DRAFT

West Plum Creek Stream Management Plan
Stream Health Assessment

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In partnership and cooperation with:

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1.0 INTRODUCTION

West Plum Creek (WPC) is the last relatively unaltered transition zone stream in the area and is home to several important plains fish species. The resident fish in West Plum Creek are the only surviving relicts of declining plains species native to the South Platte and Arkansas River basins. Colorado Parks and Wildlife (CPW), alongside partners including US Fish and Wildlife Service (USFWS), Douglas County Open Space, Chatfield Watershed Authority (CWA), and River Network, support an effort to study and assess aquatic and riparian habitat, as well as better understand hydrology and opportunities in water management with the water users. The end goal is to implement conservation actions that a diverse stakeholder group can support to help protect these fish (e.g., improving fish passage, enhancing water quality, and supporting healthy riparian conditions, as well as exploring potential opportunities for water management and flow protection). One of the first steps in this process is to assess existing conditions within the stream corridor; the Stream Health Assessment framework applied in West Plum Creek is the subject of this document.

1.1 STREAM HEALTH ASSESSMENT

A fundamental component of the Stream Management Planning effort described above is development of a Stream Health Assessment (SHA) to understand existing conditions in the watershed and the primary stressors that have played a part in influencing current conditions. Many Stream Management Plans (SMP) across the state use an adaptation of FACStream 1.0, the Functional Assessment of Colorado Streams (Beardsley et al. 2015). This is a reach-scale assessment tool that rates stream health according to the degree of impairment of several ecological variables. The Colorado Stream Health Assessment Framework (COSHAF) is a recent iteration of FACStream that can be customized to a particular stream or watershed and has been used as a river health assessment organizational framework for several SMPs. Core drivers of river health, represented by approximately 10 variables, are studied for each sub-reach within the project extent. Each reach, and each variable within each reach, is graded using an academic (A-F) grading scale that indicates the degree of impairment from a desired condition. Possible stressors and likely causes of impairment are also explored.

The COSHAF organizational framework has been adapted to fit the purpose and scope of the WPC SMP by customizing the scoring criteria to indicate degree of departure from desired aquatic habitat conditions for the species of interest. For example, the State-endangered northern redbelly dace prefers slow-moving pool habitat and overhanging banks and/or large wood for cover, so the presence of these habitat features is evaluated and included in the structural complexity scoring guidelines.

The comprehensiveness of the data used to score each variable ranges from coarse-level information designed to provide a general estimation of ecological integrity (e.g., windshield surveys, desktop assessments, anecdotal evidence) to fine resolution data collection methods with intensive quantitative metrics (e.g., hydraulic modeling, R2CROSS, riparian transects). Moderate resolution information includes rapid field assessments and detailed remote sensing analyses.

The WPC Stream Health Assessment is based on a framework that characterizes the key functions of West Plum Creek and its tributaries through eight indicators of stream health, with each indicator evaluated based on one or more measurable metrics. Grading guidelines were developed for each metric that define the range of conditions that achieve a functional and healthy stream system. When evaluated collectively, these indicators provide a comprehensive understanding of stream health by identifying the severity, extent, and causes of impairment and in some cases, the relative amount of maintenance and/or management required to sustain characteristic stream functions.

- Flow Regime (amount and timing of water supply);
- Sediment Regime/Morphology (amount, timing, and type of sediment supply, and its influence on stream channel shape and geometry);
- Water Quality (physicochemical properties of water);
- Habitat Connectivity (aquatic and terrestrial habitat connectivity);
- Corridor Connectivity (the degree to which water interacts with the adjacent riparian corridor);
- Riparian Condition (riparian habitat condition, including vegetation structure, complexity, and diversity);
- Structural Complexity (physical aquatic habitat including water depth, velocity, structural components, and substrate); and
- Biotic Community (community and trophic structure of the organisms in the reach).

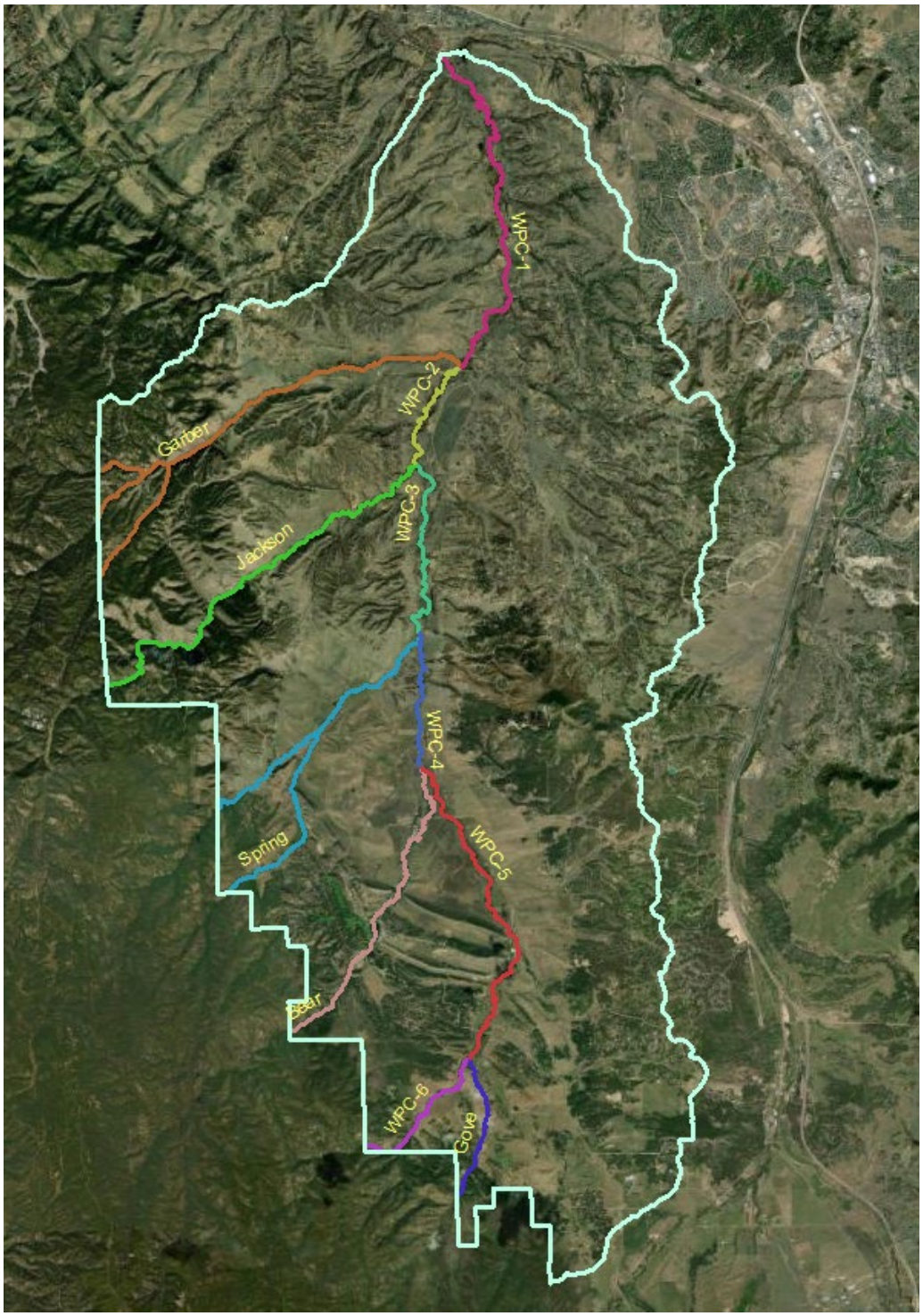
Although each indicator variable is evaluated independently, it is important to recognize the complex interactions and feedbacks between the primary drivers of stream health and function (Fischenich 2006). When one indicator is impaired by an outside stressor or disturbance, the effect often cascades through the system, resulting in broader degradation of stream health that can propagate within a reach, stream segment, or across a watershed.

This document describes each of the indicators and metrics that will be used in the WPC Stream Health Assessment to evaluate existing conditions within the watershed. It also includes the draft scoring criteria related to these categories. Scoring criteria will be refined to better reflect site-specific factors after the data collected during the 2022 field season have been evaluated in more detail.

1.2 REACH DELINEATIONS

West Plum Creek and its major tributaries have been delineated into reaches based on physical properties such as changes in hydrological behavior, tributary confluences, geomorphic characteristics (e.g., valley confinement), dominant land use and land cover types, physiographic regions, transportation networks (e.g., roadway crossings), and locations of important water management infrastructure (e.g., diversion points, reservoirs). Figure 1 displays these reach delineations. Reaches will be further subdivided into sub-reaches for scoring purposes.

Figure 1. West Plum Creek Reach Delineations



2.0 STREAM HEALTH INDICATORS AND SCORING CRITERIA

This section describes the suite of indicators and metrics that, when evaluated, provide a comprehensive understanding of stream health and function across the West Plum Creek watershed. Each of the sub-sections discusses one of the eight indicators listed in Section 1.1, with further subdivisions by metric. The discussion of each metric contains a description of the metric, the data sources used to evaluate the metric, and the scoring criteria that are applied. Publicly available data are used to the extent possible, supplemented by additional data analysis and field data collection where specified.

2.1 FLOW REGIME

Flow regime is defined as the characteristic pattern by which water is supplied to a stream segment from its contributing watershed. It is often represented by a hydrograph, and is dictated by precipitation, inter- and intra-annual weather patterns, watershed characteristics, and human influences. Flow regime is a primary determinant of a stream's structure and function. In particular, the magnitude, duration, frequency, timing, and rate of change of stream flow interact with the landscape to determine the functions that the stream performs. The West Plum Creek SHA evaluates three metrics within the flow regime indicator: **peak flow**, **base flow**, and **rate of change**:

(1) Magnitude, timing, and duration of **peak flows**. Adequate peak flows are essential to stream health and function. Snowmelt- and monsoon-driven peak flows are important for numerous watershed services, such as fishery support, riparian habitat quality, sediment flushing, water quality maintenance, recreation, aesthetics, and groundwater connection and recharge.

(2) Magnitude, timing, and duration of **base flows**. Base flows are the low flows that occur after snowpack melt, during dry season, usually from late summer to early spring. They provide critical support of aquatic habitat and riparian connectivity when the stream needs it most after peak flows have receded. Baseflow is the portion of flow that is sustained between precipitation events, and is driven by groundwater and surface water interactions within the alluvial aquifer, soil moisture, and other delayed sources.

(3) The **rate of change** metric considers the rate at which flows increase and decrease between base and peak flows. The characteristics of the ascending and descending limb of the stream's hydrograph have significant influence on critical life stages for aquatic species such as spawning and incubation period for native fish and seedling establishment period for riparian trees.

The final flow regime score is calculated as an average of the peak flow, base flow, and rate of change metric scores.

2.1.1 Data Sources

Development of scores for this indicator relies on reviewing existing USGS stream gauge data, augmented by data from three pressure transducers deployed at key locations in spring 2022. The

project partners installed three pressure transducers on the main stem of West Plum Creek just downstream of the confluence with the Bear Creek (WPC-4A), Jackson Creek (WPC-2A), and Garber Creek (WPC-1A) tributaries. Furthermore, five Stream Temperature, Intermittency, and Conductivity (STIC) loggers (Chapin et al. 2014) were also installed in spring 2022. In addition to recording stream temperature every 15 minutes, these loggers also identify and log the timing of surface water dry-up. Refer to Figure 2 for a map illustrating streamflow gauge, pressure transducer, and STIC logger locations.

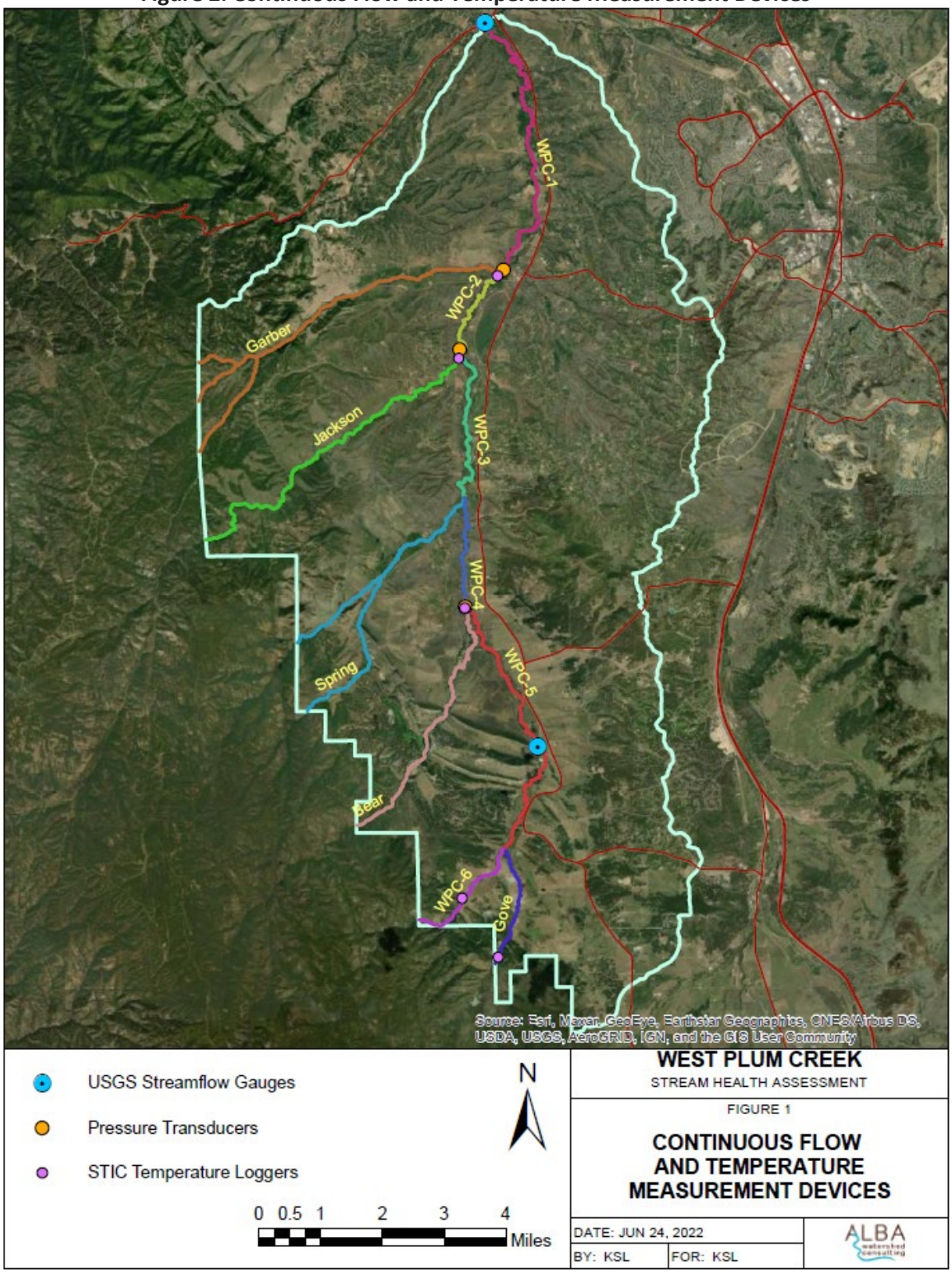
The stream gauges in the West Plum Creek watershed are:

(1) WEST PLUM CREEK AT SEDALIA, CO (PLNRSDCO) – This gauge is located at the mouth of West Plum Creek just upstream of its confluence with East Plum Creek (2015-current, active from April 1 through September 30).

(2) WEST PLUM CREEK NEAR PERRY PARK, CO (WESPERCO) – This gauge is in the upper section of the watershed in the Perry Park area downstream of Douglas County's Sandstone Ranch. The gauge is located on the main stem of West Plum Creek between confluences with Gove Creek and Bear Creek (2015-current, active from April 1 through September 30).

In addition to these sources, diversion records will also be reviewed, particularly those with corresponding dry-up locations. Current local knowledge of dry-up points or significantly reduced flow locations that are not reflected in the existing stream gauge records will also be sought out and considered. A point flow model comparing existing conditions to modeled historical conditions (i.e., without withdrawals or augmentations) may be created to further analyze flow data.

Figure 2. Continuous Flow and Temperature Measurement Devices



2.1.2 Scoring Criteria

The descriptive and semi-quantitative scoring criteria outlined in Tables 1 - 3 are used to rate the peak flow, base flow, and rate of change metrics.

Table 1. Peak Flows Metric Scoring Criteria

Grade	Description
A	Peak flows provide all the functions necessary for a healthy and resilient stream ecosystem. Peak flows drive the function of natural lateral stream movement essential for large-scale regeneration of riparian habitats, conveyance of sediment, and bed scour.
B	Peak flows have been reduced or re-timed such that the function of full (natural) lateral stream movement may not be supported but other essential functions continue to be supported. These functions include support of natural coarse- and fine-scale physical structure to support aquatic habitat, natural flushing of fine sediments and maintenance of clean gravels/cobbles, long-term dynamic equilibrium with occasional management support, maintenance of river form with occasional management support, and inundation of riparian forests, wetlands, and off-channel ponds.
C	Peak flows have been reduced or re-timed such that there is an increased risk of having adverse effects on associated functions. These functions include support of natural coarse- and fine-scale physical structure to support aquatic habitat, natural flushing of fine sediments and maintenance of clean gravels/cobbles, long-term dynamic equilibrium with occasional management support, maintenance of river form with occasional management support, and inundation of riparian forests, wetlands, and off-channel ponds.
D	Peak flows have been significantly reduced or re-timed past critical system thresholds, having a cascading deleterious effect on associated functions. Examples include reaches below diversions that have fluctuating flow regimes but severely attenuated peaks, flashy urban watersheds, or watersheds with major augmentation or withdrawal.
F	Peak flow patterns do not resemble the natural hydrograph, resulting in the near elimination of natural stream functions, and likely require intensive management in order to maintain a river minimally acceptable to the public and resource managers. Examples include rivers with overwhelming augmentation or withdrawal of water.

Table 2. Base Flows Metric Scoring Criteria

Grade	Description
A	Aquatic life is not stressed by altered base flows, which have ample magnitude to provide all the functions necessary for a healthy and resilient stream ecosystem. No known dry-up points exist.
B	Aquatic life is not critically stressed by altered base flows. Base flows support habitat availability, connectivity, and functional needs of aquatic life. Base flow magnitude is less than optimal but with minimal effects on stream function. There are no periods of no flow.

C	Base flows support aquatic life needs most of the time, but poor habitat availability, connectivity, and water quality may occur intermittently. Base flow alterations are short in duration or are during times of the season when stream functions are minimally stressed.
D	Altered base flow patterns are common and measurably affect stream function. There are 20 days per year with no flow on average.
F	Altered base flow patterns have critically reduced stream function, including eliminating native or desired species, violating water quality standards, and/or other irreversible changes. There are 20 or more days per year with no flow on average.

Table 3. Rate of Change Metric Scoring Criteria

Grade	Description
A	Flow rates of change closely resemble natural hydrograph.
B	Artificial flow changes are minimal, if any.
C	Occasional rapid artificial flow changes occur.
D	Frequent rapid artificial flow changes occur.
F	Artificially uniform hydrograph in which rapid daily fluctuations are common.

2.2 SEDIMENT REGIME

Sediment regime is defined as the amount and timing of sediment that all sources, including land erosion in the contributing watershed and upstream channel erosion, supply to a reach, as well as patterns of sediment transport in, through, and out of a reach. An altered sediment regime can cause significant impacts to stream form and function, including aquatic habitat quality and long-term channel stability. The West Plum Creek SHA evaluates the system's sediment regime and associated changes to channel morphology qualitatively.

Fluvial systems erode and route sediment and debris from sources to temporary or long-term storage at a variety of temporal and spatial scales. Sediment that enters a stream reach is either stored in the channel or on the floodplain, or transported downstream. Streams are always working to maintain a balance between inputs, outputs, and storage. However, depending on the location of the reach in a watershed, its valley slope, or its confinement by the valley margins (among other factors), a reach may not always balance sediment inputs with outputs. A reach may export more sediment than is delivered to it (net erosional, or a source reach). Conversely, it may store more sediment than it exports (net depositional). Reaches may be temporarily net erosional or net depositional depending on how they are responding to a perturbation or long-term landscape evolution. For example, as a result of the 2013 Colorado flood, many reaches of the North and South Forks of St. Vrain Creek were net depositional; however, they are now net erosional as the surplus sediment delivered to them from the upstream canyons is re-worked and transported downstream over time.

2.2.1 Data Sources

The sediment regime evaluation classifies this stream characteristic using field observations, mass balance conceptual models, unit stream power trends, and expert judgement. The sediment regime of a reach is not something that is scored; a source reach is not better or worse than a transport or depositional reach and geomorphic characteristics of a source reach should not be compared or contrasted for the purposes of scoring with a transport or depositional reach. Sediment regimes can change over time, as mentioned above, due to perturbations or stressors in the system and the current regime of a reach may deviate from its regime of the past. If there are notable and apparent human or natural stressors (such as a dam) that caused a regime change, they will be noted.

To analyze the sediment regime, reaches are classified as source, transport, or depositional, and a qualitative evaluation is completed based on expert judgement to determine how anthropogenic changes in the watershed may have contributed to changes to the natural sediment regime. This metric is not scored.

2.3 MORPHOLOGY, STREAM EVOLUTION, AND TRAJECTORY

Channel morphology, or channel form, is defined as the river channel shape and geometry. It is directly influenced by the physical attributes of the watershed (e.g., geology, topography, hydrology), channel hydraulics, sediment sources and transport, natural or human stressors, and local hillslope and floodplain uses (e.g., adjacent roadways, grazing). Biological drivers (e.g., riparian vegetation, large woody material, beaver activity, aquatic vegetation) influence river form as well, and can influence flow hydraulics and erosional patterns. The West Plum Creek SHA evaluates the system's channel morphology qualitatively.

Stream evolution models provide an alternative to morphological classifications in that they characterize streams in terms of patterns and trends of adjustment, rather than as a static feature. These models also incorporate the role of biotic factors as one of the foundational drivers in stream process and form. Stream evolution models are conceptual frameworks that identify quasi-predictable stages of geomorphic change as a response to shifting drivers and/or stressors. They provide a basis for interpreting, evaluating, and forecasting current and future stream forms and processes. Applied appropriately, they take into consideration the effects of historical impacts, geomorphic trajectory, and dynamic responses to natural or anthropogenic disturbances. The evaluations for this study will use the Cluer and Thorne (2014) and Castro and Thorne (2019) stream evolution models. The stream evolution classification evaluates the system and drivers, including flow magnitude and frequency, sediment supply and size, vegetation character, geomorphic sensitivity, the degree of human intervention, and proximity to thresholds. Similarly, these characteristics of a reach are not scored but they do provide a basis for which reaches can and should be compared to one another as well as inform evaluations of the impacts of human or natural stressors.

2.3.1 Data Sources

The evaluations for this study will be based on expert judgement and use the Cluer and Thorne (2014) and Castro and Thorne (2019) stream evolution models. The stream evolution classification evaluates the system and drivers, including flow magnitude and frequency, sediment supply and

size, vegetation character, geomorphic sensitivity, the degree of human intervention, and proximity to thresholds. These characteristics of a reach are not scored but they do provide a basis for which reaches can and should be compared to one another as well as inform evaluations of the impacts of human or natural stressors.

Current stream corridor morphology is evaluated and described as it relates to changes in water and sediment supply within the watershed. This metric is not scored but a qualitative assessment of anthropogenic stressors in the watershed that impact stream morphology is provided.

2.4 WATER QUALITY

Water quality is defined as the physico-chemical characteristics of water in a river segment, and it is influenced by natural geological weathering, biogeochemical processes, and human activities (upstream land and water uses). Suitable water quality in streams supports recreational uses, ensures public health, and supports wildlife and fish habitat. Water quality measurements that can be important for assessing stream health include parameters that fall into the following categories: (1) standard physical parameters that can be measured *in situ* with a handheld water quality instrument that provides instantaneous results (e.g., temperature, pH, conductivity, dissolved oxygen, oxidation-reduction potential, turbidity); (2) analytes that require water samples to be collected and sent to a laboratory for analysis (e.g., total and dissolved metals, nutrients); and (3) biological indicators of water quality (e.g., macroinvertebrates).

The West Plum Creek SHA uses several metrics to evaluate water quality. The list of metrics contains parameters that are relatively easy to measure and/or for which data already exist. The five water quality metrics are **temperature, dissolved oxygen, turbidity/total suspended solids, nutrients, and chemical conditions**:

(1) The ranges of many aquatic species are limited by **water temperature**, so this parameter is an important measure of habitat quality. Shading from the riparian canopy, good hyporheic exchange, and seepage from spring-fed tributaries (in some cases) contribute to lower temperatures that support the cold-, cool- and warm-water fish species present in the West Plum Creek watershed.

(2) **Dissolved oxygen** (DO) is the amount of free oxygen present in the water column and is important for the survival of fish and other aquatic species.

(3) **Turbidity** is an optical characteristic of water and a measurement of its clarity. **Total suspended solids** (TSS) is a measure of the amount of particles greater than 2 microns that are suspended in the water column. Turbidity affects the growth rate of algae and other aquatic plants in streams and lakes because increased turbidity causes a decrease in the amount of light for photosynthesis. Suspended sediments can also smother aquatic organisms, carry contaminants, and increase water temperature.

(4) **Nutrients** in the water are necessary to support aquatic life. They occur naturally due to processes such as weathering and erosion, breakdown of organic material, and atmospheric deposition, but high nutrient levels are not good for stream health. Elevated nutrient levels in surface waters can result from human activities such as fertilizer application, runoff from agricultural and urban areas, effluent from wastewater

treatment, seepage from septic systems, detergent, animal waste, and fuel combustion. When nutrients are supplied in excess, water quality suffers through algal blooms, decreased clarity, and bad odor.

(5) Metals generally occur at low concentrations in surface waters, and a number of them are essential nutrients to aquatic biota, but they are toxic at higher concentrations. CDPHE sets regulatory standards for most metals based on the uses identified for each stream segment (e.g., water supply, agriculture, recreation, aquatic life protection); if water quality samples frequently exceed these standards, the stream segment is placed on the State's 303(d) or M&E (monitoring and evaluation) list for that particular constituent. **Chemical conditions** will be reviewed and evaluated for each reach.

Macroinvertebrates are currently discussed in the Biotic Community section, but may be included as part of the water quality indicator for the final SHA. The final water quality score is calculated as an average of the five indicator scores.

2.4.1 Data Sources

Historical and current water quality data are available from a number of sources: Colorado Department of Public Health and Environment (CDPHE), Environmental Protection Agency (EPA), River Watch, Chatfield Watershed Authority (CWA), and Colorado School of Mines (CSM). In general, the monitoring locations are well-distributed throughout the watershed and cover major constituents, including physical parameters (temperature, DO, pH, conductivity, turbidity, TSS), nutrients, E. Coli, and total/dissolved metals. In addition to these data sources, instantaneous dissolved oxygen and turbidity measurements will be taken at quantitative aquatic habitat quality assessment locations, which correspond with fish monitoring locations. There will be approximately 20 of these locations throughout the watershed.

Instantaneous measurements of surface water temperature taken manually have limited value when considering optimal conditions for resident aquatic species. To address this issue, project partners installed five continuous temperature loggers in the West Plum Creek watershed for this project in spring 2022. Continuous temperature data loggers that collect temperature measurements at regular intervals provide a greater understanding of the conditions impacting aquatic habitat. The temperature loggers collect data on Gove Creek, Stark Creek, Bear Creek just upstream of the WPC confluence, Jackson Creek just upstream of the WPC confluence, and Garber Creek just upstream of the WPC confluence.

2.4.2 Scoring Criteria

The temperature metric scoring criteria outlined in Table 4 are based on regulatory standards. These criteria are not quantitative; rather, they rely on consulting current regulatory standards. This is because the CDPHE Stream Classifications for Aquatic Life differ across the watershed, as follows:

- West Plum Creek mainstem from the headwaters to the National Forest boundary, and Bear Creek from the source to the inlet of Perry Park Reservoir (Waconda Reservoir): Cold Water 1.

- West Plum Creek mainstem from the National Forest boundary to the confluence with East Plum Creek, main stems of Gove and Stark Creeks from the National Forest boundary to their confluence, main stems of Garber Creek and Jackson Creek from the National Forest boundary to the confluence with West Plum Creek, main stem of Bear Creek from the outlet of Perry Park Reservoir (Waconda Reservoir) to the confluence with West Plum Creek: Warm Water 1.
- Spring Creek from the National Forest boundary to the confluence with West Plum Creek: Warm Water 2.

Table 4. Temperature Metric Scoring Criteria

Grade	Description
A	Temperature regime is within the expected range for the given watershed location. The temperature regime is supported by dense streambank vegetation which shades the channel, an appropriate flow regime, and/or healthy surface water/groundwater interactions.
B	Temperature regime is within the range of expected conditions. Natural aquatic biota are minimally impaired and regulatory standards are not exceeded.
C	Temperature regime is altered to a degree that could significantly affect natural aquatic biota and/or regulatory standards are occasionally exceeded. Alterations to the natural temperature regime may be caused by lack of shading, altered flow regime, and/or disrupted surface water/groundwater interactions. CDPHE Monitoring and Evaluation (M&E) listed reaches fall in this category.
D	Temperature regime is altered to a degree that is known to affect natural aquatic biota and/or regulatory standards are frequently exceeded. CDPHE 303(d)-listed reaches fall in this category.
F	The temperature regime is fundamentally altered. Natural biota are severely impaired and/or regulatory standards are chronically exceeded.

Similar to temperature, the dissolved oxygen metric scoring criteria outlined in Table 5 are based on regulatory standards. Following data collection and review, the scoring criteria for DO may be updated with numerical concentrations, and indicators of impaired DO such as abundance of algal growth or frequently stagnating/pooling water may also be added to the descriptors.

Table 5. Dissolved Oxygen Metric Scoring Criteria

Grade	Description
A	Dissolved oxygen concentrations are within the expected range for the given watershed location.
B	Dissolved oxygen concentrations are within the range of natural variability. Natural aquatic biota are minimally impaired. Regulatory standards are not exceeded.
C	Dissolved oxygen concentrations are altered to a degree that could significantly affect natural aquatic biota. Regulatory standards are occasionally exceeded. CDPHE Monitoring and Evaluation (M&E) listed reaches fall in this category.
D	Dissolved oxygen concentrations are altered to a degree that is known to affect natural aquatic biota. Regulatory standards are frequently exceeded. CDPHE 303(d) listed reaches fall in this category.

F	Dissolved oxygen concentrations are fundamentally altered. Natural biota are severely impaired. Regulatory standards are chronically exceeded.

Regulatory standards do not currently apply for turbidity/TSS, so the scoring criteria presented in Table 6 may be updated with numerical concentrations following data collection and evaluation.

Table 6. Turbidity/TSS Metric Scoring Criteria

Grade	Description
A	Turbidity levels and/or TSS concentrations are within the expected range for the given watershed location.
B	Turbidity levels and/or TSS concentrations are within the range of natural variability. Natural aquatic biota are minimally impaired.
C	Turbidity levels and/or TSS concentrations are occasionally elevated to a degree that could significantly affect natural aquatic biota.
D	Turbidity levels and/or TSS concentrations are frequently elevated to a degree that is known or suspected to affect natural aquatic biota.
F	Turbidity levels and/or TSS concentrations are chronically elevated. Natural biota are severely impaired.

The scoring criteria outlined in Table 7 based on adherence to interim regulatory standards set by CDPHE for nitrogen and phosphorus are used to rate the nutrients metric.

Table 7. Nutrients Metric Scoring Criteria

Grade	Description
A	Nutrient levels are within the expected range for the given watershed location.
B	Nutrient levels are within the range of natural variability. Natural aquatic biota are minimally impaired. Interim regulatory standards are not exceeded. Examples include rural watersheds with low-density land use or high-density land use and buffers. No severe point sources are present.
C	Nutrient levels are altered to a degree that could significantly affect natural aquatic biota. Examples include reaches with significant agricultural or urban runoff. Interim regulatory standards are occasionally exceeded.
D	Nutrient levels are altered to a degree that is known or suspected to affect natural aquatic biota. Interim regulatory standards are frequently exceeded.
F	Unnaturally eutrophic or oligotrophic conditions clearly affect the distribution and abundance of characteristic aquatic life. Interim regulatory standards have been exceeded consistently.

Similarly, the scoring criteria outlined in Table 8 based on adherence to regulatory standards set by CDPHE are used to rate the chemical conditions metric.

Table 8. Chemical Conditions Metric Scoring Criteria

Grade	Description
A	Chemical conditions are within the expected ranges for the given watershed location.
B	Chemical conditions are within the range of natural variability. Natural aquatic biota are minimally impaired even though background concentrations of certain metals may be elevated. Regulatory standards are not exceeded (except for metals with elevated background concentrations).
C	Chemical conditions are altered to a degree that could potentially limit natural aquatic biota. Stressors are present which create conditions that may warrant inclusion on State impaired waters lists. CDPHE Monitoring and Evaluation (M&E) listed reaches fall in this category.
D	Chemical conditions are altered to a degree that is known to be lethal or limiting to natural aquatic biota. Regulatory standards are frequently exceeded. CDPHE 303(d) listed reaches fall in this category.
F	The chemical environment is fundamentally altered. Natural biota are severely impaired. Regulatory standards have been exceeded consistently.

2.5 HABITAT CONNECTIVITY

Habitat connectivity is defined as the interaction and interconnectedness between a river segment and its surrounding landscape, including pathways for movement of biological organisms and organic matter through the riparian corridor. This indicator includes connectivity of both terrestrial and aquatic communities and considers both longitudinal (upstream/downstream) and lateral (channel/floodplain/upland) directions. The West Plum Creek SHA evaluates two metrics within the habitat connectivity indicator: **aquatic connectivity** and **terrestrial connectivity**:

(1) The **aquatic connectivity** metric addresses the ability for aquatic organisms to migrate and disperse in both longitudinal (upstream/downstream) and lateral (between the channel and floodplain, e.g., side channels) directions. This metric considers presence or absence of barriers to aquatic movement, as well as the density of these barriers within a reach. Scoring the reaches by density of barriers will enable better comparison between reaches for prioritizing fish passage or understanding how fragmentation is shaping the fish community.

(2) The **terrestrial connectivity** metric addresses the ability of terrestrial organisms to move both longitudinally (upstream/downstream) and laterally (between the channel and riparian zone, between riparian zone and upland areas). This metric considers habitat fragmentation, including barriers created by roads, railroads, trails, bridges, stretches of riparian area devoid of vegetation or brush piles, areas of poor vegetative quality (e.g., low herbaceous and shrub density and poor quality vegetation such as a monoculture of non-native smooth brome), exposed rip rap, fences, etc.

The final habitat connectivity score is calculated as an average of the aquatic connectivity and terrestrial connectivity indicator scores.

2.5.1 Data Sources

Data to score this indicator will come from inventorying and mapping diversions and other infrastructure, as well as roadway crossings such as bridges and culverts. Initial mapping will be done using the Colorado Water Conservation Board's GIS layer identifying known in-stream structures as well as aerial imagery. The WPC SHA team is working with US Fish and Wildlife Service to implement their Southeast Aquatic Resources Partnership (SARP) tools for surveying both low-head dams and stream crossings. Field technicians will be trained on evaluating structures and completing data sheets in a systematic way to provide information about the presence and severity of each of these barriers. Connectivity is enhanced with the presence of side-channels and backwater areas, so these will be mapped and qualitatively evaluated in representative reaches as well. Fieldwork will be augmented by review of historical aerial imagery.

2.5.2 Scoring Criteria

The scoring criteria outlined in Tables 9 and 10 based on presence and extent of barriers to aquatic species movement and the size of the riparian corridor, respectively, are used rate the aquatic habitat connectivity and terrestrial habitat connectivity metrics.

Table 9. Aquatic Habitat Connectivity Metric Scoring Criteria

Grade	Description
A	No significant barriers exist that prevent migration or dispersal of aquatic organisms within the entire ecoregion and upstream headwaters.
B	Fewer than 0.2 impermeable migration/dispersal barriers are present per mile and/or there are minor migration/dispersal impediments on the reach or adjacent reaches. Mild loss of side channel and/or backwater area access may impact spawning and cover for certain species.
C	Between 0.2 and 0.5 impermeable migration/dispersal barriers are present per mile and/or there are multiple migration/dispersal impediments on the reach or adjacent reaches. Moderate loss of side channel and/or backwater area access may impact spawning and cover for certain species.
D	Between 0.5 and 1 impermeable migration/dispersal barriers are present per mile and/or migration/dispersal is severely impeded on the reach or adjacent reaches. Substantial loss of side channel and/or backwater area access may impact spawning and cover for certain species.
F	The reach is effectively isolated. More than one impermeable migration/dispersal barrier is present per mile and/or migration/dispersal is completely impeded on the reach or adjacent reaches. Access to side channel and/or backwater areas for spawning and cover is unavailable.

Table 10. Terrestrial Connectivity Metric Scoring Criteria

Grade	Description
A	A continuous corridor of functional riparian habitat at least twice the width of the active channel is present within the reach. No appreciable barriers exist within the reach or between the reach and adjacent wetland and riparian habitats. Intact upland habitat between 25-100 feet wide beyond the riparian corridor may be present if not constrained by topography.

B	A continuous corridor of functional riparian habitat at least equal to the width of the active channel is present within the reach. Barriers impeding migration or dispersal within the reach or between the reach and adjacent wetland and riparian habitats are permeable and easily passed by most organisms. Examples include gravel roads, minor berms, ditches, or barbed wire fences. More significant barriers could impede access of plant/animal species in the reach to up to 10% of the surrounding habitat. Intact upland habitat between 25-50 feet wide beyond the riparian corridor may be present if not constrained by topography.
C	A continuous corridor of functional riparian habitat at least half the width of the active channel is present within the reach. Barriers to migration or dispersal retard the ability of many species to move within the reach or between the reach and adjacent wetland and riparian habitats. Passage of species through such barriers is still possible but may be slowed, constrained to certain times of day, increasingly dangerous, or require additional travel. Examples include busy two-lane roads, rail lines, small/medium artificial water bodies, or widely scattered residential development. More significant barriers could impede access of plant/animal species in the reach to up to 25% of the surrounding habitat. Intact upland habitat may be present, albeit narrow.
D	A continuous corridor of functional riparian habitat less than half the width of the active channel is present within the reach. Barriers to migration or dispersal preclude the ability of many species to move within the reach or between the reach and up to 75% of adjacent wetland and riparian habitats. Travel to those habitats is strongly restricted and may include a high chance of mortality. Up to 50% of the surrounding wetland/riparian habitat is functionally isolated from the reach. Quality upland habitat is extremely limited or absent.
F	A continuous corridor of functional riparian habitat is absent altogether. The reach is essentially isolated from the surrounding wetland/riparian habitat by impermeable migration and dispersal barriers. An interstate highway or concrete-lined water conveyance canal are examples of barriers that would generally create functional isolation. Quality upland habitat is absent.

2.6 CORRIDOR CONNECTIVITY

Corridor connectivity describes the degree to which water interacts with the adjacent riparian corridor. This indicator rates the degree to which the planform extent of effective floodplain is decreased due to either hydrologic impacts, channel impacts (e.g., enlargement, entrenchment, channelization), or land uses in the floodplain area (e.g., levees, drainage ditches, development, floodplain fill) that impede water access and spatial distribution. The WPC SHA evaluates corridor connectivity using two metrics, **existing seasonal connectivity** and **potential seasonal connectivity**:

(1) The **existing seasonal connectivity** metric is a calculated ratio that relates the square footage of land between zero and two vertical feet of the channel per foot of channel length (sf/ft). This ratio is then compared to a reference value for a geomorphically similar reach in good condition in the study area. The existing seasonal connectivity, or “near channel connectivity” metric is a proxy measure of the extent and frequency with which typical seasonal high flows interact with the channel and adjacent floodplain. This

interaction is critical for supporting riparian vegetation, maintaining a high water table and consistent hyporheic exchange, and ensuring that certain native species can access off-channel habitats as needed.

(2) The **potential seasonal connectivity** metric is a calculated ratio that relates the square footage of land between zero and five vertical feet of the channel per foot of channel length (sf/ft). This ratio is then compared to a reference value for a geomorphically similar reach in good condition in the study area. The potential seasonal connectivity, or "high flows connectivity" metric is a proxy measure of the extent and frequency with which higher flows and/or existing flows with the addition of several large beaver dams, such as those that have historically and recently been present in the watershed, interact with the channel and adjacent floodplain. This interaction would have compounding benefits that would bolster riparian vegetation growth and recruitment, raise the water table, and provide native species of concern with reliable access to off-channel habitats.

2.6.1 Data Sources

This analysis relies on high-resolution topographic data obtained from the Colorado Water Conservation Board and the Denver Regional Council of Governments.

2.6.2 Scoring Criteria

The scoring criteria outlined in Tables 11 and 12 are used rate the existing and potential seasonal connectivity metrics.

Table 11. Existing Seasonal Connectivity Metric Scoring Criteria

Grade	Description
A	The ratio of square footage of land between zero and two vertical feet of the channel to feet of channel length is approximately equal to the reference ratio for a geomorphically similar reach.
B	Slight deviation from reference ratio for geomorphically similar reach.
C	Moderate deviation from reference ratio for geomorphically similar reach.
D	Severe deviation from reference ratio for geomorphically similar reach.
F	Extreme deviation from reference ratio for geomorphically similar reach.

Table 12. Potential Seasonal Connectivity Metric Scoring Criteria

Grade	Description
A	The ratio of square footage of land between zero and five vertical feet of the channel to feet of channel length is approximately equal to the reference ratio for a geomorphically similar reach.
B	Slight deviation from reference ratio for geomorphically similar reach.

C	Moderate deviation from reference ratio for geomorphically similar reach.
D	Severe deviation from reference ratio for geomorphically similar reach.
F	Extreme deviation from reference ratio for geomorphically similar reach.

2.7 RIPARIAN CONDITION

Riparian areas, or lands that occur along and are influenced by watercourses, are a critical part of a healthy and resilient stream ecosystems, providing physical roughness that slows water velocities and mitigates the impacts of flood flows; bank stability through root system cohesiveness; habitat for a diversity of riparian plants, animals, and microbes; water quality improvement; shade for the stream corridor to maintain a healthy thermal regime; large wood to stream channels, which creates beneficial habitat complexity; organic matter to the water column; and off-channel habitats like backwaters, wetlands, and side channels that act as refugia for fish and other aquatic species. Well-established and connected riparian areas also link stream corridor and upland ecological processes. Riparian condition is defined as the degree to which riparian areas support river health and critical functions. The WPC SHA evaluates a single metric within the riparian condition indicator: **vegetation structure and complexity**.

The vegetation structure and complexity metric describes riparian vegetation and its ability to support characteristic riparian functions. Healthy riparian zones are characterized by a high level of vertical and horizontal complexity, including a mosaic of habitat types and multiple vegetation layers. Included in these considerations are structure, height, cover, species diversity, complexity, age, and patchiness/interspersion of riparian vegetation. The character and complexity of riparian vegetation are primarily driven by above ground saturation and the associated disturbance caused by seasonal flooding, alluvial groundwater, and erosional and depositional changes that create bars and distribute overbank fine sediment. Complex riparian corridors in turn influence a spectrum of physical functions in the river ecosystem while providing critical wildlife habitat.

2.7.1 Data Sources

The Denver Regional Council of Governments (DRCOG) has embarked on a project to develop a detailed high-resolution regional land cover dataset in 2021 following a successful pilot study in 2020. The WPC drainage is part of the target area mapped in spring 2022. The high-resolution mapping includes structures, impervious surfaces, roads, open water, grassland, shrubland, tree canopy, turf, barren, and cropland classifications. This dataset will be used to rate the vegetation structure and complexity metric. It will be field verified by Douglas County field technician interns at as many locations as possible. The interns will also note instances of Russian olive at the locations they visit for qualitative assessments, as these invasive species have established in many areas throughout the WPC drainage. Russian olive, a Colorado List B species, is a perennial tree or shrub that reproduces by seed or root suckers. Once thought to be a beneficial windbreak tree, Russian olive is detrimental to riparian zones because it outcompetes native plants, interferes with natural plant succession and nutrient cycling, and taxes water reserves.

2.7.2 Scoring Criteria

The scoring criteria outlined in Table 13 based on the ability of the riparian corridor to support river health functional attributes are used to rate the vegetation structure and complexity indicator.

Table 13. Vegetation Structure and Complexity Indicator Scoring Criteria

Grade	Description
A	Native riparian conditions that are expected for a well-functioning stream in its watershed location. Vegetation diversity is self-sustaining with intact hydrology and topography that supports an abundance of native flora and fauna. Habitat is characteristically patchy, with strong interspersion of patches and good vertical structure. Full support of stream health.
B	Riparian habitat resembles native conditions with detectable changes. Vegetation is self-sustaining, requiring little or no maintenance to preserve characteristic structure diversity. Native species predominate, although minor presence of problematic species may occur. Noxious species do not threaten function. Habitat maintains a high degree of patchiness and interspersion, with little homogenization or loss of vertical structure. Minor reduction in the support of stream health attributes.
C	Decreased plant diversity, loss of structural complexity, and/or homogenization of vertical structure, patchiness, and interspersion are evident, but the riparian area is vegetated. Small populations of noxious species may occur, and a significant proportion of the species are exotic or invasive natives. Examples include floodplain hayfields. Riparian land use contributes to the degradation of one or more stream health attributes.
D	Decreased plant diversity, loss of structural complexity, and/or homogenization of vertical structure, patchiness, and interspersion are severe. Riparian habitat may be isolated from the river and noxious weeds, invasive species, or exotics may be prevalent or dominant. Bare ground or impervious surfaces make up a significant portion of land cover. Vegetation tends to be unnatural, landscaped, or manicured. Examples include residential lawns, sports fields, and golf courses. Riparian land use contributes to stream dysfunction.
F	Riparian area is developed or wholly converted with predominantly bare ground, impervious surfaces, or otherwise lacking in vegetation as a result of land use and management actions. Riparian habitat function is essentially extinguished, and land use contributes substantially to stream dysfunction.

2.8 STRUCTURAL COMPLEXITY

Structural complexity is defined as the degree of heterogeneity and physical composition of a stream that results from interactions between flow regime, sediment dynamics, wood loading, and other factors. The more complex and heterogeneous the physical structure of a stream, the more enhanced the habitat for resident aquatic species. Structural complexity considers hydraulic characteristics (water depth and velocity patterns), bed and bank features, woody material, and streambed substrate. Two metrics comprise the structural complexity indicator: **macrohabitat** and **microhabitat**:

(1) The **macrohabitat** metric considers physical habitat relevant to fish and larger animals, including distribution and diversity of water depth, velocity, and physical cover, shape of bed and bank features, and other large physical structure provided by rock, wood, vegetation, etc. Macrohabitat includes cobble/sand bars, undercut banks, presence/absence of secondary channels/backwaters, and presence, extent, and quality of large wood.

(2) The **microhabitat** metric considers physical habitat relevant to small aquatic species such as benthic macroinvertebrates and larval fish, particularly the availability of interstitial spaces among the river bed substrate, degree of embeddedness, armoring, proportion of fine sediment, algae cover, and patches of organic material or detritus accumulations.

The final structural complexity score is calculated as an average of the macrohabitat and microhabitat indicator scores.

2.8.1 Data Sources

In scoring the structural complexity indicator, a concerted effort is made to integrate quantifiable records and observations from fieldwork conducted in a quantitative manner by staff at approximately 20 fish monitoring locations, as well as qualitative habitat assessments conducted by field technician interns at approximately 50 locations.

The following features that are important for heterogeneity and complexity within the channel are evaluated in the field in some form at both the quantitative and qualitative aquatic habitat assessment locations. These features are important for some or all of the species of concern that inhabit the West Plum Creek drainage.

- Bedforms including riffles, runs, pools, and glides;
- Split flows and secondary/side channels;
- Backwater areas;
- Off-channel ponds;
- Point bars;
- Residual pool depth (riffle crest depth minus deepest pool depth);
- Signs of beaver activity (active and historical chews, dams, bank dens);
- Presence, size, and quality of large wood;
- Undercut banks; and
- Overhanging vegetation.

The microhabitat indicator is scored in the field through visual observations of embeddedness and presence/absence of aquatic vegetation and algae cover. Embeddedness measures the degree to which gravel and cobble substrates are surrounded by fine sediment. It relates directly to the suitability of the stream substrate as habitat for macroinvertebrates, fish spawning, and egg incubation.

2.8.2 Scoring Criteria

The scoring criteria outlined in Table 14 based on estimates of diversity of depth/velocity combinations, topographic complexity of beds and banks, physical structure of the reach, and elements of complexity and cover are used to rate the macrohabitat metric.

Table 14. Macrohabitat Metric Scoring Criteria

Grade	Description
A	Macro-scale structural heterogeneity in the reach is considered to be representative of expected aquatic habitat conditions given its watershed location. All velocity-depth combinations and structural components (features formed by wood, rock, vegetation, and debris dams/jams) are present in characteristic distribution.
B	Most typical velocity-depth combinations are present, but distribution of structural components (features formed by wood, rock, vegetation, and debris dams/jams) is slightly skewed due to dispersed stressors or minimal direct impacts. The reach still maintains heterogeneity and is varied and complex. Pools provide adequate cover for fish and other aquatic organisms. Woody material, undercut banks, and other natural elements also provide cover.
C	Some typical velocity-depth combinations or characteristic structural elements (features formed by wood, rock, vegetation, and debris dams/jams) are absent or limited. Pools provide some cover for fish and other aquatic organisms. The reach may have homogeneous stretches and may lack cover provided by woody material and undercut banks. Examples include reaches with increased pool/run habitat, lack of off-channel habitat, or skewed riffle-pool ratio. Reaches with artificial structure or hardened/armored banks also fall into this category.
D	Some typical velocity-depth combinations or characteristic structural elements (features formed by wood, rock, vegetation, and debris dams/jams) are absent, making the reach uncharacteristically homogeneous. Pools may provide minimal cover for fish and other aquatic organisms. Examples include reaches with graded or heavily armored banks, or with features that are frequently limited by inundation or low flow.
F	Homogeneous form with uniform velocity-depth pattern, lack of physical structure, and lack of pools. Examples include reaches with severely homogenized physical characteristics such as atypical plane-bed morphology.

The scoring criteria outlined in Table 15 based on field observations of interstitial space availability, embeddedness, and presence of algae and aquatic vegetation are used to rate the microhabitat metric.

Table 15. Microhabitat Metric Scoring Criteria

Grade	Description
A	Micro-scale structural heterogeneity in the reach is considered to be representative of expected aquatic habitat conditions given its watershed location. Interstitial spaces appropriate for natural geographic conditions. Riffles support clean gravel substrates.

B	All aspects of micro-scale structural diversity are present, but distribution of features is skewed due to dispersed stressors or minimal direct impacts. Examples include reaches with mild fine sediment deposition or slightly decreased interstitial space (mild embeddedness, 10-20%) for either cobble- or gravel-bed reaches, depending on natural geographic conditions. Some algae/aquatic vegetation is present.
C	Some aspects of micro-scale structural diversity are lacking or limited. Examples include reaches with altered bed material distribution, patches of armoring, increased cover of persistent algae/aquatic vegetation, decreased detritus/organic accumulation patches, or moderate embeddedness (20-30%) for either cobble- or gravel-bed reaches, depending on natural geographic conditions.
D	Some aspects of micro-scale structural diversity are lacking or severely limited, making the reach uncharacteristically homogeneous. Examples include reaches with widespread armoring, persistent algae/aquatic vegetation in riffles, lack of any detritus/organic accumulation patches, or severe embeddedness (30-40%) for either cobble- or gravel-bed reaches, depending on natural geographic conditions.
F	Completely static or homogeneous armored micro-scale physical structure. Examples include gravel- or cobble-bed streams that are aggrading with fine material (embeddedness >40%) or choked with algae, alluvial streams unnecessarily scoured to bedrock, or grouted/hardened artificial streambeds.

2.9 BIOTIC COMMUNITY

Biotic community is defined as the health of resident aquatic biota including microbes, periphyton (attached algae), macrophytes (aquatic plants), macroinvertebrates (aquatic insects), fish, amphibians, and any other organism that is part of the aquatic biological community for all or part of its life history. The biotic composition of a stream is impacted by all other stream health factors. Because the productivity and survival of aquatic organisms is dependent on all other aspects of stream function, the health and structure of the biotic community is a prime indicator of overall stream health. There are three metrics within the biotic community indicator: **macroinvertebrates**, **fishery**, and **herps**.

(1) **Benthic macroinvertebrates** are excellent indicators of the condition of lotic aquatic systems because macroinvertebrates are found in almost all freshwater environments, have a small home range, are relatively easy to sample and identify, and the different taxonomic groups show varying degrees of sensitivity to pollution and other stressors (CDPHE 2016a, Barbour et al. 1999). Thus, measuring the benthic macroinvertebrate community is a useful tool for stream health monitoring, particularly if baseline data are available.

Many comparative metrics may be used to assess the health of the benthic community, including the number of individuals; total number of taxa; total number of pollution-sensitive Ephemeroptera, Plecoptera, Trichoptera (EPT) taxa; ratios of different functional feeding groups or taxonomic groups; Shannon-Wiener Diversity Index (SDI); Hilsenhoff Biotic Index (HBI); and many others. The SDI is a mathematical measure of species diversity within a given community. For benthic macroinvertebrates, values range from 0-5, and higher values indicate higher species diversity (MacArthur 1965). The HBI reveals

the relative abundance of pollution-tolerant species. Scores range from 0-10, where a higher value indicates more pollution-tolerant species are present (Hilsenhoff 1987).

The Colorado Department of Public Health and Environment (CDPHE) monitors streams throughout the state for assessment and protection of water resource quality. Their principal indicator is a multi-metric index (MMI) based on direct benthic macroinvertebrate sample data. By using five to six equally weighted metrics, the MMI combines measures of diversity, abundance, pollution tolerance, community structure, and other factors to generate a normalized score of 0-100 for each sample. Scores may then be compared to reference threshold scores for one of three generalized Colorado biotypes (mountains, transition, plains). In "grey" areas where the MMI alone is not sufficient, CDPHE also compares SDI and HBI results to attainment and impairment threshold values.

(2) Fish population monitoring, typically conducted via electrofishing surveys, is used to determine fish species composition (including relative abundances of species), density estimates, age or size class distribution, and other metrics related to the health of the **fishery**. One of the main drivers of the WPC Stream Management Plan and component Stream Health Assessment is the presence and persistence of several native South Platte Basin plains fish species that have been extirpated from the rest of their historical range. These species include the Northern Redbelly Dace (State of Colorado Tier 1 Species of Greatest Conservation Need), Common Shiner (State of Colorado Threatened Species), Plains Topminnow (State of Colorado Tier 1 Species of Greatest Conservation Need, USFS Sensitive Species), and Iowa Darter (State of Colorado Species of Concern). A comprehensive understanding the upper and lower distribution limits of State-listed species, a better quantification of species diversity along the entire longitudinal gradient of West Plum Creek, and a review of seasonal differences in fish populations is important for this project.

(3) The **herps** metric includes an assessment of the presence of both Northern Leopard Frogs and bullfrogs, as the former is also listed as a State of Colorado Tier 1 Species of Greatest Conservation Need, and the latter preys on the former.

2.9.1 Data Sources

Much of the study area is on a provisional CDPHE 303(d) list for macroinvertebrates, but monitoring has not occurred since 2010 to support this listing. Information about the composition of the benthic macroinvertebrate community would also inform the objective of supporting a healthy native plains-species fishery. Therefore, the WPC SHA is partnering with CPW and the RiverWatch program to collect macroinvertebrate community data for this project at 8-9 locations depending on private property access, many of which are coincident with historical CDPHE monitoring locations. Given the paucity of current data, the relative ease of collecting and analyzing macroinvertebrate data, and the useful information that can be gleaned from these data, the WPC SHA provides a good opportunity for evaluating the macroinvertebrate community and tracking changes over time.

The CPW database holds a significant amount of historical fishery data for the West Plum Creek watershed (1912 to present). In particular, the database includes more than 200 location-date

combinations for fish presence/absence and relative abundance by species. These data span both public and private property, and are spatially well-distributed across the entire study area, with a total of 67 discrete locations. While most of the monitoring was completed within the stream reaches, some occurred in nearby ponds or ditches. CPW is partnering with Colorado State University's (CSU) Larval Fish Laboratory (LVL) to conduct fishery monitoring at 20-22 locations depending on access during 3 seasons: summer 2022, fall 2022, and spring 2023.

Herp data will be collected as a component of fish monitoring, quantitative and qualitative aquatic habitat assessments, and any other fieldwork occurring in the West Plum Creek watershed in 2022 and 2023. Field staff will be trained on distinguishing calls and identifying the different life stages of both Northern Leopard Frogs and bullfrogs to determine where these species are found.

2.9.2 Scoring Criteria

The scoring criteria outlined in Table 16 to rate the benthic macroinvertebrate metric are currently based on adherence to regulatory standards set by CDPHE for the relevant biotype (biotype 1, transition) using mainly MMI scores and CDPHE-designated attainment and impairment thresholds. However, these guidelines may be refined to potentially include other comparative metrics.

Table 16. Benthic Macroinvertebrate Metric Scoring Criteria

Grade	Description
A	The reach is considered to be representative of the expected condition for aquatic insect communities and aquatic life use for a well-functioning stream in its process domain. No management is needed other than protection of existing conditions. MMI score is 80-100 and the reach is in attainment for aquatic life use (CDPHE 2016).
B	Some detectable stressors are evident with minor alterations to aquatic insect communities. The ecological system retains its overall structure and supports a high level of function. Some management may be required to sustain or improve this condition. MMI score is 61-79 and the reach is in attainment for aquatic life use (CDPHE 2016).
C	The reach supports and maintains essential components of the unimpaired aquatic insect community, but exhibits measurable signs of degradation and less than optimal community parameters. Management is required (or recommended) to maintain and improve this condition. MMI score is 46-60 and meets the CDPHE (2016) attainment threshold for aquatic life use.
D	Detectable alterations or degradation of aquatic life use are present, but the system still supports a fundamental aquatic insect community structure and function. Active management is required (or recommended) to maintain and improve characteristic functional support. MMI score is 34-45 and is considered to be in the "gray area" between aquatic life use attainment and impairment (CDPHE 2016).
F	Clear impairment to the aquatic insect community and aquatic life is present. This level of alteration generally results in an inability to support characteristic aquatic organisms, or makes the stream segment biologically unsuitable. MMI score is < 34 and aquatic life use is thus considered "impaired" (CDPHE 2016).

The scoring criteria outlined in Table 17 based on presence and proportions of native species are used to rate the fishery metric. This scoring scheme is based on the CPW historical fishery dataset for West Plum Creek, as follows: number of native species is the total count of all species considered native to the South Platte Basin encountered in the reach across all sample sites and dates; number of State Wildlife Action Plan (SWAP) species is the number of SWAP Species of Greatest Conservation Need (SGCN) species encountered in the reach across all sample sites and dates; proportion of native species is the proportion of fish that are native across all sample sites and dates in the reach; and Common Shiner multiple life stages is whether breeding-age adults (>70 mm) and juvenile Common Shiners are present.

Table 17. Fishery Metric Scoring Criteria

Grade	Description
A	The reach supports the expected native species for the given watershed location. At least 11 native fish species are present in the reach, and numerically native fish comprise 98% or greater of sampled fish. Of the native fish species present in the reach, at least 3 are State Wildlife Action Plan (SWAP) species. Multiple life stages are present for Common Shiner (juveniles and breeding age adults).
B	The reach supports a majority of the expected native species for the given watershed location. Between 8 and 11 native fish species are present in the reach, and numerically native fish comprise 95% or greater of sampled fish. Of the native fish species present in the reach, at least 2 are SWAP species. Multiple life stages are present for Common Shiner (juveniles and breeding age adults).
C	The reach supports some of the expected native species for the given watershed location. Between 6 and 8 native fish species are present in the reach, and numerically native fish comprise 90% or greater of sampled fish. Of the native fish species present in the reach, at least 1 is a SWAP species. Common Shiner multiple life stages are not present.
D	The reach supports few or none of the expected native species for the given watershed location. Between 4 and 5 native fish species are present in the reach, and numerically native fish comprise 60% or greater of sampled fish. Of the native fish species present in the reach, none are SWAP species. Common Shiner multiple life stages are not present.
F	The reach does not support native fish, and/or the fishery exhibits a highly degraded condition. Fewer than 4 native fish species are present in the reach. Of the native fish species present in the reach, none are SWAP species. Common Shiner multiple life stages are not present.

The scoring criteria outlined in Table 18 based on evidence of Northern Leopard Frogs and/or bullfrogs are used to rate the herps indicator.

Table 18. Herps Metric Scoring Criteria

Grade	Description
A	Northern Leopard Frogs have been detected in the reach or riparian corridor, including evidence of breeding. Bullfrogs have not been detected.
B	Northern Leopard Frogs have been detected in the reach or riparian corridor, but evidence of breeding has not been observed. Bullfrogs have not been detected.

C	Both Northern Leopard Frogs and bullfrogs have been detected in the reach or riparian corridor in relatively equal numbers.
D	Both Northern Leopard Frogs and bullfrogs have been detected in the reach or riparian corridor, but bullfrogs predominate, or no frogs detected in the reach at all.
F	Only bullfrogs have been detected in the reach or riparian corridor.

2.10 OVERALL STREAM HEALTH ASSESSMENT REACH SCORES

Upon assigning scores for each indicator and category to each reach within the WPC SHA extent, the individual category scores are "rolled up" to derive a stream health assessment score for each reach. The percent contributions of each stream health indicator are provided in Table 19. A weighted average by reach is then calculated to yield a final score for each reach within the WPC SHA.

Table 19. Percent Contribution to Overall Stream Health Assessment Score by Indicator

Category	Percent
Flow Regime	20
Sediment Regime	0
Morphology	0
Water Quality	10
Habitat Connectivity	10
Corridor Connectivity	15
Riparian Condition	15
Structural Complexity	20
Biotic Community	10

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