel condition and dynamics; and riparian/upland vegetation. The condition rankings of the indicators identify potential systematic and symptomatic deficiencies to physical and ecological processes at the watershed and reach scales. These condition rankings are used to guide development of potential actions to improve the processes that benefit the species of concern. In addition, the data collected for each indicator documents the baseline environmental conditions and these data can also be used to monitor actions that are implemented and the systems response through time (i.e., intervention analysis and effectiveness monitoring).

The Middle Methow reach scale indicators were interpreted to be in the following conditions:

1. **Unacceptable condition**: vegetation condition (disturbance) due to past and present floodplain development for agriculture, commercial and residential use.

2. **At risk condition**: water temperature, main channel physical barriers, large wood, pools, off-channel habitat, floodplain connectivity, bank stability/channel migration, vertical channel stability, vegetation condition (structure), and vegetation condition (canopy cover).

3. **Adequate condition**: turbidity, chemical contamination/nutrients, channel substrate, and fine sediment.

The geomorphic potential, which is a measure of the streams capability to dynamically adjust to changes in the hydrologic, geomorphic and biotic regimes, was interpreted to be moderate from RM 50.0 to 47.0; high from RM 47.0 to 41.3; and low from RM 41.3 to 41.0. Geomorphic potential for the reach is interpreted to be in a degraded condition primarily due to the following: (1) floodplain development for agriculture, residential, and commercial uses restricts floodplain connectivity, and has altered the riparian vegetation structure , (2) irrigation diversions within the main channel reduce instream flows and during low flow periods may reduce habitat quality and availability, (3) levees disconnect historic channel paths and disconnect floodplain areas, (4) bank protection restricts lateral channel migration,affects hydraulics and sediment transport that could result in localized scour and channel incision, and (5) large wood removal from the river and along riparian buffer zone reduces channel complexity and roughness, and reduces large wood recruitment potential.

Based on the indicators analysis and geomorphic potential, the following prioritized habitat action classes are recommended:

1. Protect and maintain current habitat: this habitat action class includes protecting intact tracts of quality habitats throughout the reach. Quality aquatic and terrestrial habitats are fragmented in the reach, and protection of these habitats will maintain current physical and ecological processes. There are several conservation easements already in-place throughout the reach. Some examples of quality habitats include tracts of intact riparian vegetation, cold water sources, off-channel habitats, and beaver colony areas.

2. Reconnect isolated habitat: this habitat action class includes reconnecting both aquatic and terrestrial habitats throughout the reach. Re-establish and protect a continuous riparian buffer zone (maximize width where possible, otherwise a minimum width of 30 meters) along the alluvial area of the reach and along all secondary waterways (minimum width of 10 meters). In addition, all tributaries, main channel barriers, and off-channel barriers (i.e., Bear Creek, Barkley Diversion Dam, “Sugar Dike” area, and Doran side channel area) should be reconnected to the Methow River to provide appropriate fish passage, transfer of energy, and rearing habitat. These actions address most of the reach scale deficiencies and will help provide long-term resiliency to all species reliant on riverine habitat and processes. Some benefits include (1) aquatic re-colonization of disconnected habitat, (2) transfer of energy (i.e., food web), (3) expanding macroinvertebrate habitat, (4) improving water quality, (5) increasing channel complexity, (6) allowing lateral channel migration, and (7) increasing habitat connectivity of terrestrial dependent species (amphibian, avian, reptilian, and mammalian species).

3. Reconnect processes: this habitat action class includes improving fluvial and ecological interactions between the channel and its floodplain. Remove or modify

anthropogenic features that presently disconnect floodplain processes. Reconnection of the floodplain processes improves groundwater recharge, expands the hyporheic zone, and increases off-channel habitat. Beaver re-introduction in suitable floodplain type side channels would further increase the above processes, and habitat quantity, and improve diversification of aquatic and vegetation species. These actions include (1) removal or modification of bank protection (i.e., riprap and levees), where appropriate, that inhibit lateral channel migration and exaggerate vertical channel migration that may result in the possible disconnection of the floodplain, (2) install large wood (i.e., instream and floodplain wood loading) that contribute to the creation and maintenance of side channels, provide fish cover, and increase biomass, and (3) re-introduction of beavers where appropriate to create complex off-channel habitat and riparian vegetation structure, and to store water on the floodplain for additional groundwater recharge.

4. Reconnect isolated habitat units: this habitat action class includes the placing of boulders along high energy reaches where wood would not be retained and the use of large wood to provide habitat connectivity, fish cover, and increase biomass. Large boulder placements (using rounded to subrounded boulders) could be considered along the high energy reaches to provide hydraulic roughness and resting areas for migrating salmonids. Large wood placements could be considered in side channels and alcoves to provide additional fish cover, side channel complexity, and biomass. Creation of habitat, such as alcoves and off-channel area, could be considered to provide rearing habitat and high-flow refugia.

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LITERATURE CITED

Parenthetical Reference	Bibliographic Citation
Aspect 2009	Aspect Consulting, LLC. 2009, Preliminary feasibility assessment of multipurpose storage, Twin Lakes area, Okanogan County, Washington; Project No. 040028-001-19 (Draft).
Beechie et al. 1996	Beechie, T., et al., 1996, Restoration of habitat-forming processes in Pacific Northwest watersheds: a locally adaptable approach to salmonids habitat restoration. P. 48-76 in D. L. Peterson and C. V. Klimas, editors. The role of restoration in ecosystem management. Society for Ecological Restoration, Madison Wisconsin.
Beechie et al. 2010	Beechie, T., et al., 2010, Process-based principles for restoring river ecosystems. BioScience 60(3): 209-222..
Beechie and Bolton 1999	Beechie, T. and Bolton, S., 1999, An approach to restoring salmonid habitat-forming processes in Pacific Northwest watersheds. Fisheries 24(4):6-15.
Braatne et al. 1996	Braatne, J., Rood, S. and Heilman, P., 1996, Life history, ecology, and conservation of riparian cottonwoods in North America, In: Stettler, R., Bradshaw, H., Jr., Heilman, P., and Hinckley, T., (eds): Biology of Populus and its implications for management and conservation: NRC Research Press, Ottawa, Ontario, Canada.
Burton 1997	Burton, T., 1997, Effects of basin-scale timber harvest on water yield and peak streamflow: Journal of the American Water Resources Association 14, pp.1187-1196.
Bustard and Narver 1975	Bustard, D., and Narver, D., 1975, Aspects of the winter ecology of juvenile coho salmon (Oncorhynchus kisutch) and steelhead trout (Salmo gairdneri): Journal of the Fisheries Resource Board of Canada 32:667-680.
CCPUD 1998	CCPUD (Chelan County Public Utility District), 1998, Aquatic species and habitat assessment: Wenatchee, Entiat, Methow, and Okanogan watersheds: Chelan County Public Utility District Number 1, Wenatchee, Washington, 100 p.
Crandall 2009	Crandall, J., 2009, Methow subbasin monitoring inventory. Report prepared for the Methow Restoration Council: Wild Fish Conservancy, Twisp, Washington, 53 p.
Frissell et al. 1986	Frissell, C., et al., A hierarchical framework for stream habitat classification: viewing stream in a watershed context: Environmental Management, 10: p. 199-214.

Parenthetical Reference	Bibliographic Citation
Hillman 2006	Hillman, T., 2006, Monitoring strategy for the Upper Columbia Basin, second draft report, August 2006, prepared for the Upper Columbia Salmon Recovery Board, Bonneville Power Administration, and National Marine Fisheries Service: BioAnalysts, Inc., Boise, Idaho, 98 pp.
Kauffman et al. 1997	Kauffman, J., et al., 1997, An Ecological perspective of riparian and river restoration in the western United States. Fisheries 22(5):12-14.
Konrad et al. 2003	Konrad, C.P., Drost, B.W., and Wagner, R.J., 2003, Hydrogeology of the unconsolidated sediments, water quality, and ground-water/surface-water exchanges in the Methow River basin, Okanogan County, Washington: U.S. Geological Survey, Water-Resources Investigations Report 03-4244, 137 p.
Montgomery and Bolton 2003	Montgomery, D., and Bolton, S., 2003, Hydrogeomorphic Variability and River Restoration, p. 39-80 *in*: American Fisheries Society.
Montgomery and Buffington 1993	Montgomery, D., and Buffington, J., 1993, Channel classification, prediction of channel response, and assessment of channel condition: Timber/Fish/Wildlife Agreement, Report TFW-SI-110-93-002, Seattle, WA
Naiman et al. 1988	Naiman, R.J., Johnson, C.A., and Kelley, J.C. 1988. Alteration of North American streams by beaver: BioScience 38: 753-762.
Naiman et al. 1992	Naiman, R.J., Lonzarich, D.G., Beechie, T.J., and Ralph, S.C. 1992. General principles of classification and the assessment of conservation potential in rivers. Pages 93-123 *in*: P.J. Boon, P. Calow, and G.E. Petts, editors. River conservation and management. John Wiley and Sons, New York, NY.
Naiman et al. 2000	Naiman, R.J., Bilby, R.E., and Bisson, P.A. 2000. Riparian ecology and management in the pacific coastal rain forest. BioScience 50: 996-1011.
Neuendorf et al. 2005	Neuendorf, K., Mehl, Jr., K., Jackson, J.P., and Jackson, J.A., 2005, Glossary of Geology, 5th edition: American Geological Institute, 779 p.
NOAA Fisheries 2008	National Marine Fisheries Service, Consultation on Remand for Operation of the Federal Columbia River Power System, 11 Bureau of Reclamation Projects in the Columbia Basin and ESA Section 10(a)(1)(A) Permit for Juvenile Fish Transportation Program (Revised and reissued pursuant to court order, NWF v. NMFS, Civ. No. CV 01-640-RE (D. Oregon)), May 5, 2008, F/PNR/2005/05883

Parenthetical Reference	Bibliographic Citation
ODFW 1995	Oregon Department of Fish and Wildlife, 1995, A guide to placing large wood in streams: Oregon Department of Fish and Wildlife, Habitat Conservation District, Portland, OR.
Ohlson 1996	Ohlson, T., 1996, Fire regimes of the ponderosa pine-Douglas-fir/beardless bluebunch wheatgrass plant association in the Methow Valley of North Central Washington: Master thesis, Washington State University, 87 p.
Pollock et al. 2003	Pollock, M.M., heim, M., and Naiman, R.J., 2003. Hydrologic and geomorphic effects of beaver dams and their influence on fishes *in* Bregory, S.V., Boyer, K., and Gurnell, A., [editors]: The ecology and management of wood in the world rivers: American Fisheries Society, Bethesda, Maryland, pp.213-234.
Pollock et al. 2004	Pollock, M.M., Pess, G.R., Beechie, T.J., and Montgomery, D.R., 2004. The importance of beaver ponds to Coho salmon production in the Stillaguamish River Basin, Washington, USA: North American Journal of Fisheries Management 24: 749-760.
Reclamation 2007	Reclamation (Bureau of Reclamation), 2007, Methow subbasin geomorphic assessment, Okanogan County, Washington: Bureau of Reclamation Technical Service Center, Denver, CO, 120 p. + appendices
Reclamation 2010	Reclamation (Bureau of Reclamation), 2010, Geomorphology and hydraulic modeling for the Middle Methow River from Winthrop to Twisp, Technical Report No. SRH-2009-42: U.S. Department of the Interior, Bureau of Reclamation, Technical Service Center, Denver, CO, 70 p.
Roni et al 2002	Roni, P., et al. 2002, A review of river restoration techniques and a hierarchical strategy for prioritizing restoration in Pacific Northwest Watersheds. North American Journal of Fisheries Management 22:1-20.
Roni 2005	Roni, P. [editor], 2005, Monitoring River and Watershed Restoration: American Fisheries Society, Bethesda, Maryland, 350 p.
Rood et al. 2003	Rood, S., Bourley, C., Ammon, E., Heki, L., Klotz, J., Morrison, M., Molsey, D., Scoppettone, G., Swanson, S., and Wagner P., 2003, Flows for floodplain forests: A successful riparian restoration. Bioscience, vol. 53, no. 7, pp. 647-656.
Rosgen 1996	Rosgen, D., 1996. Applied river morphology. Wildland Hydrology, Pagosa Springs, CO.

Parenthetical Reference	Bibliographic Citation
Skidmore et al. 2009	Skidmore, S., Thorne, C., Cluer, B., Pess, G., Beechie, T., Castro, J., and Shea, C., 2009, Science base and tools for evaluating stream engineering, management, and restoration proposals; prepared for NOAA Fisheries and U.S. Fish and Wildlife Service: Manual available online at www.restorationreview.com
Stoffel et al. 1991	Stoffel, K., Joseph, N., Waggoner, S., Gulick, C., Korosec, M., and Bunning, B., 1991, Geologic map of Washington – Northeast Quadrant; Washington Division of Geology and Earth Resources, Geologic Map GM-39.
Stewart-Oaten and Bence 2001	Stewart-Oaten, A., and Bence, J., 2001, Temporal and spatial variation in environmental impact assessment: *Ecological Monographs*, 71(2):305-339.
Swales et al. 1986	Swales, S., Lauzier, R., and Levings, C., 1986, Winter habitat preferences of juvenile salmonids in two interior rivers in British Columbia: Canadian Journal of Zoology 64:1506-1514.
UCSRB 2007	Upper Columbia Salmon Recovery Board, 2007, Upper Columbia spring Chinook salmon, steelhead, and bull trout recovery plan: Upper Columbia Salmon Recovery Board, Wenatchee, Washington, 300 pp. Web site: http://www.ucsrb.com/plan.asp
USDA 2008	United States Forest Service, 2008, Stream Inventory Handbook, Level I & II, Pacific Northwest Region, Region 6, Version 2.8, 114 p.
USGS 2002	U.S. Geological Survey, 2002, Gains and losses of streamflow in the Methow River for September 11-13. 2001, provisionary data: http://wa.water.usgs.gov/projects/methow/maps/methowseepmap.pdf.
Waitt, Jr., 1972	Waitt, Jr., 1972, Geomorphology and glacial geology of the Methow drainage basin, Eastern North Cascade Range, Washington; University of Washington doctoral dissertation, 155 p.
WDOE 1990	Washington State Department of Ecology, 1990, Methow River water quality survey and assessment of compliance with water quality standards: Washington State Department of Ecology, Surface Water Investigations Section, Olympia, Washington, 37 p.

GLOSSARY

Some terms in the glossary appear in this reach assessment report.

TERM	DEFINITION
2D-hydraulic analysis	A two-dimensional computer model that simulates hydraulic variables, such as depth-averaged velocity, depth, and bed shear stress, both longitudinally and laterally across an input terrain. Model results are used to produce water surface profiles and innundation areas for discharges of interest.
action	Proposed protection or rehabilitation strategy to improve selected ecosystem processes, thereby partially rehabilitating a riverine ecosystem. Examples of actions include the removal or setback of a levee, reconnecting the stream to its floodplain, planting appropriate vegetation to reestablish a riparian corridor, placement of large woody to force side channel formation or provide fish cover, or implementation of best management practices to minimize adverse effects to the ecosystem.
adaptive management	Adaptive management is a process that promotes flexible decisionmaking that can be adjusted in the face of uncertainties as outcomes from management actions and other events become better understood, with an aim to reduce uncertainty over time via system monitoring. In this way, decisionmaking simultaneously maximizes one or more resource objectives and, either passively or actively, accrues information needed to improve future management (adapted from National Research Council 2004).
alluvial fan	A low, outspread, relatively flat to gently sloping mass of loose rock material, shaped like an open fan or a segment of a cone, deposited by a stream at the place where it issues from a narrow mountain valley upon a plain or broad valley, or where a tributary stream is near or at its junction with the main stream, or wherever a constriction in a valley abruptly ceases or the gradient of the stream suddenly decreases; it is steepest near the mouth of the valley where its apex points upstream, and it slopes gently and convexly outward with a gradually decreasing gradient (Neuendorf et al. 2005).
alluvium	A general term for clay, silt, sand, gravel, or similar unconsolidated detrital material, deposited during comparatively recent geologic time by a stream, as a sorted or semi-sorted sediment on the river bed and floodplain (Neuendorf et al. 2005).
anadromous (fish)	A fish, such as the Pacific salmon, that spawns and spends its early life in freshwater but moves into the ocean where it attains sexual maturity and spends most of its life span.
anthropogenic	Caused by human activities.
bedrock	A general term for the rock, usually solid, that underlies soil or other unconsolidated, superficial material (Neuendorf et al. 2005). The bedrock is generally resistant to fluvial erosion over a span of several decades, but may erode over longer time periods.

TERM	DEFINITION
canopy cover (of a stream)	Vegetation projecting over a stream, including crown cover (generally more than 1 meter [3.3 feet] above the water surface) and overhang cover (less than 1 meter [3.3 feet] above the water).
cfs	Cubic feet per second; a measure of water flows
channel morphology	The physical dimension, shape, form, pattern, profile, and structure of a stream channel.
channel planform	Characteristics of the river channel that determine its two-dimensional pattern as viewed on the ground surface, aerial photograph, or map.
channel stability	The ability of a stream, over time and under the present climatic conditions, to transport the sediment and flows produced by its watershed in such a manner that the stream maintains its dimension, pattern, and profile without either raising or lowering the level of the streambed.
channel units	Morphologically distinct areas within a channel segment that are on the order of one to many channel widths in length. Channel units are somewhat stage dependent and observers may yield inconsistent classifications. To minimize the inconsistencies, channel units are interpreted in the field based on the fluvial processes that created them during channel forming flows and mapped in the geographic information system (GIS) which provides geospatial reference.
channelization	Alteration of a natural channel typically by straightening and deepening the stream channel to permit the water to move faster, to reduce flooding, or to drain wetlands.
constructed features	Human-made features that are constructed in the river and/or floodplain areas (e.g., levees, bridges, riprap).
controls	A feature that is highly resistant to erosion by flowing water and limits the ability of a river or stream to migrate across a valley in either the lateral (horizontal) or vertical direction or both. Geologic controls are naturally occuring features such as bedrock outcrops, landslides, or alluvial fans that erode slowly over long periods of time. Human-constructed features such as highways, railroads, bridge abutments, or riprap may also act as controls and limit the ability of a river to migrate.
degradation	Wearing down of the land surface through the processes of erosion and/or weathering including the lowering of a stream bed due to scouring (incision). Also refers to loss of functional elements within an ecosystem and subsequent negative impacts to fluvial processes and dependant life forms.
depositional channel segments	At channel forming flows (1.5- to 2.0-year recurrance interval), depositional channel segments are transport-limited with channel adjustments (deposition) occuring in response to increased sediment supply.
diversity	Genetic and phenotypic (life history traits, behavior, and morphology) variation within a population.

TERM	DEFINITION
ecosystem	A unit in ecology consisting of the environment with its living elements, plus the non-living factors, that exist in and affect it (Neuendorf et al. 2005).
floodplain	The surface or strip of relatively smooth land adjacent to a river channel constructed by the present river in its existing regimen and covered with water when the river overflows its banks. It is built on alluvium, carried by the river during floods and deposited in the sluggish water beyond the influence of the swiftest current. A river has one floodplain and may have one or more terraces representing abandoned floodplains (Neuendorf et al. 2005).
floodplain-type side channel	A side channel, alcove or spring that has ephemeral or perrenial flow that is located within the floodplain.
fluvial process	Those processes related to the movement of flowing water that shape the surface of the earth through the erosion, transport, and deposition of sediment, soil particles, and organic debris.
general indicator	Interpretation of one or more specific indicators (i.e., water quality) that is used to define or refine potential environmental deficiencies caused by natural or anthropogenic impacts that negatively affect a life stage(s) of the species of concern (i.e., limiting factor). General indicators (sometimes referred to as pathways) are typically analyzed at the reach, valley segment, watershed, and basin scales.
geomorphic potential	The capability of streams to form, connect and sustain fluvial systems (including fish habitat) by dynamically adjusting longitudinally, vertically and laterally to changes in the hydrologic, geomorphic, and biotic regimes over time.
geomorphic reach	An area containing the active channel and its floodplain bounded by vertical and/or lateral geologic controls, such as alluvial fans or bedrock outcrops, and frequently separated from other reaches by abrupt changes in channel slope and valley confinement. Within a geomorphic reach, similar fluvial processes govern channel planform and geometry through driving variables of flow and sediment. A geomorphic reach is comprised of a relatively consistent floodplain type and degree of valley confinement. Geomorphic reaches may vary in length from 100 meters in small, headwater streams to several miles in larger systems (Frissell et al. 1986).
geomorphology	The study of the classification, description, nature, origin, and development of present landforms and their relationships to underlying structures, and of the history of geologic changes caused by the actions of flowing water.

TERM	DEFINITION
GIS	Geographical information system. An organized collection of computer hardware, software, and geographic data designed to capture, store, update, manipulate, analyze, and display all forms of geographically referenced information.
gravel bar-type side channel	A side channel, alcove or spring that has ephemeral or perrenial flow that is located on or adjacent to a gravel bar.
habitat connectivity	Suitable aquatic and/or terrestrial conditions that are connected and needed to provide the physical and ecological processes necessary for the transfer of energy (i.e. food web) to maintain all life stages of species that are dependent on the riverine ecosystem.
habitat unit	A channel-wide segment of a stream which has a distinct set of characteristics. Habitat units and channel units are used interchangeably in the literature, however, habitat units are identified and measured during low-flows and sometimes include several channel units. For example, "pool habitat" is measured from the head of the pool scour to the crest of the pool tailout, which technically includes the following "channel units", pool, run, and riffle.
indicator	A variable used to forecast the value or change in the value of another variable; for example, using temperature, turbidity, and chemical contaminents or nutrients to measure water quality.
inner zone (IZ)	Area where ground-disturbing flows take place; characterized by the presence of primary (perennial) and secondary (ephemeral) side channels, a repetitious sequence of channel units, and relatively uniform physical attributes indicative of localized transport, transition, and deposition.
intervention analysis	Analysis of variables based on samples collected at an impact site before and after an intervention (i.e. a habitat improvement action), so that effects of the intervention may be determined.
large woody debris (LWD)	Large downed trees or parts of trees that are transported by the river during high flows and are often deposited on gravel bars or at the heads of side channels as flow velocity decreases. The trees can be downed through river erosion, wind, fire, landslides, debris flows, or human-induced activities. Generally refers to the woody material in the river channel and floodplain with a diameter of at least 20 inches and has a length greater than 35 feet in eastern Cascade streams (USFS 2006).
limiting factor	Any factor in the environment that limits a population from achieving complete viability with respect to any Viable Salmonid Population (VSP) parameter.

TERM	DEFINITION
overflow channel	A channel that is expressed by no or little vegetation through a vegetated area. There is no evidence of water at low stream discharges. The channel appears to have carried water recently during a flood event. The upstream and/or downstream ends of the overflow channel usually connect to the main channel.
outer zone (OZ)	Area that may become inundated at higher flows, but does not experience a ground-disturbing flow; generally coincidental with the historic channel migration zone unless the channel has been modified or incised leading to the abandonment of the floodplain. (also knows as the floodprone zone)
parcel	A smaller unit within a subreach that has differing impacts on physical and/or ecological processes than an adjacent unit, and the need to sequence or prioritize potential rehabilitation actions within the context of the subreach and reach.
peak flow	Greatest stream discharge recorded over a specified period of time, usually a year, but often a season.
reach-based ecosystem indicators (REI)	Qualitative and/or quantifiable physical and/or biological indicators that are referenced to watershed characteristics and reach characteristics.
Reclamation	U.S. Department of the Interior, Bureau of Reclamation
response reach	A reach that is more responsive to change and often characterized by unconfined and moderately confined alluvial plains/channels that lack lateral geologic controls within close proximity to the channel which often define confined channels. A response reach can be further subdivided into individual subreaches that comprise morphologically distinct areas providing geomorphic control and transitional habitat and biological potential at a finer scale.
riparian area	An area adjacent to a stream, wetland, or other body of water that is transitional between land and water ecosystems. Riparian areas usually have distinctive soils and vegetation community/composition resulting from the interaction of the water body and adjacent soil.
riprap	Materials (typically large angular rocks) that are placed along a river bank to prevent or slow erosion.
river mile (RM)	Miles from the mouth of a river or its confluence with the next downstream river.
side channel	A channel that is not part of the main channel, but appears to have water during low-flow conditions and has evidence for recent higher flow (e.g., may include unvegetated areas [bars] adjacent to the channel). At least the upstream end of the channel connects to, or nearly connects to, the main channel. The downstream end may connect to the main channel or to an overflow channel. May also be referred to as a secondary channel.

TERM	DEFINITION
spawning and rearing habitat	Stream reaches and the associated watershed areas that provide all habitat components necessary for adult spawning and juvenile rearing for a local salmonid population. Spawning and rearing habitat generally supports multiple year classes of juveniles of resident and migratory fish, and may also support subadults and adults from local populations.
subbasin	A subbasin represents the drainage area upslope of any point along a channel network (Montgomery and Bolton 2003). Downstream boundaries of subbasins are typically defined in this assessment at the location of a confluence between a tributary and mainstem channel. An example would be the Middle Fork John Day River subbasin.
subreach	Distinct areas comprised of the floodplain and off-channel and active-channel areas. They are delineated by lateral and vertical controls with respect to position and elevation based on the presence/absence of inner or outer riparian zones.
subreach complex	A subreach that has been subdivided, or parceled, into smaller areas due to complicated anthropogenic impacts and the need to sequence implementation actions.
terrace	A relatively stable, planar surface formed when the river abandons the floodplain that it had previously deposited. It often parallels the river channel, but is high enough above the channel that it rarely, if ever, is covered by water and sediment. The deposits underlying the terrace surface are alluvial, either channel or overbank deposits, or both. Because a terrace represents a former floodplain, it can be used to interpret the history of the river.
transition channel segment	At channel forming flows (1.5- to 2.0-year recurrance interval), transition channel segments are actively adjusting to changes in sediment supply due to natural or anthropogenic distubances, and trend toward either a supply-limited condition (localized incision) or transport-limited (localized aggradation).
transport channel segment	At channel forming flows (1.5- to 2.0-year recurrance interval), transport channel segments are supply-limited and convey sediment inputs which may cause coarsening of the stream bed and/or localized incision.
tributary	A stream feeding, joining, or flowing into a larger stream or lake (Neuendorf et al. 2005).
valley segment	An area of river within a watershed sometimes referred to as a subwatershed that is comprised of smaller geomorphic reaches. Within a valley segment, multiple floodplain types exist and may range between wide, highly complex floodplains with frequently accessed side channels to narrow and minimally complex floodplains with no side channels. Typical scales of a valley segment are on the order of a few to tens of miles in longitudinal length.

TERM	DEFINITION
vertical channel migration	Movement of a stream channel in a vertical direction; the filling and raising or the removal or erosion of streambed material that changes the elevation of the stream channel.
viable salmonid population	An independent population of Pacific salmon or steelhead trout that has a negligible risk of extinction over a 100-year time frame. Viability at the independent population scale is evaluated based on the parameters of abundance, productivity, spatial structure, and diversity (ICBTRT 2007).
watershed	The area of land from which rainfall and/or snow melt drains into a stream or other water body. Watersheds are also sometimes referred to as drainage basins. Ridges of higher ground form the boundaries between watersheds. At these boundaries, rain falling on one side flows toward the low point of one watershed, while rain falling on the other side of the boundary flows toward the low point of a different watershed.

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APPENDICES

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APPENDIX A

Reach-based Ecosystem Indicators

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APPENDIX B

Monitoring Inventory

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APPENDIX C

Reach Documentation

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APPENDIX D

Stream Inventory Survey

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APPENDIX E

Riparian Vegetation Assessment

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APPENDIX F

GIS Database

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