

TECHNICAL MEMO

To: Stephanie Grigsby, Design Workshop
From: David Shaw, Erika Groh, and Catherine Shnurrenberger (CS Surveys)
Date: September 18, 2024
Cc: River Revitalization Steering Committee

Subject: Truckee River Downtown Corridor Ecological Features Assessment

Introduction and Purpose of the Assessment

Balance Hydrologics and CS Surveys are working together with Design Workshop on preparation of the Truckee River Revitalization Action Plan (Plan) for the Town of Truckee. In developing the Plan, we understand that Design Workshop and the Steering Committee would like to:

- Characterize the degree to which Plan elements may disrupt wildlife and vegetation corridors;
- Describe the impacts of in-channel sedimentation on aquatic habitat and riparian vegetation, and whether proposed Plan elements might reduce or increase sediment delivery to the Truckee River;
- Evaluate whether proposed plan elements may affect river flows or harm or benefit riparian areas; and
- Identify opportunities to improve riparian and floodplain functions and values.

To provide a context in which to carry out these evaluations, Balance and CS Surveys have developed this baseline assessment of ecological functions. This assessment aims to address a goal of the Town of Truckee's General Plan: to "Preserve and expand the quantity and quality of natural systems in Truckee by promoting aquatic and terrestrial biodiversity and by implementing environmental, ecological, and conservation-minded strategies."

The Study Area for the Truckee River Revitalization Project extends from the junction of Highway 89 and West River Street at the upstream end to near the Highway 267 overpass at the downstream end (**Figure 1**). The Study Area includes light commercial development, residential development, and natural upland and riparian vegetation.

Previous Studies

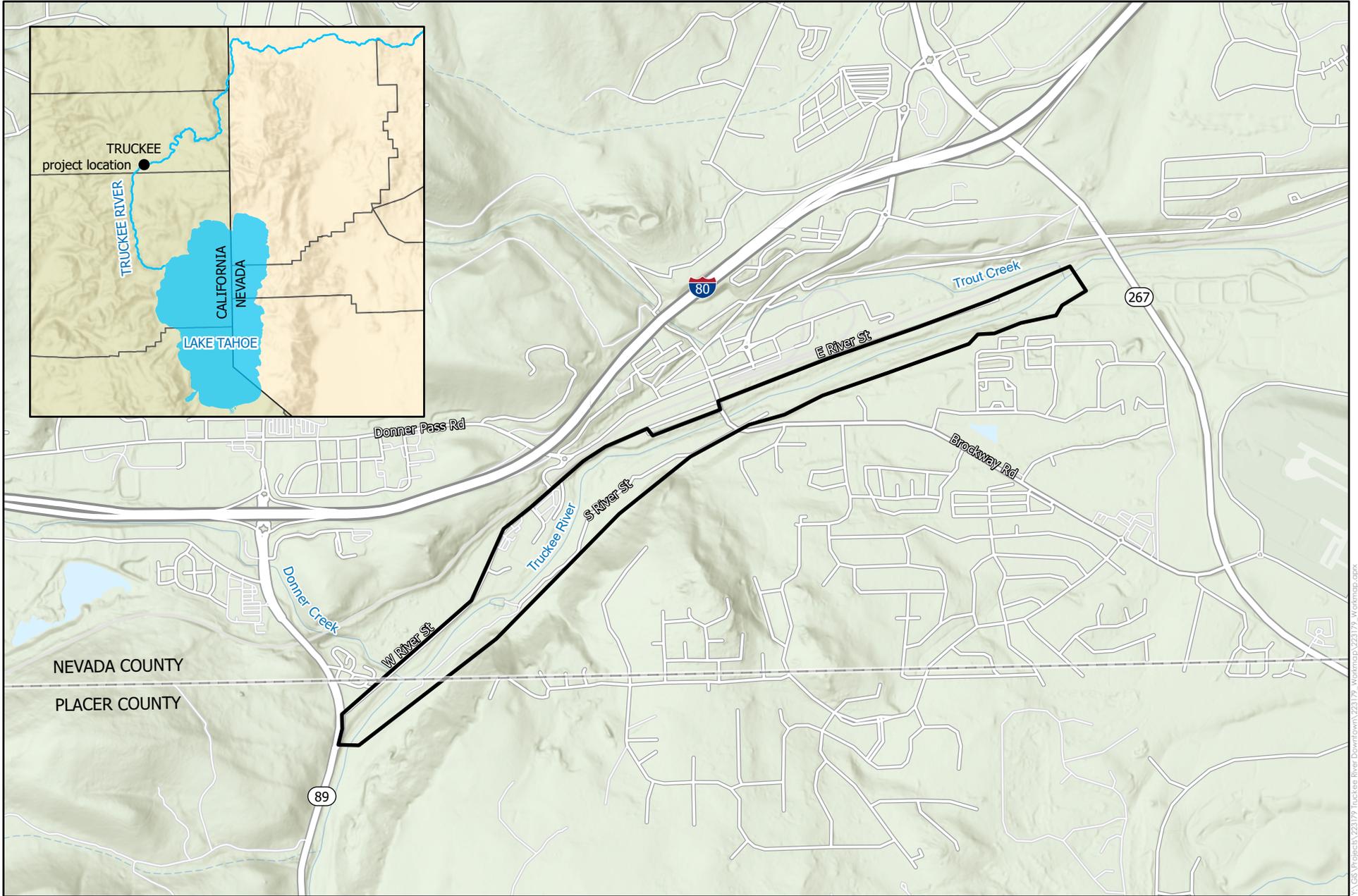
This assessment is based primarily on our and others' previous work within the Study Area, as supplemented by reconnaissance-level field observations. We have reviewed and utilized the following prior published work:

- Downtown River Revitalization Strategy (Town of Truckee, 2005)
- Town of Truckee GIS spatial data (where available)
- Downtown Truckee River Revitalization Assessment (Balance Hydrologics, 2018)
- Truckee River Legacy Trail Phase 4 Resource Assessments
- Truckee River Watershed Council bioassessment data (where available)
- Water quality data, as available from the Truckee River Watershed Council, Truckee River Information Gateway (TRIG), and the Town of Truckee's Truckee River Water Quality Monitoring Program
- Truckee River Corridor Access Plan (EDAW, 2006)
- 100-year floodplain mapping and Flood Insurance Studies completed by FEMA
- Big Jack East NEPA Resource Assessments (Tahoe National Forest)
- Placer County River Trail Resource Assessments, CEQA and NEPA
- Truckee Springs Resource Assessments (Town of Truckee)

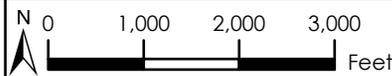
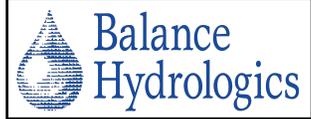
Baseline (Existing) Conditions

Geomorphology

The unique geological and land-use history of the Town River Corridor has left a distinct range of geomorphic features within the Study Area, shown in **Figures 2a, 2b, and 2c**, and discussed in detail below.



DATA SOURCES: California State Parks, Esri, TomTom, Garmin, SafeGraph, GeoTechnologies, Inc., METI/NASA, USGS, Bureau of Land Management, EPA, NPS, US Census Bureau, USDA, USFWS, Esri, NASA, NGA, USGS, FEMA, Esri, CGIAR, USGS



DATE: MARCH 25, 2024 PN: 223179

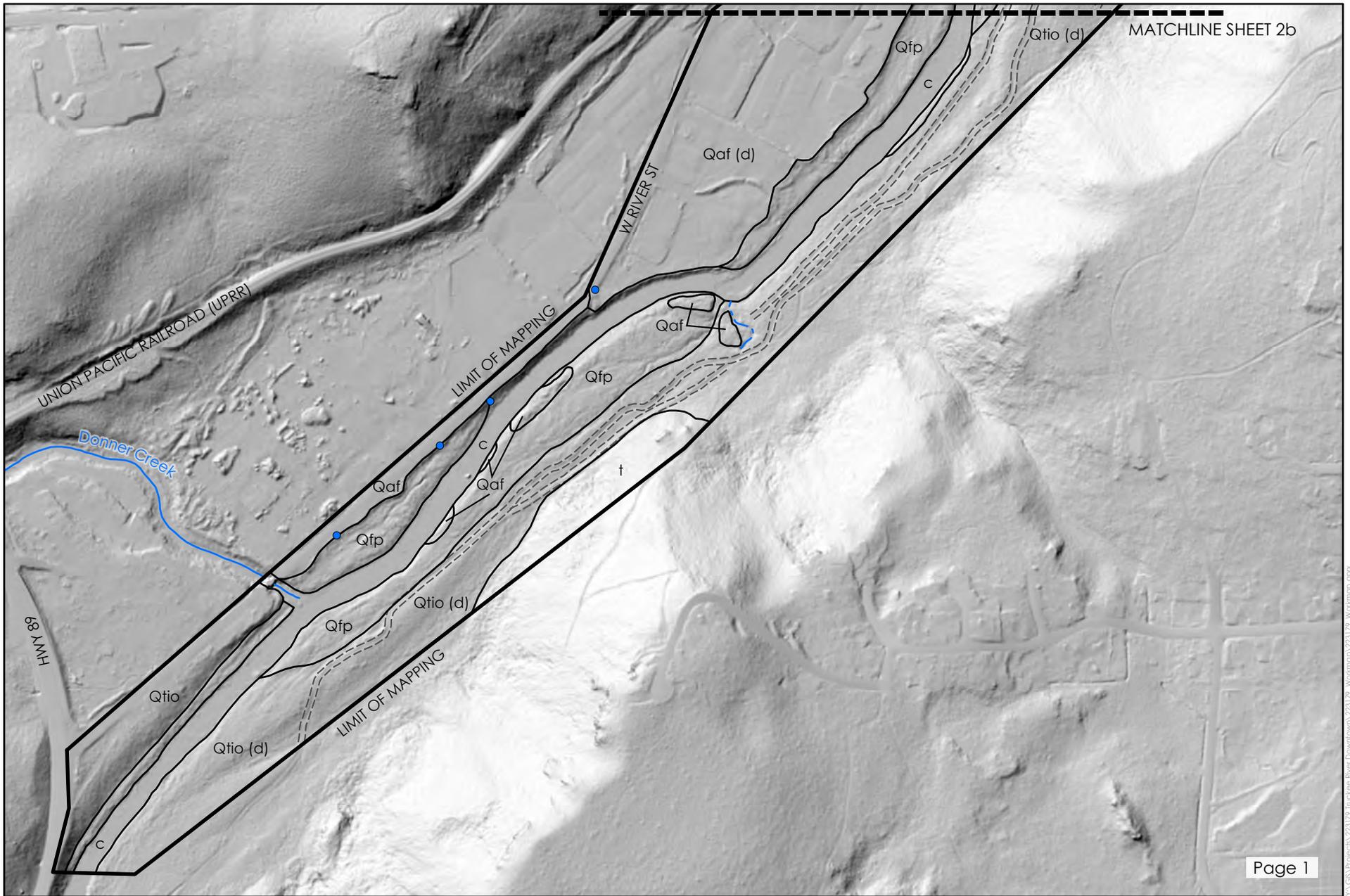
Figure 1	Study Area Truckee River Downtown Placer and Nevada Counties, California
	Scale: 1:24,000

Pre-development conditions

The Truckee River has a history of repeated glaciation, most recently in the late Pleistocene (from about 250,000 to 15,000 years ago). Glaciers moved large amounts of material from surrounding peaks to the valleys where it was deposited as till and glacial outwash. Geologic mapping compiled by Saucedo (2005) indicates that the Study Area reach of the Truckee River between the Town of Truckee and Boca is largely confined within the glacial outwash features (see **Figures 2 and 3**). Many of the glacial outwash features were derived by glacial outburst floods ('jokulhlaups' of Birkeland, 1964), which left behind large boulders that now control the locations of riffles and pools in the system. As a result, the Truckee River in the Study Area acquired a channel form created roughly 20,000 years ago, with very limited or no active channel migration or meandering occurring since that time, except as induced by human disturbance.

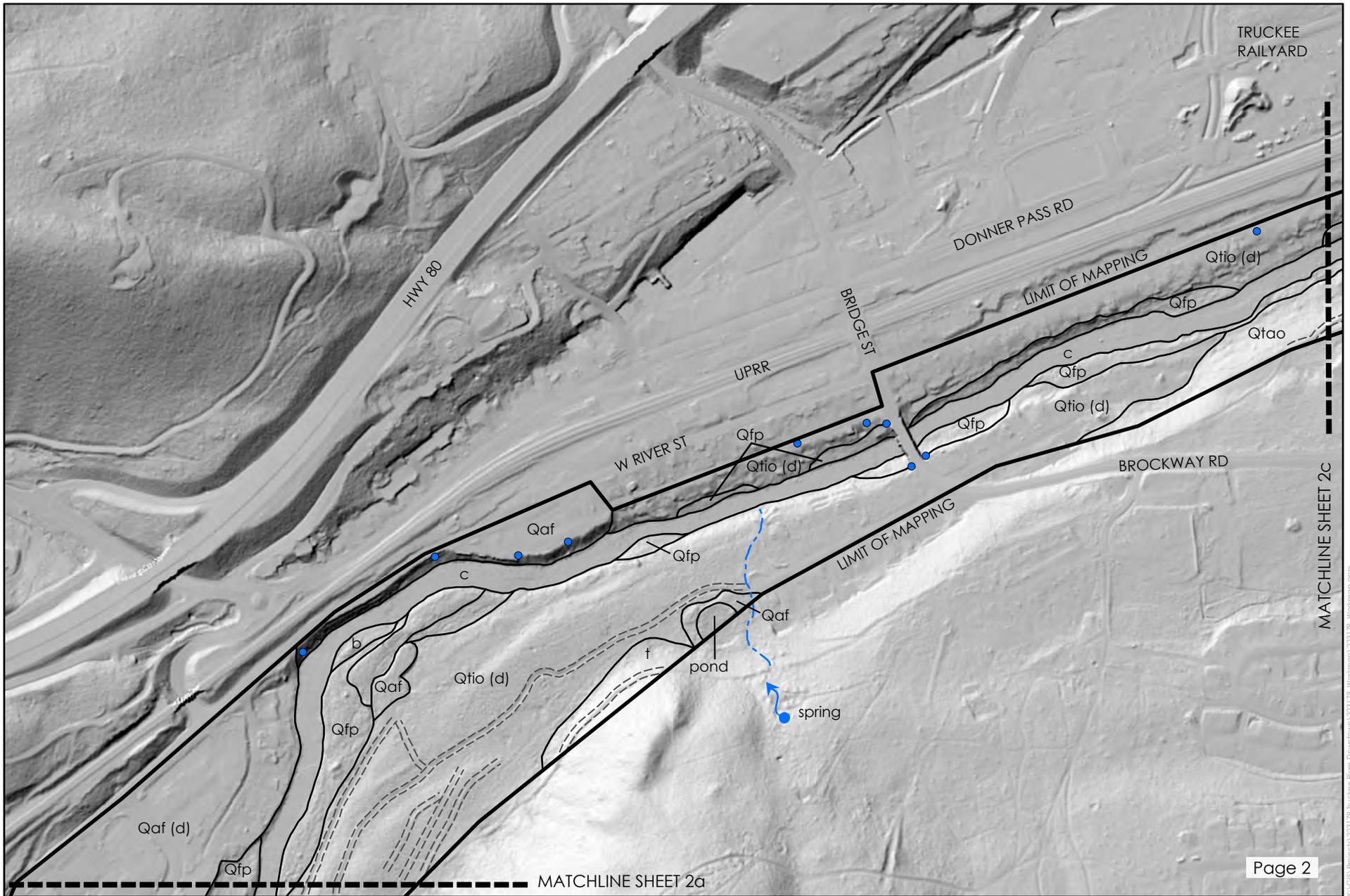
Channel bed material appears to have a bi-modal grain size distribution, with steeper boulder riffles separated by lower-gradient gravel and cobble reaches that exhibit a more dynamic gravel/cobble riffle-and-pool morphology within the confines of the channel. Channel gradient varies from 3.3 percent in the steeper boulder riffles and 0.6 percent in the gravel and cobble reaches.¹ Scour pools are formed in gravel and cobble substrate at the tail of boulder riffles, as well as around very large immobile boulders, where localized scour occurs and provides habitat and cover for fish.

¹ Channel gradient is interpreted from LiDAR returns off the water surface at low flows.

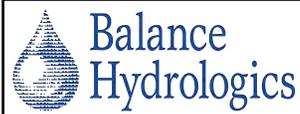


DATA SOURCES:

	<ul style="list-style-type: none"> ● Stormwater Outlet - - - Drainage Ditch ~ Tributary Stream ~ Ephemeral Stream == Trail 	<ul style="list-style-type: none"> b bar c channel Qaf artificial fill d disturbed 	<ul style="list-style-type: none"> Qfp active floodplain Qtao Tahoe outwash Qtio Tioga outwash Tv bedrock 	<p>N</p> <p>0 250 500 750 Feet</p>	<p>Figure 2a</p> <p>Scale: 1:6,000</p>	<p>Geomorphic Features Map</p> <p>Truckee River Downtown Placer and Nevada Counties, California</p>
			<p>DATE: APRIL 11, 2024</p>	<p>PN: 223179</p>		

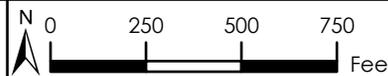


DATA SOURCES:



- Stormwater Outlet
- - - Drainage Ditch
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- - - Ephemeral Stream
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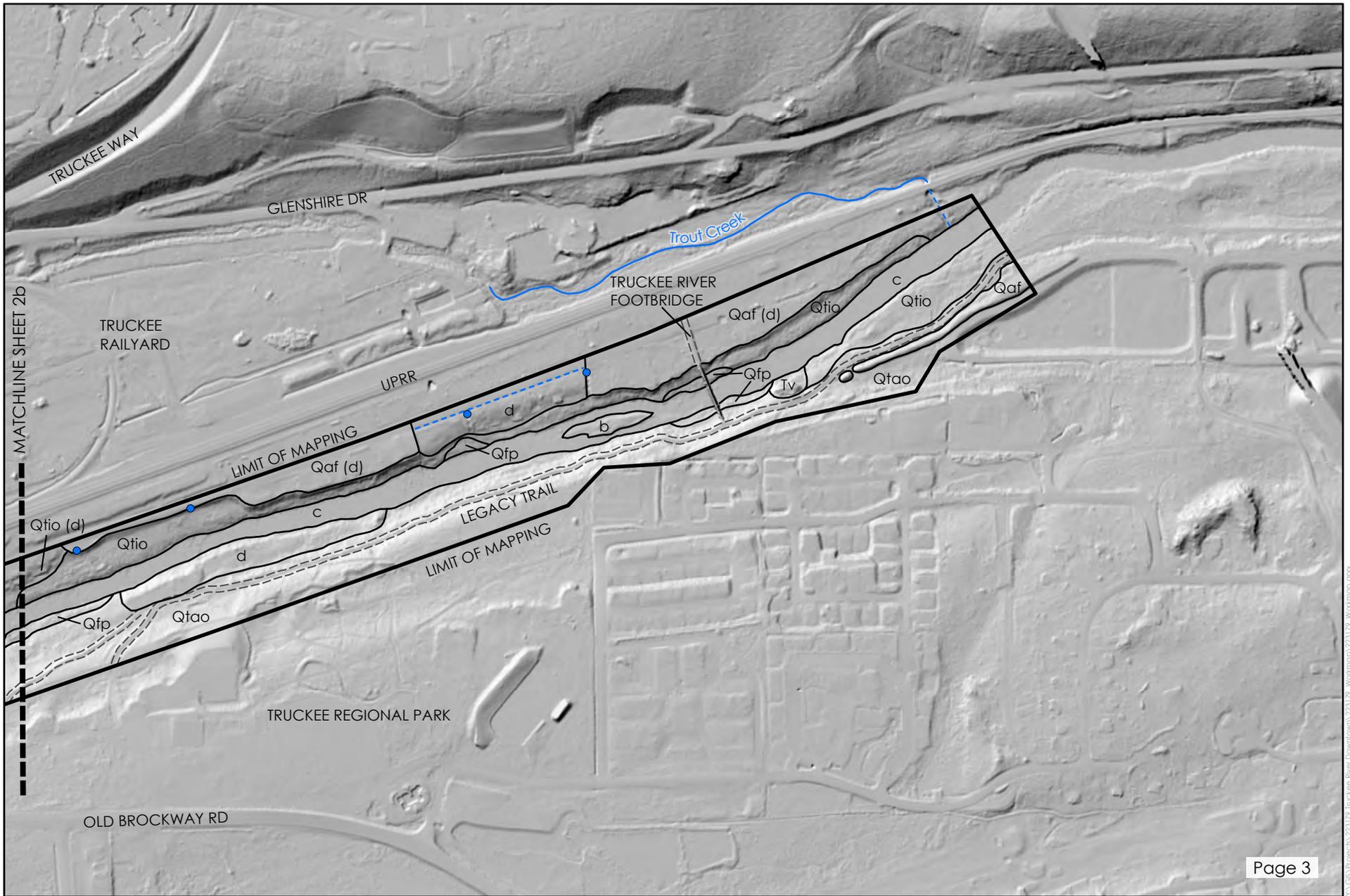
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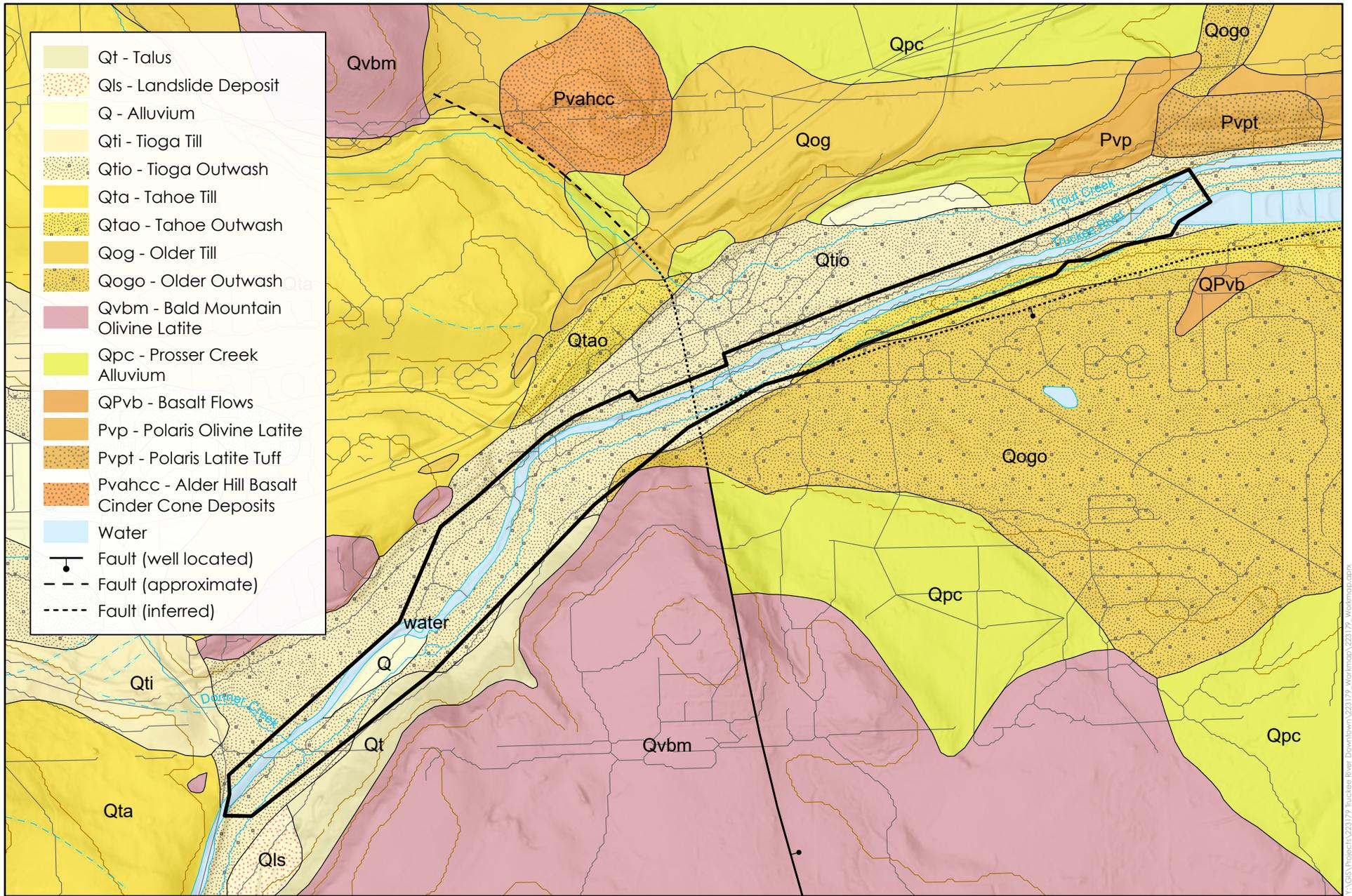
Figure 2b
Scale: 1:6,000

Geomorphic Features Map
Truckee River Downtown
Placer and Nevada Counties,
California



DATA SOURCES:

	<ul style="list-style-type: none"> ● Stormwater Outlet - - - Drainage Ditch ~ Tributary Stream - · - Ephemeral Stream - - - Trail 	<ul style="list-style-type: none"> b bar c channel Qaf artificial fill d disturbed 	<ul style="list-style-type: none"> Qfp active floodplain Qtao Tahoe outwash Qtio Tioga outwash Tv bedrock 		<p>Figure 2c</p>	<p>Geomorphic Features Map Truckee River Downtown Placer and Nevada Counties, California</p>
			<p>DATE: APRIL 11, 2024</p>	<p>PN: 223179</p>	<p>Scale: 1:6,000</p>	



DATA SOURCES: Saucedo, G. J., 2005, Geologic map of the Lake Tahoe basin, California and Nevada: U.S. Geological Survey, Regional Geologic Map Series Map No. 4, scale 1:100,000.

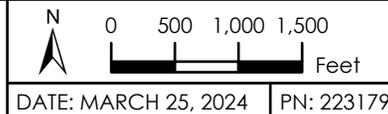
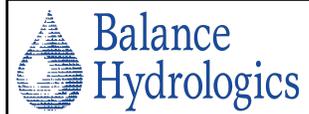


Figure 3
Scale: 1:18,000

Geologic Map
Truckee River Downtown
Placer and Nevada Counties,
California



Figure 4. Boulders and large cobble derived from glacial outburst flooding largely control channel form and limit channel migration.

Geomorphic features mapping

The Town River Corridor is mostly comprised of active channel (**Figure 2**, Unit c), floodplains (Qfp), and glacial outwash terraces (Qtao and Qtio), with extensive disturbed surfaces associated with current and historical land uses. Channel migration and floodplain dynamics throughout much of the Study Area are limited by bank material composed of very coarse outwash deposits and relatively high adjacent glacial outwash terraces and fill (Qaf), as well as disturbance (d) associated with infrastructure such as embankments and abutments for West River Street and private parcels. Where present, gravel-cobble reaches appear to be more dynamic than the boulder riffles and follow a somewhat predictable form, such as riffle-pool-glide sequences.

Bar deposits within the channel tend to be flooded annually, and vegetation communities therefore tend to be dynamic within the channel. Active floodplains are very limited within the Study Area, largely due to the glacial outwash history, and also due to extensive disturbance and historical fill placement within the river and floodplain corridor.

Terraces nearest the river channel are associated with outwash from the most recent glaciation, and are commonly mistaken for abandoned floodplains; however, they formed during glacial-fluvial processes between 14,000 and 26,500 years ago (Birkeland, 1964). Older terraces form many of the nearly flat areas at higher elevations.

Human disturbance

The Study Area falls within the center of Washoe (Wa She Shu) territory. Three general settlement areas have been reported from the confluence with Donner Creek, east to Boca and the confluence of the Little Truckee River (Lindstrom, 2017). As late as the 20th century, the Washoe would make long treks across the Sierra passes for hunting, trading, and gathering acorns. These aboriginal trek routes, patterned after game trails, are often the precursors of our historical and modern road systems, which closely follow the alignment of the Truckee River. As such, any proposed activities within the Town River Corridor will require careful consideration of cultural resources.

Since the 1800's, the Town River Corridor has experienced physical and ecological impacts, in part due to anthropogenic disturbances associated with logging, milling, ice harvest, dairy and cattle ranching, recreation, modern transportation, and land and community development (Lindstrom, 2017). The associated infrastructure permanently transformed the landscape. Roads, railroads, flumes, drainage ditches, and diversions over a de-forested landscape created flow paths, erosion, and fine sediment transport delivery from the hillsides directly to tributary streams and the Truckee River. Diversions for the Truckee lumberyard are among the most significant of the in-channel modifications that took place at that time. Railroad construction and development along the Truckee River corridor through downtown consisted of mass grading in many areas, with fill placement directly in the channel and floodplain.

During the 1950s, 60s, and 70s, the rural ranching- and timber-based economy- began shifting to more recreational and community development, especially after the Olympics in 1960. The Town of Truckee experienced rapid population growth in the 1990's upwards of a 56% increase from 1991 to 2000 (Town of Truckee, 2015). Today, primary land uses consist of residential-commercial development, on-going road improvements, and recreational uses.

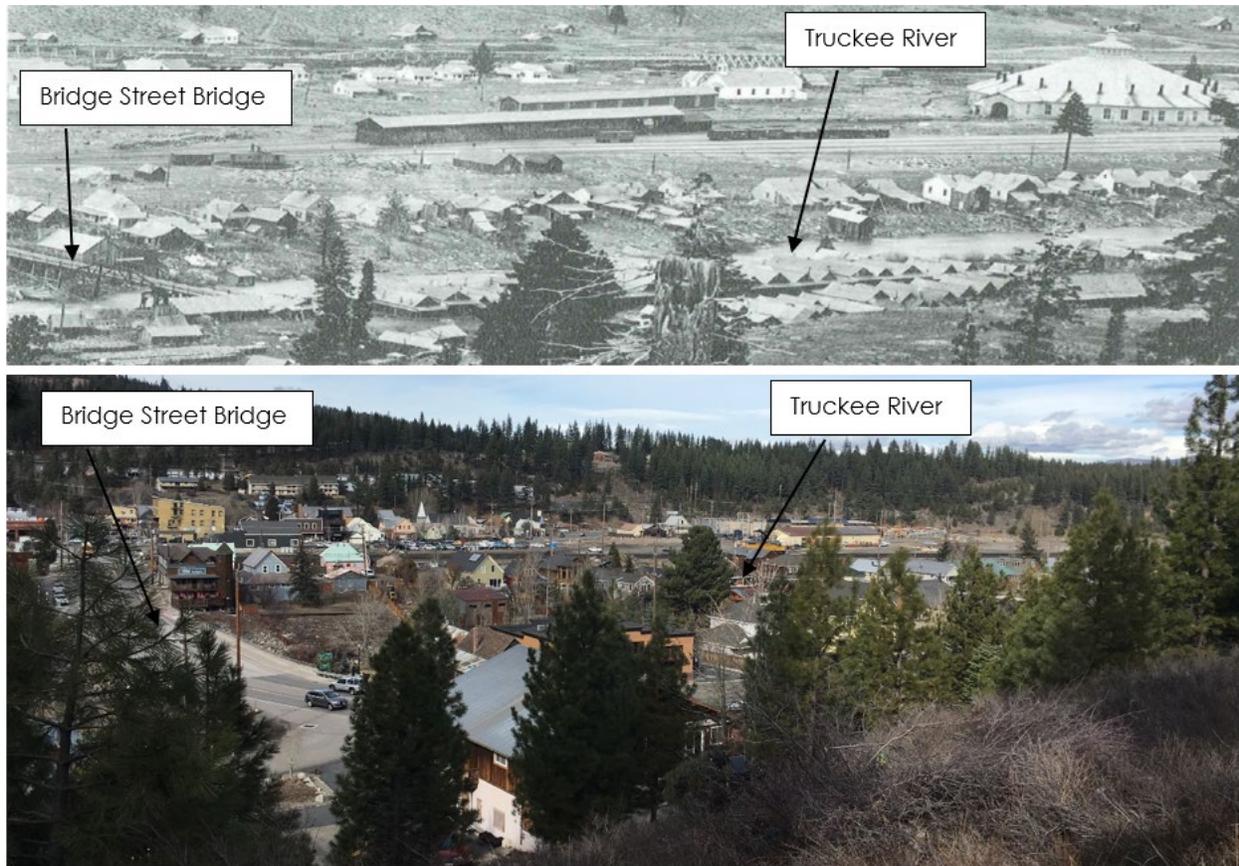


Figure 5. Historical and modern view of East River Street and the railyard.

Hydrology

The total watershed area for the Truckee River within the Study Area is approximately 585 square miles, however, this area is inclusive of the watershed areas for two large, dam-regulated lakes that modulate the natural flow regime. First, Lake Tahoe is located roughly 14 miles upstream of the Study Area. Flow from Lake Tahoe into the Truckee River—the only outlet for the lake—is regulated by a dam near Tahoe City, California. The watershed area of Lake Tahoe measured at the dam is 507 square miles. Several unregulated tributaries contribute flow to the Truckee River between Lake Tahoe and the Study Area, including Bear Creek, Deer Creek, and Squaw Creek, among other smaller streams. Second, Donner Lake is located roughly 3 miles west of the Study Area and has a watershed area of about 14 square miles. A dam on the east end of Donner Lake regulates flow into Donner Creek, a major tributary to the Truckee River. Cold Creek, which flows from Coldstream Canyon, is not regulated and accounts for almost half of the Donner Creek watershed. Donner Creek enters the Truckee River at the upstream extent of the Study Area. Subtracting the watershed areas for Lake Tahoe and Donner Lake, the unregulated watershed area is on the order of 64 square miles.

For the purposes of flood hazard mapping, the Federal Emergency Management Agency publishes Flood Insurance Rate Maps (FIRMs) showing areas of high, moderate, and low flood risk. **Figure 6** shows portions of the Study Area mapped by FEMA as “Zone AE,” and the “100-year floodway,” where Base Flood Elevations have been calculated for the 100-year flood event, and where the town has placed restrictions on development.

Limitations on topographic resolution used for FEMA mapping can cause inaccuracies in determining actual flooding extents. Furthermore, the extent of inundation during the 100-year flood may have little to do with riparian and floodplain functions and values, especially in the built environment where historical disturbance has limited historical floodplain extents. It is therefore also useful to consider the “Geomorphic Floodplain,” which is (or historically was) inundated on a much more frequent basis, such as the 1- to 5-year flow. This area is typically where riparian vegetation and riverine processes take place, and where water quality and habitat benefits are most effective.

Water quality

The Truckee River is listed as impaired for suspended sediment concentration (SSC), and the Lahontan Regional Water Quality Control Board has adopted a Total Maximum Daily Load for SSC (TMDL, Lahontan RWQCB, 2008). Suspended sediment monitoring data suggest that most fine sediment comes from the “Town Corridor” identified by Balance Hydrologics (2014b) as between State Route (SR)89 and Boca.

The TMDL consists of a number of indicators and target values for each indicator (Water Board, 2008, Table 4.13-TR-1). The only direct indicator is suspended sediment concentration in the Truckee River, with a numeric target of less than or equal to 25 milligrams per liter (mg/L) as an annual 90th percentile value measured at Farad (USGS Station 10346000). Additional indirect indicators include best management practices (BMPs) and restoration implementation, including:

- Implementing road sand application BMPs and monitoring their effectiveness;
- Implementing and maintaining BMPs on ski runs;
- Maintenance or decommissioning of dirt roads, especially those roads with high potential for sediment delivery to surface waters; and
- Legacy site restoration and BMP implementation.



DATA SOURCES: Esri, NASA, NGA, USGS, FEMA, Maxar

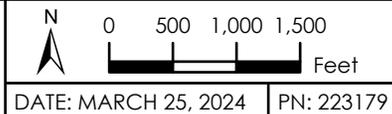
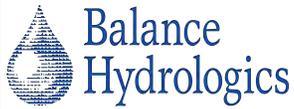


Figure 6
Scale: 1:18,000

FEMA 100-year Floodway
Truckee River Downtown
Placer and Nevada Counties,
California

Measurements of fine sediment load within the Town River Corridor indicate that the numeric target has been met since the TMDL was adopted, and the Town of Truckee and CalTrans have made efforts to complete projects that are expected to reduce sediment discharge to the Truckee River. Monitoring of riverbed conditions from 2012 to 2014, however, indicated an increase in fine sediment deposition downstream of the Study Area (Balance Hydrologics 2014a), and the highest suspended sediment production and delivery to the Town Corridor was observed to be sourced from developed areas in the lower Donner Creek watershed (Balance Hydrologics, 2014b).

Both the Town and Caltrans are responsible for recovery of road traction sand applications. During the winters of 2013 through 2017, Caltrans reported an annual average application rate of approximately 38 tons per lane per mile of Interstate 80, with no available reporting of recovery rates. For the same period, the Town of Truckee reported applying approximately 6,000 tons of sand to roads, with a 94% recovery rate over the same period (Balance Hydrologics, 2018). This results in approximately 1 ton of unrecovered traction sand application per mile of road within the Town limits, equal to approximately 26.2 tons/square mile (Balance Hydrologics, 2018); however, the proportion of unrecovered sand which makes it to the Truckee River is not known.

The Town's stormwater ordinance requires both temporary and permanent Stormwater Best Management Practices (BMPs) for construction and development activities, and the Town is incorporating stormwater management BMPs into upcoming Capital Improvement Projects. From 2010 through 2016, the Town jointly participated with Placer County in implementing the Truckee River Water Quality Monitoring Program (TRWQMP), and the town continues to operate turbidity monitoring equipment on the Truckee River upstream and downstream of Town's boundaries; however, data from these stations have not been analyzed, and limited to no water quality monitoring has occurred since 2014 within the Town limits or the Downtown Corridor.

Vegetation communities mapping

The purpose of the vegetation survey is to map plant communities and land use types within the Study Area, and to describe the ecological health and function of those areas. The ecological health is based on the function and composition of observed plant species, the resistance/resilience of each plant community under stressors such as climate change and fragmentation, and the presence/absence of and potential for non-native invasive and/or noxious weeds.

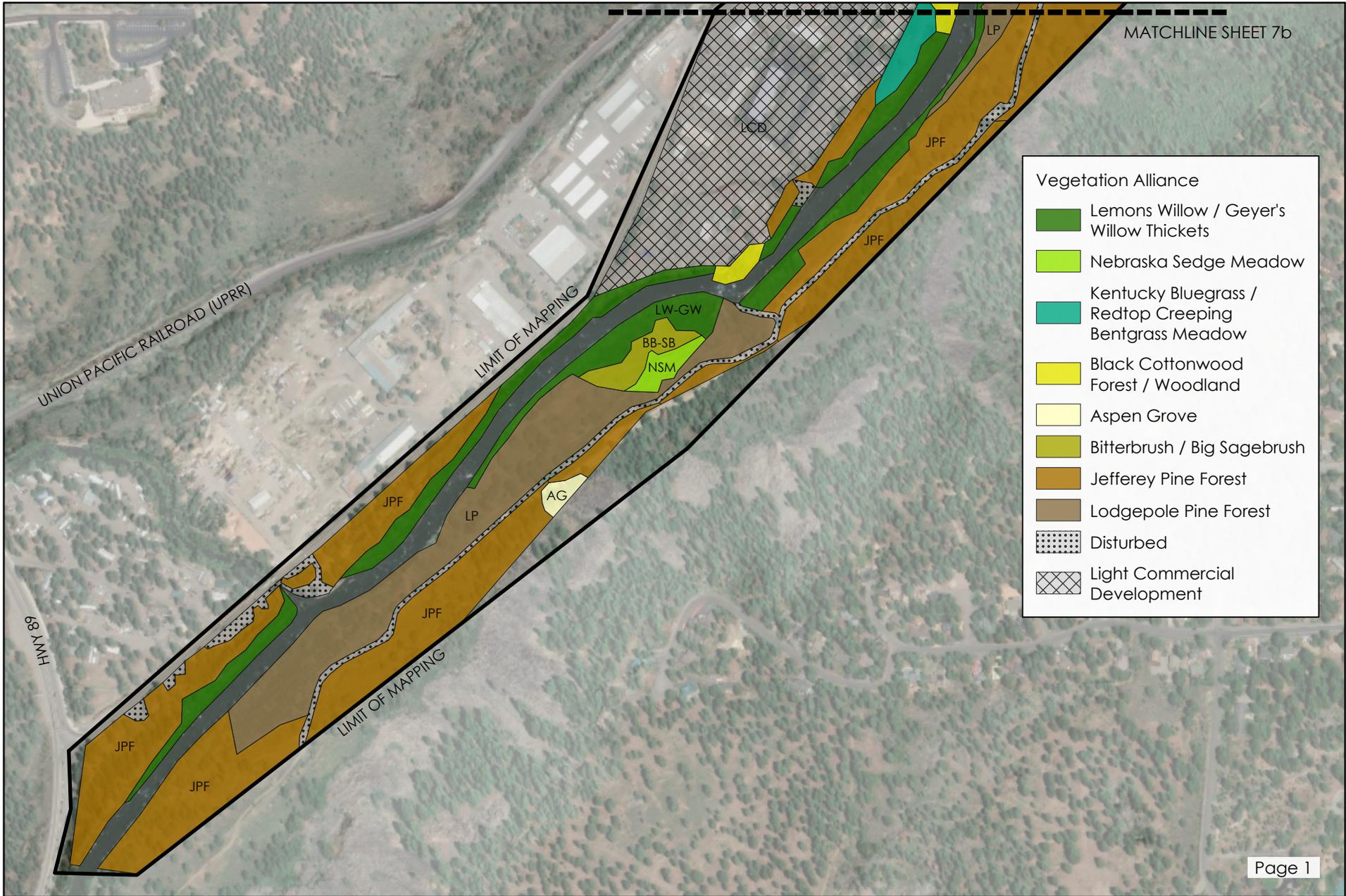
The vegetation was mapped according to the Manual of California Vegetation online edition (CNPS 2024), as shown in **Figures 7a, 7b, and 7c**. Vegetation types are described as alliances based on the dominant species in the vegetation layer that best defines the vegetation type. For forest types, the vegetation is based on the dominant species in the forest canopy layer, for shrub dominated communities, species in the shrub layer define the community and for herbaceous communities, species in that layer define the species.

Mountain Alder Thicket – For this vegetation alliance, mountain alder (*Alnus incana*) is dominant or co-dominant in the shrub canopy. Other shrubs may include mountain maple (*Acer glabrum*), red osier dogwood (*Cornus sericea*), and willow species (*Salix* spp.). Trees such as white fir (*Abies concolor*), lodgepole pine (*Pinus contorta ssp. murrayana*), and Jeffrey pine (*Pinus jeffreyi*) may be present at low cover. Within the Study Area, Pacific willow (*Salix lasiandra*), sandbar willow (*Salix exigua*), and Lemmon’s willow (*Salix lemmonii*) are the most common co-dominant species. In the Study Area, this vegetation type is found along the banks of the Truckee River.

Black Cottonwood Forest and Woodland – Black cottonwood (*Populus trichocarpa*) is dominant or co-dominant in the tree canopy. White fir, mountain alder, lodgepole pine, and willow species may be co-dominant with black cottonwood. For the Cottonwood stands in the Study Area, Lemmon’s willow, lodgepole pine, and mountain alder are present and sometimes co-dominant. Cottonwood stands or patches of cottonwood are present on the higher terraces of the Truckee River floodplain. These surfaces currently only receive flow and maintain saturated soils during high flow events.

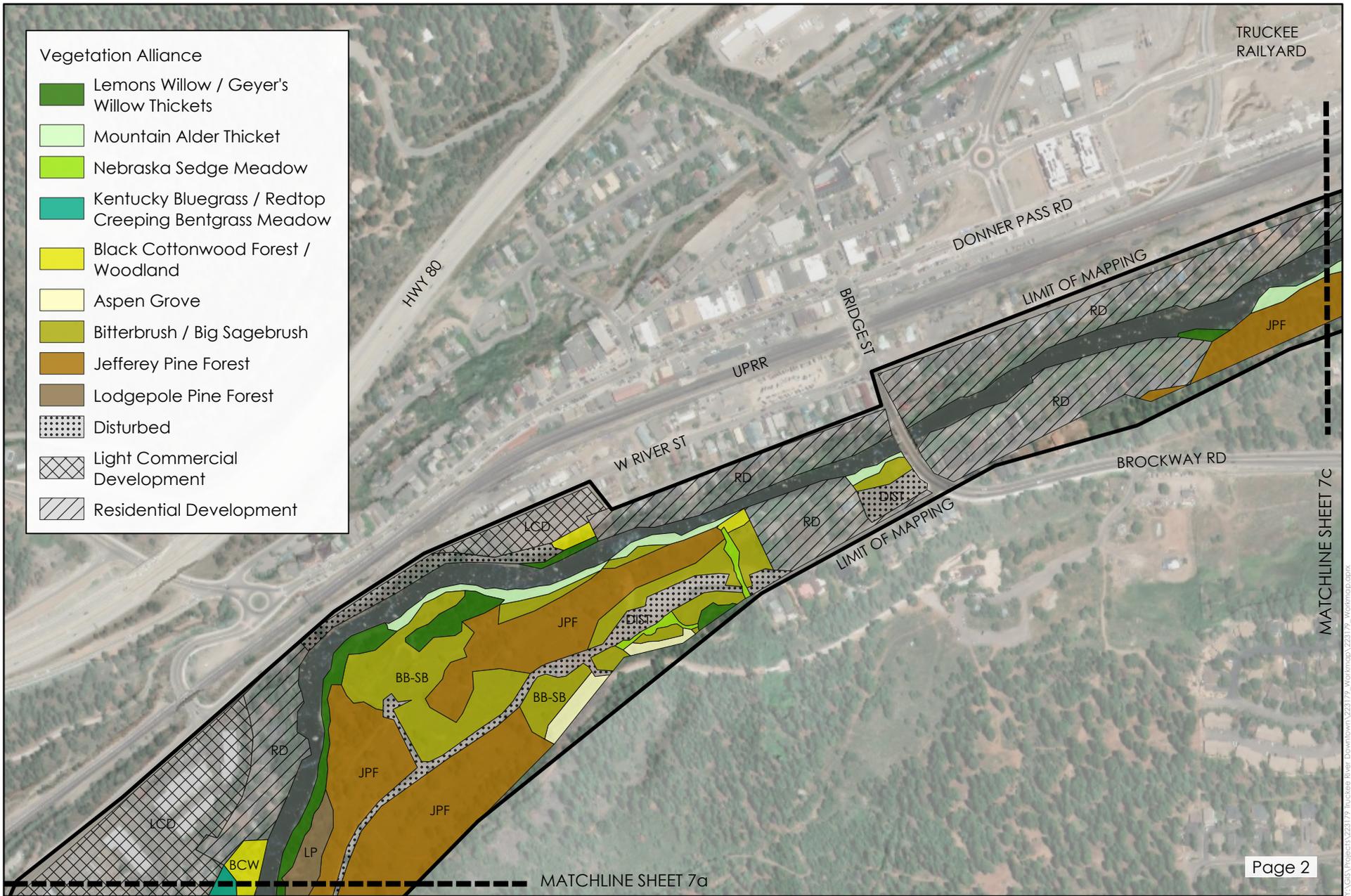
Regeneration of cottonwoods is limited throughout the Study Area, with few pole age (10 – 25 year old) cottonwoods present. Regeneration appears to be by vegetative means, root sprouting, and cladostosis (sprouting from dropped branches and twigs). Regeneration from seed would require more regular and longer duration flooding in the late spring/early summer to allow for deposition, germination of seeds, and growth of cottonwood seedlings. This typically occurs on point bars and active floodplains, and it does not occur in the Study Area.

Throughout the Study Area, cottonwood seedlings and saplings (poles) have been damaged and killed by current and past beaver activity. The lack of regeneration has left this section of the Truckee River with only mature and decadent trees, which are less capable of vegetative regeneration.

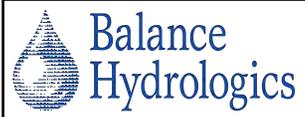


DATA SOURCES: Sources: Esri, Airbus DS, USGS, NGA, NASA, CGIAR, N Robinson, NCEAS, NLS, OS, NMA, Geodatatyrrelsen, Rijkswaterstaat, GSA, Geoland, FEMA, Intermap and the GIS user community, Maxar

<p>Balance Hydrologics</p>	<p>Vegetation Survey Data Source: C.S. Ecological Surveys and Assessments</p>		<p>Figure 7a</p>	<p>Vegetation Communities Truckee River Downtown Placer and Nevada Counties, California</p>
		<p>DATE: MARCH 27, 2024 PN: 223179 Scale: 1:6,000</p>		



DATA SOURCES: Sources: Esri, Airbus DS, USGS, NGA, NASA, CGIAR, N Robinson, NCEAS, NLS, OS, NMA, Geodatasyretsen, Rijkswaterstaat, GSA, Geoland, FEMA, Intermap and the GIS user community, Maxar



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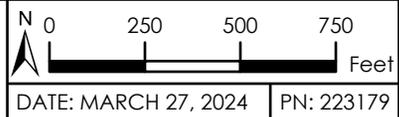
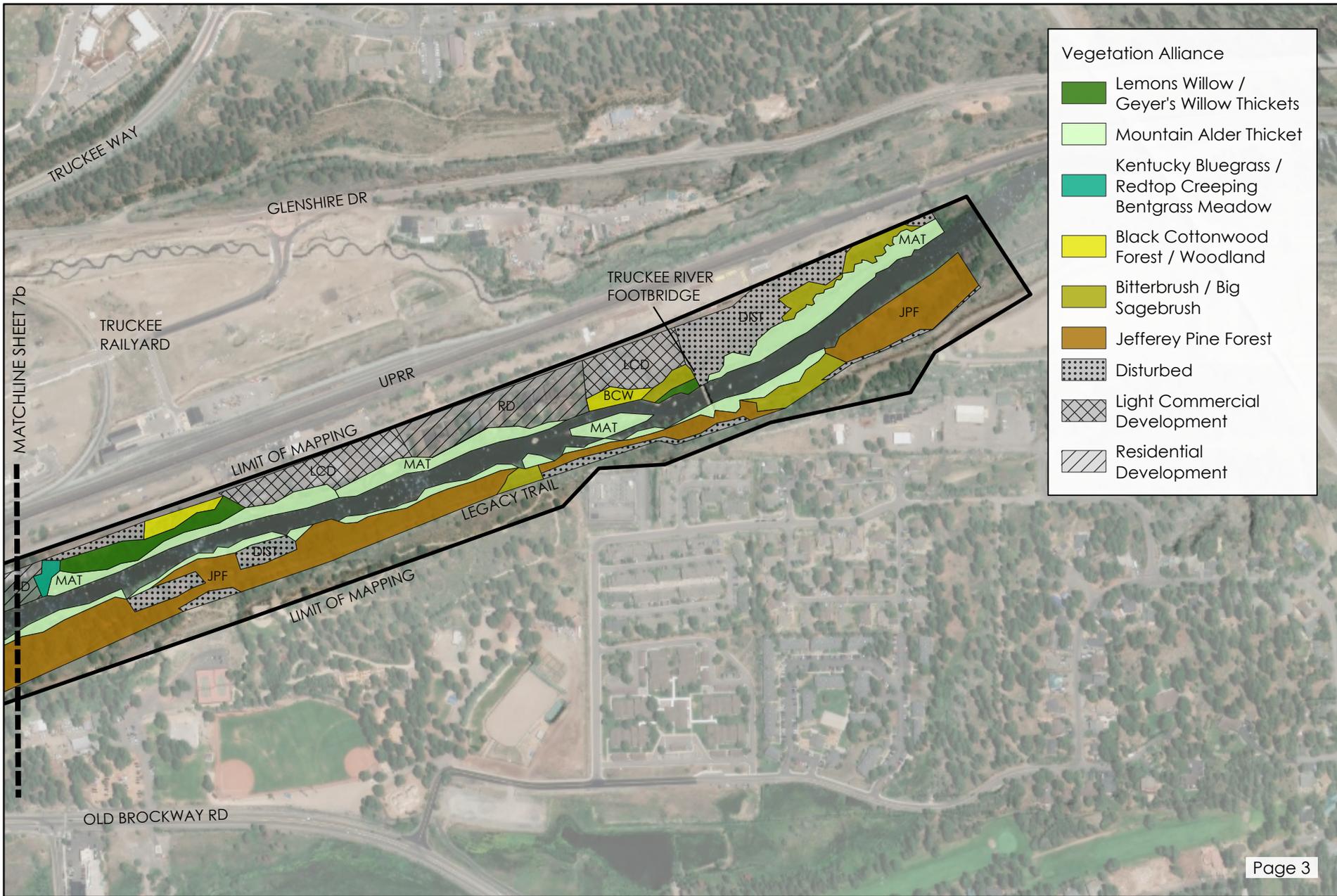


Figure 7b
Scale: 1:6,000

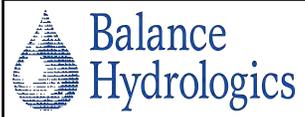
Vegetation Communities
Truckee River Downtown
Placer and Nevada Counties,
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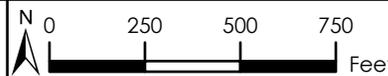
Vegetation Alliance

- Lemons Willow / Geyer's Willow Thickets
- Mountain Alder Thicket
- Kentucky Bluegrass / Redtop Creeping Bentgrass Meadow
- Black Cottonwood Forest / Woodland
- Bitterbrush / Big Sagebrush
- Jefferey Pine Forest
- Disturbed
- Light Commercial Development
- Residential Development

DATA SOURCES: Sources: Esri, Airbus DS, USGS, NGA, NASA, CGIAR, N Robinson, NCEAS, NLS, OS, NMA, Geodatastyrelsen, Rijkswaterstaat, GSA, Geoland, FEMA, Intermap and the GIS user community, Maxar



Vegetation Survey Data Source:
C.S. Ecological Surveys and Assessments



DATE: MARCH 27, 2024 PN: 223179

Figure 7c

Scale: 1:6,000

Vegetation Communities
Truckee River Downtown
Placer and Nevada Counties,
California

Jeffrey Pine Forest and Woodland – Jeffrey pine is dominant or co-dominant in the tree canopy. In our area, white fir, lodgepole pine, red fir (*Abies magnifica*) and incense cedar (*Calocedrus decurrens*) are often present and/or co-dominant in the tree canopy.

Typical understory species in the Study Area include antelope bitterbrush (*Purshia tridentata*), big sagebrush (*Artemisia tridentata*), mountain snowberry (*Symphoricarpos rotundiflorus*), serviceberry (*Amelanchier utahensis* and *A. alnifolia*), snowbrush (*Ceanothus velutinous*), and mountain whitethorn (*C. cordulatus*). This vegetation alliance is an upland forest type and is located either outside the geomorphic floodplain or on upper terraces that are rarely flooded by the Truckee River.

Antelope Bitterbrush - Big Sagebrush Scrub – In our area antelope bitterbrush and big sagebrush are co-dominant in the shrub canopy. Other shrub species such as green rabbitbrush (*Chrysothamnus viscidiflorus*), rubber rabbitbrush (*Ericameria nauseosa*), snowbrush, mountain snowberry, and serviceberry are also present. Within the Study Area, scattered lodgepole pine or Jeffrey pine are present in this vegetation alliance. Common herbaceous species include: squirreltail grass (*Elymus elymoides*), Kentucky bluegrass (*Poa pratensis*), Sandberg's bluegrass (*Poa secunda*), Indian ricegrass (*Achnatherum hymenoides*), sulphur buckwheat (*Eriogonum umbellatum*), and mountain brome (*Bromus carinatus*). This vegetation alliance occurs in upland areas and high terraces that are not flooded or inundated during the growing season. Within the Study Area, this vegetation alliance often forms a patchwork with either the Jeffrey pine alliance or the Lodgepole pine alliance.

Lemmon's Willow / Geyer's Willow Thickets – The Manual of California Vegetation online edition only recognizes the Lemmon's willow thicket as a vegetation alliance with Lemmon's willow as the dominant species in the shrub canopy. Within the Study Area, and throughout the Truckee-Tahoe area it is common to have willow thickets in which Lemmon's willow and Geyer's willow (*S. geyeriana*) are co-dominant in the shrub canopy. Other common species in the shrub canopy are mountain alder, Wood's rose (*Rosa woodsia*), and Pacific willow. The understory species vary depending on the hydrologic conditions. Areas with saturated soils for most of the growing season support sedge and rush species such as Nebraska sedge (*Carex nebrascensis*) and Baltic rush (*Juncus balticus*). Drier areas support understory species such as Kentucky bluegrass, five finger cinquefoil (*Potentilla gracilis*), yarrow (*Achillea millefolium*), and goldenrod (*Solidago elongata*). Within the Study Area, this vegetation alliance is present along the banks of the Truckee River, often integrating with Mountain Alder Thickets. There is also a more extensive patch of this vegetation alliance on the lower terraces adjacent to the Truckee River in an area that is seasonally flooded.

Nebraska Sedge Meadows – Nebraska sedge is dominant or co-dominant in the herbaceous layer often with yarrow, western bistort (*Bistorta bistortoides*), field sedge (*C. praegracilis*), beaked sedge (*C. utriculata*), tufted hairgrass (*Deschampsia cespitosa*), creeping spikerush (*Eleocharis macrostachya*), willowherb (*Epilobium ciliatum*), Baltic rush, and Kentucky bluegrass. This vegetation alliance occurs only in areas that have saturated soils throughout at least part of the growing season. One area of Nebraska Sedge Meadow borders a spring fed tributary that flows through the historic ice pond near South River Street. This vegetation alliance is also present adjacent to some of the Lemmon's willow/ Geyer's willow thickets and is supported by an ephemeral tributary to the Truckee River.

Kentucky Bluegrass - Redtop - Creeping Bentgrass Meadows – Typically within this vegetation alliance, creeping bentgrass (*Agrostis gigantea*), redtop (*Agrostis stolonifera*), meadow foxtail (*Alopecurus pratensis*), meadow fescue (*Festuca arundinacea*), Timothy (*Phleum pratense*) and/or *Poa pratensis* is dominant or co-dominant in the herbaceous layer. Other common species that occur in this vegetation alliance are yarrow, five finger cinquefoil, meadow barley (*Hordeum brachyantherum*), Baltic rush, field horsetail (*Equisetum arvense*), and Oregon checker mallow (*Sidalcea oregana*). Emergent trees and shrubs may be present at low cover. Within the Study Area, Kentucky bluegrass is the dominant species. This vegetation alliance is found adjacent to the Lemmon's willow/Geyer's willow thickets and/or the Nebraska sedge meadow, on the upper floodplain, or lower terraces.

Lodgepole Pine Forest and Woodland – In this vegetation alliance, lodgepole pine is the dominant species in the forest canopy. Other species may be present in the forest canopy such as Jeffrey pine, white fir, and aspen (*Populus tremuloides*). This vegetation alliance is known to occur on terraces, lake and meadow margins, and depressions that flood seasonally within the Tahoe area. In other areas this vegetation alliance may occur on upland slopes and ridges to the tree line. Within the Study Area this vegetation type often occurs on the upper terraces between the Mountain Alder or Lemmon's Willow/Geyer's Willow thickets and Jeffrey Pine Forest/Woodlands and/or the Antelope Bitterbrush – Big Sagebrush Scrub vegetation alliance.

Aspen Groves – In this vegetation alliance, aspen is the dominant or co-dominant species in the tree canopy with white fir, lodgepole pine, Jeffrey pine, and black cottonwood. The shrub layer is open to continuous, and is composed of species such as serviceberry, mountain snowberry, creeping snowberry (*Symphoricarpos mollis*), snowbrush, Wood's rose, and antelope bitterbrush. Within the Study Area, this vegetation type occurs at the base of the north facing forested slope where snowmelt from the hillslope supports the Aspen groves.

Residential Development – Includes residential homes, landscaped areas, and access such as roads and driveways.

Light Commercial Development – Includes business/commercial development and associated areas such as parking areas, roads, and work yards.

Disturbed – Recently disturbed areas such as dirt roads, parking areas, areas where natural vegetation has been removed and any current vegetation is composed of colonizer or disturbance species, not the naturally occurring vegetation alliances.

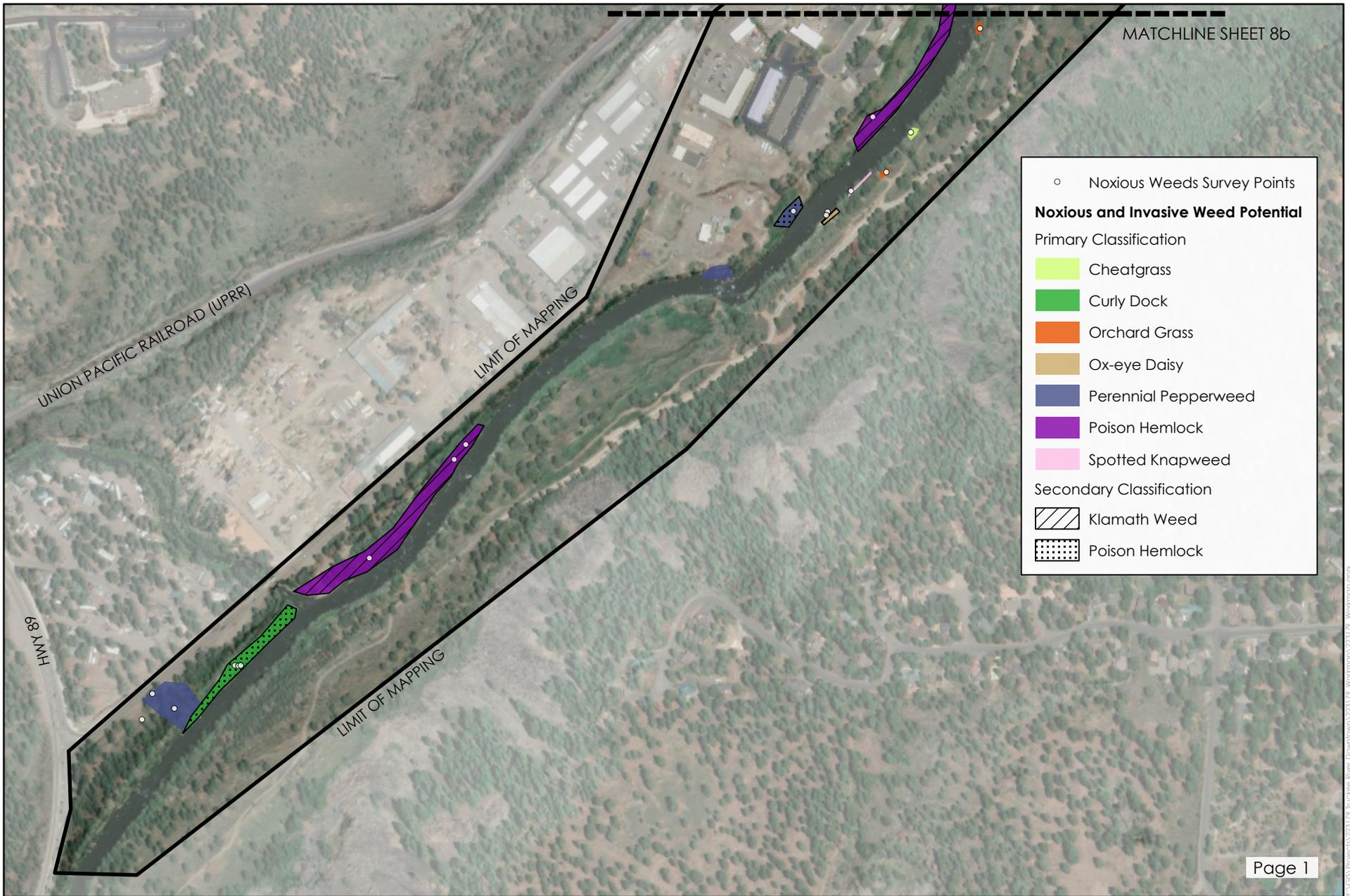
Historical and ongoing impacts to vegetation

Vegetation throughout the Study Area has been affected by both natural and human disturbances. Development activities such as logging, spring development, water diversions, logging, mining, grazing, construction of homes, commercial buildings, railroads, and roads began in 1863. All these activities have affected current vegetation composition and ecological health. Potential areas for noxious weed occurrences are shown in **Figures 8a, 8b, and 8c**.

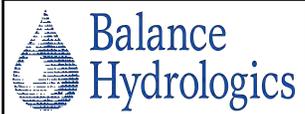
The Study Area is mostly surrounded by developed lands, and the vegetation alliances within the Study Area are fragmented. For example, the upland Jeffrey Pine Forest and Woodland Alliance would naturally extend to both the north and south of the Truckee River but currently is limited due to the residential development to the south of the Study Area and the commercial and residential development to the north of the Study Area. Riparian vegetation along the shore of the river is fragmented due to residential development. This is true for all vegetation alliances within the Study Area, and this fragmentation can affect the ecological function of the vegetation communities.

Wildlife

Riparian habitat within the Town Corridor is patchy, but nevertheless provides habitat for aquatic and terrestrial species, such as aquatic insects, insectivorous birds, amphibians, and terrestrial wildlife such as small and large mammals. The CDFW's Terrestrial Connectivity, Areas of Conservation Emphasis (ACE) dataset summarizes information on terrestrial connectivity (**Figure 9**). ACE hexagons are ranked from 1 to 5 with 1 having the most limitations for connectivity and 5 representing "Irreplaceable and Essential Corridors". These 2.5 square mile hexagons consider the presence of mapped corridors or linkages and the juxtaposition to large, contiguous, natural areas (CDFW 2024). The area containing and adjacent to the Study Area is ranked primarily as "1 – Limited Connectivity Opportunity" due to presence of existing



DATA SOURCES: Sources: Esri, Airbus DS, USGS, NGA, NASA, CGIAR, N Robinson, NCEAS, NLS, OS, NMA, Geodatasyrstelen, Rijkswaterstaat, GSA, Geoland, FEMA, Intermap and the GIS user community, Maxar



Vegetation Survey Data Source:
C.S. Ecological Surveys and Assessments

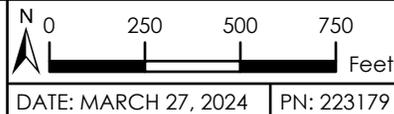
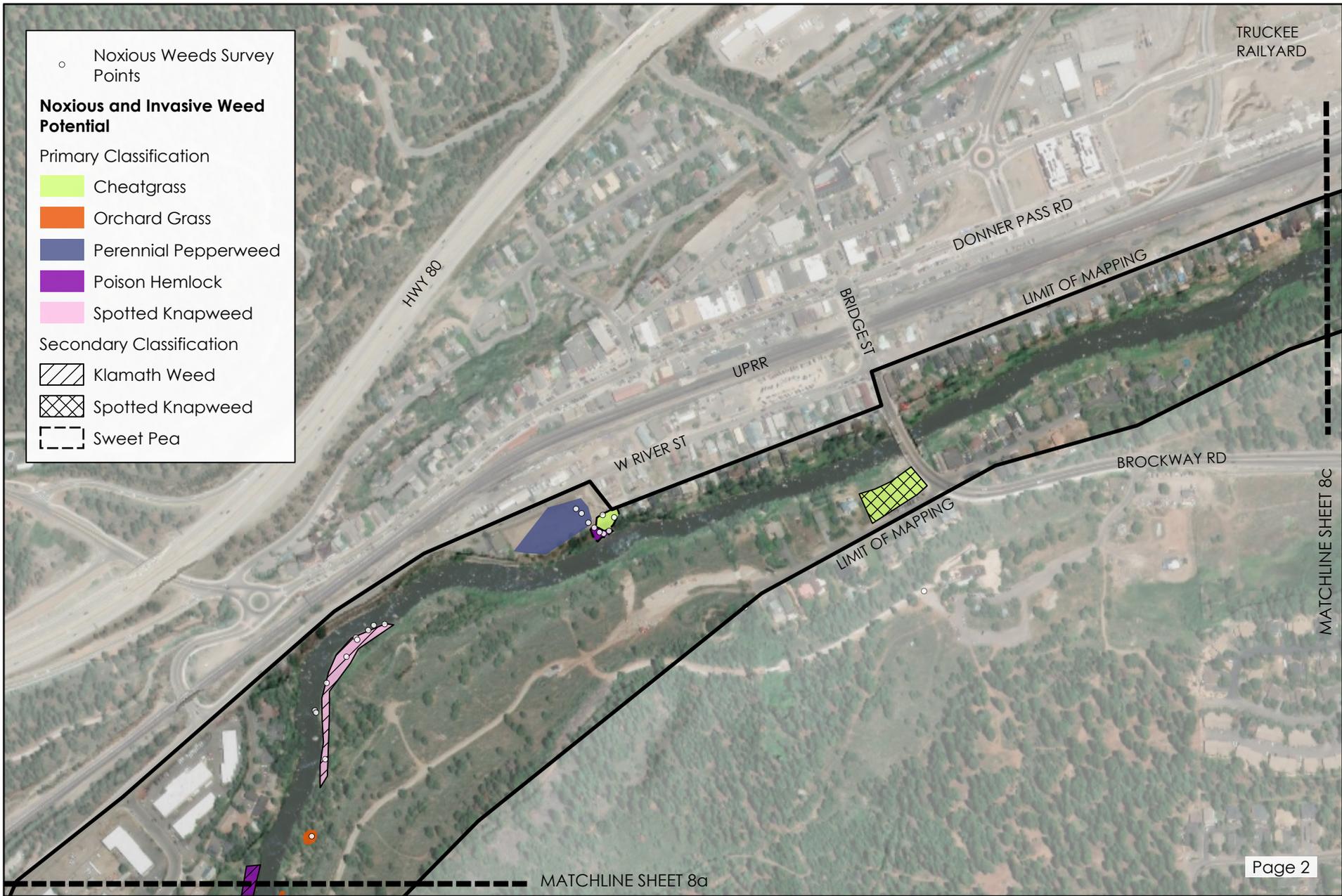
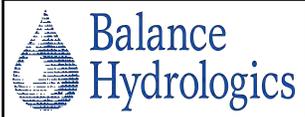


Figure 8a
Scale: 1:6,000

Noxious Weed Potential
Truckee River Downtown
Placer and Nevada Counties,
California



DATA SOURCES: Sources: Esri, Airbus DS, USGS, NGA, NASA, CGIAR, N Robinson, NCEAS, NLS, OS, NMA, Geodatasysteien, Rijkswaterstaat, GSA, Geoland, FEMA, Intermap and the GIS user community, Maxar



Vegetation Survey Data Source:
C.S. Ecological Surveys and Assessments

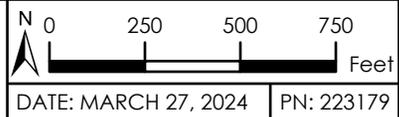
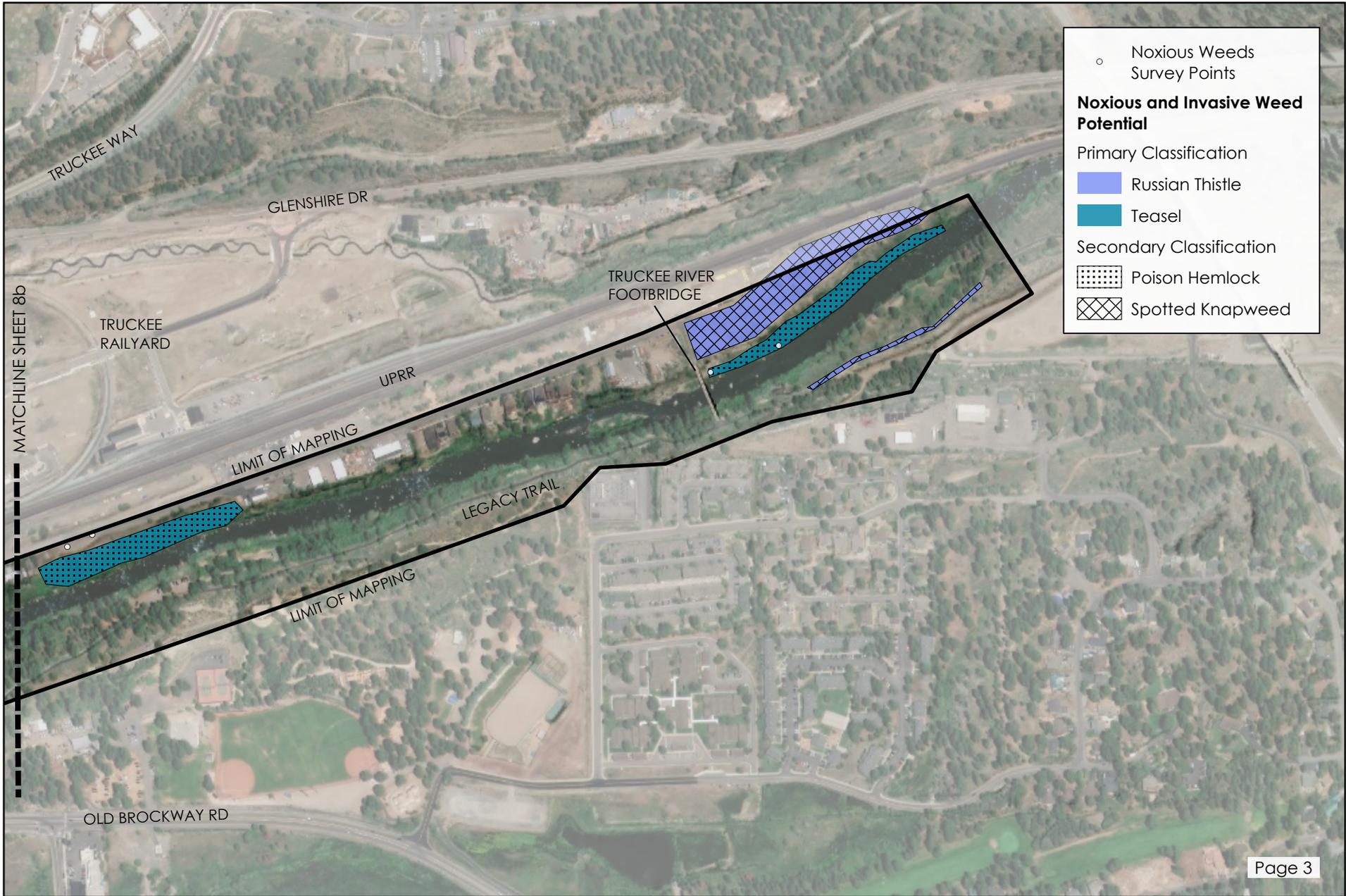
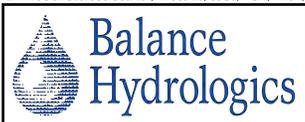


Figure 8b
Scale: 1:6,000

Noxious Weed Potential
Truckee River Downtown
Placer and Nevada Counties,
California



DATA SOURCES: Sources: Esri, Airbus DS, USGS, NGA, NASA, CGIAR, N Robinson, NCEAS, NLS, OS, NMA, Geodatastyretsen, Rijkswaterstaat, GSA, Geoland, FEMA, Intermap and the GIS user community, Maxar



Vegetation Survey Data Source:
C.S. Ecological Surveys and Assessments

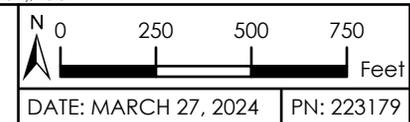
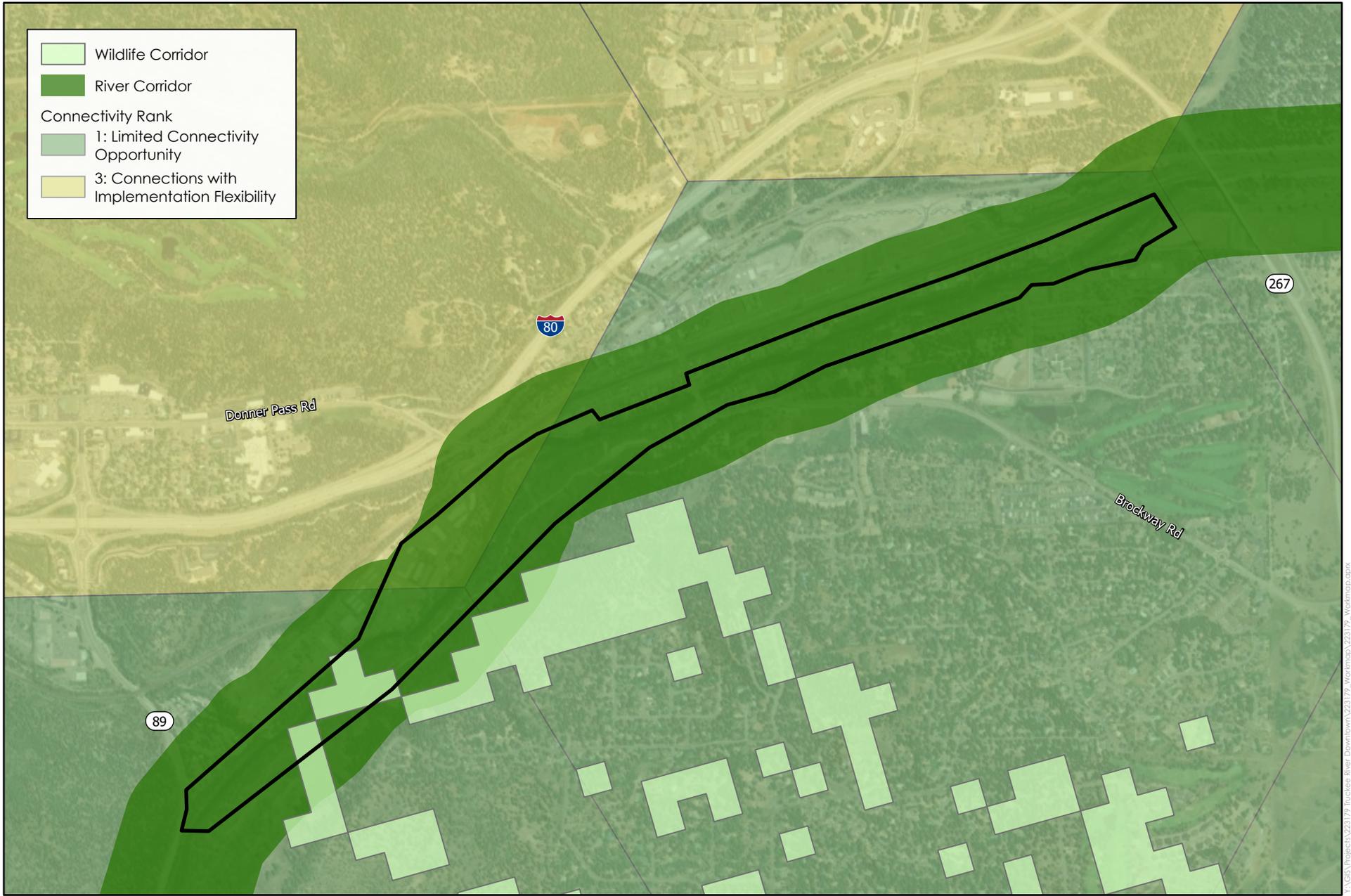
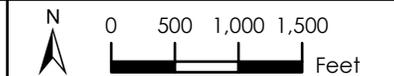
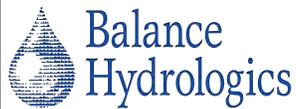


Figure 8c
Scale: 1:6,000

Noxious Weed Potential
Truckee River Downtown
Placer and Nevada Counties,
California



DATA SOURCES: Esri, NASA, NGA, USGS, FEMA, Maxar, California Department of Water Resources.



DATE: SEPTEMBER 13, 2024 | PN: 223179

Figure 9

DWR Wildlife Corridors
 Truckee River Downtown
 Placer and Nevada Counties,
 California

development that limits direct connections to large “Natural Landscape Blocks”. Immediately downstream of the downtown corridor, the State of California has designated most of the Truckee River from Trout Creek to the Nevada state line as a Wild Trout Waterway. A goal of the State of California’s Wild Trout Policy is to protect high-quality wild trout habitat from “adverse impact by land or water development projects” (CFGC, 2023).

Although the downtown corridor is not explicitly mapped by CDFW as an essential corridor for connectivity at a regional level, the corridor itself likely provides linkages to nearby essential corridors. To the south of the Study Area, the Truckee River connects to U.S. Forest Service (USFS) Lands that are mapped as a “Natural Landscape Block” and some “Natural Areas Small” provide a nexus to USFS lands to the south and to open lands of other ownership to the east. This increases the functionality of the Study Area as a wildlife corridor.

It should also be noted that when these smaller “Natural Areas” are connected, there is an indirect connection between the Study Area and ACE polygons that are ranked as “5 -Irreplaceable and Essential Corridors”. The preservation and maintenance of the “Natural Areas Small” within the Study Area, and of the Truckee River Riparian Corridor, are important in maintaining terrestrial and riparian connectivity with these “Irreplaceable and Essential Corridors.”

Wildlife surveys were not completed as part of this overview study; however, the Donner Basin Watershed Assessment (CBEC and others, 2016) provides a comprehensive list of the many species that may be expected to occur within the downtown corridor. Common mammal species include: American black bear (*Ursus americanus*), North American beaver (*Castor canadensis*), bobcat (*Lynx rufus*), coyote (*Canis latrans*), long-tailed weasel (*Mustela frenata*), mountain lion (*Puma concolor*), Columbian black-tailed deer (*Odocoileus hemionus columbianus*), mule deer (*Odocoileus hemionus*), common porcupine (*Erethizon dorsatum*), raccoon (*Procyon lotor*), striped skunk (*Mephitis mephitis*), western spotted skunk (*Spilogale gracilis*), ground squirrels (*Spermophilus spp.*), chipmunks (*Neotamias spp.*), and voles (*Arborimus spp.*).

Common amphibian species expected to use the river include Sierran chorus frog (*Pseudacris sierrae*), and western toad (*Bufo boreas*).

Common migratory birds that may occur include: Clark’s grebe (*Aechmophorus clarkii*), great blue heron (*Ardea herodias*), great egret (*Ardea alba*), turkey vulture (*Cathartes aura*), Canada goose (*Branta canadensis*), mallard (*Anas platyrhynchos*), common merganser (*Mergus merganser*), Cooper’s hawk (*Accipiter cooperii*), red-tailed hawk (*Buteo jamaicensis*),

American coot (*Fulica americana*), killdeer (*Charadrius vociferus*), band-tailed pigeon (*Patagioenas fasciata*), mourning dove (*Zenaida macroura*), great horned owl (*Bubo virginianus*), common nighthawk (*Chordeiles minor*), Anna's hummingbird (*Calypte anna*), white-headed woodpecker (*Picoides albolarvatus*), northern flicker (*Colaptes auratus*), Steller's jay (*Cyanocitta stelleri*), Clark's nutcracker (*Nucifraga columbiana*), black-billed magpie (*Pica hudsonia*), common raven (*Corvus corax*), mountain chickadee (*Poecile gambeli*), pygmy nuthatch (*Sitta pygmaea*), brown creeper (*Certhia americana*), American dipper (*Cinclus mexicanus*), western bluebird (*Sialia mexicana*), American robin (*Turdus migratorius*), savannah sparrow (*Passerculus sandwichensis*), dark-eyed junco (*Junco hyemalis*), brown-headed cowbird (*Molothrus ater*), pine grosbeak (*Pinicola enucleator*), and evening grosbeak (*Coccothraustes vespertinus*).

Common native fish species that may be expected to occur in the Study Reach include Paiute sculpin (*Cottus beldingi*), speckled dace (*Rhinichthys osculus*), and mountain whitefish (*Prosopium williamsoni*). There are also introduced fish such as rainbow trout (*Oncorhynchus mykiss*), brown trout (*Salmo trutta*), and eastern brook trout (*Salvelinus fontinalis*).

Special Status species known or likely to occur near the Donner Basin (CBEC and others, 2016) may also be expected to occur within the Town Corridor. These listed species may include: California wolverine (*Gulo gulo leteu*), Pacific fisher (*Martes pennanti*), Sierra marten (*Martes americana sierrae*), Sierra Nevada mountain beaver (*Aplodontia rufa californica*), Sierra Nevada red fox (*Vulpes vulpes necator*), Sierra Nevada snowshoe hare (*Lepus americanus taхоensis*), Pallid bat (*Antrozous pallidus*), Townsend's big-eared bat (*Corynorhinus townsendii*), Sierra Nevada yellow-legged frog (*Rana sierra*), Bald eagle (*Haliaeetus leucocephalus*), Northern goshawk (*Accipiter gentilis*), Yellow rail (*Coturnicops noveboracensis*), Black tern (*Chlidonias niger*), California spotted owl (*Strix occidentalis occidentalis*), Great gray owl (*Strix nebulosa*), Long-eared owl (*Asio otus*), Black-backed woodpecker (*Picoides arcticus*), Willow flycatcher (*Empidonax traillii*), Vaux's swift (*Chaetura vaux*), Yellow warbler (*Dendroica petechia*), Yellow-headed blackbird (*Xanthocephalus xanthocephalus*), and Lahontan cutthroat trout (*Oncorhynchus clarkii henshawi*).

Recommendations

The Truckee River downtown corridor has undergone extensive disturbance due to historical land use, modifications to the floodplain, and impaired water quality from within the Town of Truckee. With increasing human access and use by the community and our visitors, preservation, restoration, and ongoing stormwater management policies and actions have the potential to minimize or reverse these impacts. Opportunities for protection and enhancement include:

- Vegetation Management consisting of
 - Treating noxious and invasive weeds to enhance riparian and upland habitats
 - Thinning overstocked forested areas
 - Promoting cottonwood regeneration
- Enhancing riparian areas in conjunction with
 - Fill removal and floodplain re-exposure
 - Reconnecting hydrology to disturbed floodplain areas
 - Enhancing sediment deposition in existing floodplain areas
- Providing human access points in strategic locations, while incorporating principles of “Eco-revelatory design” to protect riparian areas, raise awareness, and increase stewardship of the river corridor.
- Ongoing implementation of the Town’s stormwater management program and expansion of the town’s water quality monitoring program to evaluate its effectiveness.

Vegetation Management

The natural vegetation alliances within the Study Area primarily support native species. The ecological condition of the upland vegetation is good, and there is limited enhancement potential for these areas. The ecological condition of the riparian vegetation is good to poor. Enhancement of meadow vegetation and willow thickets would require improved connectivity to surface and ground water, which would necessitate larger scale restoration. Black Cottonwood Forests and Woodlands are no longer regenerating at a rate that will sustain the existing stands. Measures to improve regeneration are needed to maintain these stands, however, ongoing maintenance is needed to increase the potential for success. Aspen Groves also have limited regeneration and would benefit from enhancement and maintenance. Noxious and invasive weed species exist throughout the Study Area mainly in areas that serve as vectors for weed propagation: the Legacy Trail, existing roads/trails, and the river. There are small

“Natural Areas” at the west end of the project south of the river that provide connectivity to high value wildlife corridors, and these should be preserved.

Jeffrey Pine Forest and Woodland and Lodgepole Pine Forest and Woodland

The two-upland forest/woodland vegetation alliances (Jeffrey Pine and Lodgepole) have both been logged in the past. These areas are now composed of second and third growth trees. There is currently good regeneration both within the Lodgepole Pine Forest and Woodland Alliance and within the Jeffrey Pine Forest and Woodland Vegetation Alliance. Both vegetation alliances are located primarily within Regional Park Lands, Land Trust Lands, or U.S. Forest Service Lands, and are therefore unlikely to be directly affected by development, apart from limited effects from utilities that run through the Study Area.

The main disturbance to these two vegetation alliances is recreation, from the paved Legacy Trail and the dispersed unofficial trails. There have been some direct impacts: tree removal, clearing of vegetation, and compaction of soil. These trails also serve as a vector for introduction of invasive/noxious weeds species, an indirect effect. Russian thistle and spotted knapweed are two noxious/invasive weed species that have established on the margins of the Legacy Trail downstream of the pedestrian bridge. Cheatgrass is an invasive species that has spread into disturbed areas along the Legacy Trail and in high use areas throughout the Study Area.

Overstocked forests with high tree density, especially younger trees that can serve as ladder fuels, increase the potential for higher intensity fires. The Jeffrey Pine Forest/Woodland Alliance within the Study Area does not appear to be “overstocked”, and there are openings within the forested areas that reduce fuel loads and limit the potential for crown fires. The trees do not currently appear to be adversely affected by pathogens such as the pine bark beetle, however, the effects of this pathogen increase with drought and other stressors.

The Lodgepole Pine Forest/Woodland Alliance is overstocked in some areas, particularly the south side of the river near the confluence with Donner Creek. Typically, this vegetation alliance, when located adjacent to an active river system, experiences periods of natural disturbance that remove trees, leaving openings for new trees to sprout. The terraces where this vegetation alliance is located have little connection to the Truckee River, limiting natural processes. This vegetation alliance is also subject to pathogens, and wildfire in the overstocked areas would increase fire intensity and susceptibility to pathogens.

Enhancement Potential

Treat known weed populations and watch for future weeds, limited to the Legacy Trail and other high use areas. Thin overstocked areas on the south bank near Donner Creek. Watch for conifer die off due to stressors and remove dead trees.

Antelope Bitterbrush – Big Sagebrush Scrub

This alliance occurs within the forested vegetation types, and between the upland forest and riparian area. This vegetation alliance is healthy. There is good regeneration, and both shrub and herbaceous cover is composed predominantly of native species. The same noxious/invasive weed species found in the forest vegetation alliances are present in Antelope Bitterbrush – Big Sagebrush Scrub Alliance, with scattered areas of cheatgrass in openings and spotted knapweed and Russian thistle along the Legacy Trail downstream of the pedestrian bridge.

Enhancement Potential

Hand pull Russian thistle along the Legacy Trail. Pull or treat Spotted Knapweed with approved herbicides.

Black Cottonwood Forest and Woodland

Black Cottonwood Forests/Woodlands are in small, limited areas on the upper terraces along the Truckee River. Some of these areas may be within the geomorphic floodplain but none of them are now hydrologically connected to the Truckee River. This limits reproduction from seed which requires sustained overbank spring flows that allow seed to deposit on point bars and the active floodplain (Borman and Larson, 2002). In low moisture environments such as higher terraces, cottonwoods reproduce vegetatively, sprouting from stumps, roots, or discarded branches and twigs. This mode of regeneration was observed within the Study Area, but it was limited.

Overall, the ecological health of the Cottonwood Forests/Woodlands in the Study Area is poor. Nearly all areas have older, often decadent trees and little regeneration. Beavers have removed young and mature trees in the past and some beaver activity is present now. There has been some attempt at protecting trees from beavers (e.g., wire mesh around the lower portion of the trunks). The mesh is old, ineffective, and currently the aspens are growing into the mesh, potentially harming the cambium which is the layer beneath the bark where new cells that grow wood and bark tissue are generated.

The condition of the Cottonwood stands is very poor, and the lack of regeneration may lead to a loss of these majestic trees, which are an aesthetic asset of the Truckee River as it runs through town. Regeneration at this point will be difficult and require expenditure, effort, and maintenance.

Enhancement Potential

Cottonwoods are not a long-lived species. Individual trees often only live about 75 years. When cottonwoods are connected to the active floodplain there is continual mortality and regeneration. Cottonwoods within the Study Area do not have this cycle of mortality and regeneration leading to mature or decadent trees that are more susceptible to disease and less able to reproduce vegetatively. Without regeneration there will be a decrease in cottonwood stands.

Regeneration may be stimulated by removing some decadent and mature trees, thereby stimulating the root buds to sprout more stems. The existing sapling and pole age cottonwoods should be protected from beavers with fencing. This may be removed once trees are larger and/or there is no sign of beaver activity. Any area where regeneration is being encouraged should also be fenced. Vulnerable older trees, where beaver activity is high, should also be protected. A monitoring plan should be set up to maintain fencing and wire mesh, and to observe the growth of young cottonwood stems.

Lemmons' Willow/Geyer's Willow Thickets

Willow thickets are present along the banks of the Truckee River and in some adjacent wet areas and side channels. Habitat for willow thickets is limited, which also limits the regeneration. Willows with abundant floodplain area for establishment will spread vegetatively. Regeneration is stimulated by removal of living stems; in this way a large extensive thicket may withstand herbivory by beavers. Within the Study Area, recent beaver activity was found scattered throughout, but less than ten percent of the stems were browsed at any willow patch. Decadent and dead material was found mostly where willows existed in drier conditions.

The banks of the Truckee River and the active floodplain where willow thickets and alder thickets grow are good habitat for many weed species. Perennial pepperweed, bull thistle, spotted knapweed, poison hemlock, sweatpea, ox-eye daisy, Klamathweed, teasel, orchard grass, and curly dock were all found in and around willow thickets.

Enhancement Potential

Remove and/or treat weeds with appropriate herbicides at mapped areas and check potential weed areas for new occurrences. Remove dead willow stems from areas with decadent stands. Consider planting stakes only in areas with appropriate conditions and protection from beavers.

Mountain Alder Thickets

Mountain Alder Thickets are found along the banks of the Truckee River and intergrade with willow thickets. Willow species are often a co-dominant in the shrub layer of Mountain Alder Thickets. Mountain alders prefer areas with larger substrate that allow water to move easily from the river into the adjacent soil. Mountain alders mainly spread vegetatively, and this is the primary means of reproduction in established stands. Mountain alders within the Study Area seem to have good regeneration and stands do not have many dead or decadent stems.

The understory species are mostly appropriate native wetland sedges and grasses, though poison hemlock, teasel, bull thistle, and Klamath weed can occur in Mountain Alder Thickets.

Enhancement Potential

Remove and/or treat weeds with appropriate herbicides at mapped areas and check potential weed areas for new occurrences.

Kentucky Bluegrass – Redtop – Creeping Bentgrass Meadows

There is limited habitat for meadow vegetation in the Study Area. Often Kentucky bluegrass represents a more degraded wet meadow where the depth to groundwater has dropped to more than a meter during the growing season. The largest (0.76 acre) area where Kentucky Bluegrass-Redtop-Creeping Bentgrass Meadow is mapped was most likely Nebraska Sedge Meadows before flow regulation and incision reduced connectivity to the Truckee River. Currently, the ecological condition of this meadow type is fair. There are areas of bare ground and potential for invasive weed species to establish. The other two small areas of this meadow type are transitional and likely represent a reduction in hydrologic function.

Enhancement Potential

Monitor this area for invasive/noxious weeds and remove as needed. A larger project that evaluates the potential for larger scale riparian restoration would be beneficial at the 0.76-acre area located near the Sierra Pet Clinic. Such a project, if it were to reconnect surface and ground water that would support wetland/riparian species, would likely convert this area to a Nebraska Sedge Meadow.

Nebraska Sedge Meadow

Nebraska Sedge Meadow is only mapped at two locations in the Study Area, downstream from Truckee Springs and the historic pond, and at the west end of the project on the south side of the river where an ephemeral tributary supports this vegetation alliance (see **Figure 7a** and **7b**).

At both locations the ecological condition is fair to poor, this is because at both locations, surface and groundwater connection is marginal for this vegetation type. The exact factors affecting the decrease in hydrologic function have not been investigated, but it appears that climate change and past human impacts have affected these two areas. One population of bull thistle, a noxious weed, was mapped near the outflow of the historical pond.

Enhancement Potential

Hand-pull existing bull thistles. Monitor for weeds in the future. Consider restoration projects that would reconnect or enhance surface and groundwater hydrology at both locations.

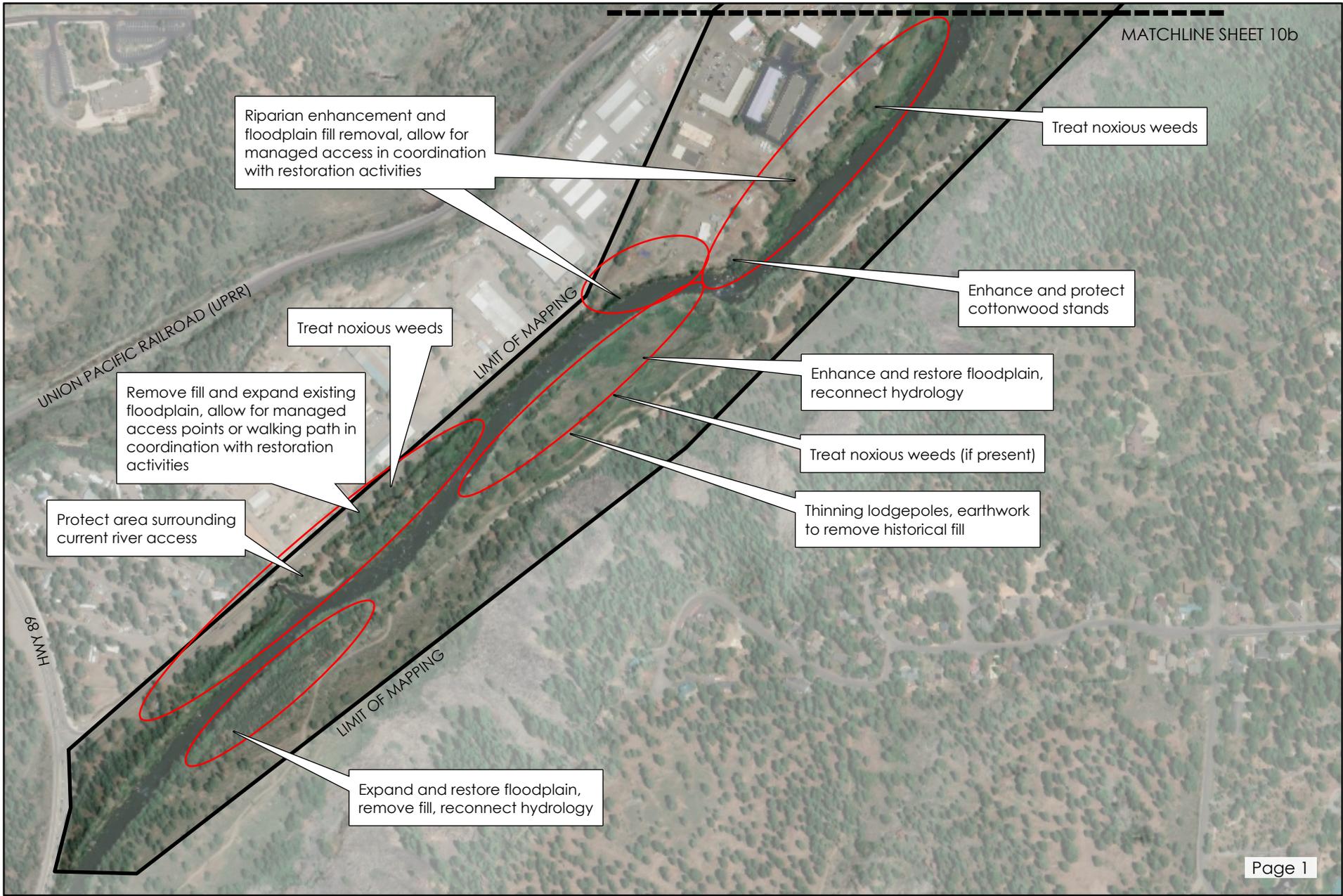
Potential Floodplain Restoration and Protection

The geomorphology and associated ecology of the Truckee River Downtown Corridor has been extensively disturbed due to past land uses and encroachment into floodplain areas. Geomorphic and disturbance mapping shown in **Figure 2** highlights areas where fill placement and disturbance has taken place within the Study Area and provides the basis for identifying where restoration activities may be most beneficial in offsetting the legacy impacts. **Figure 7** highlights some of the general locations where functional riparian communities exist and could be protected.

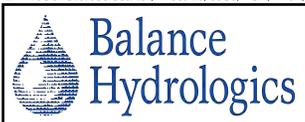
Restoration and protection opportunities could include the following types of actions, with the general locations of potential activities shown in **Figure 10**.

Remove fill from historical floodplain areas

Artificial fill placement has constricted the channel and eliminated floodplain functions. Portions of properties along West River Street and East River Street, and in some cases the roads themselves, have been built on this fill, in some places up to 15 feet high. Many exposed banks are now unstable and eroding, delivering sediment directly to the river. Removing fill to expose historical floodplain soils and seedbanks would allow for a more extensive and functional riparian corridor.



DATA SOURCES: Sources: Esri, Airbus DS, USGS, NGA, NASA, CGIAR, N Robinson, NCEAS, NLS, OS, NMA, Geodatasysteien, Rijkswaterstaat, GSA, Geoland, FEMA, Intermap and the GIS user community, Maxar



Ecological Enhancement Recommendations:
C.S. Ecological Surveys and Assessments

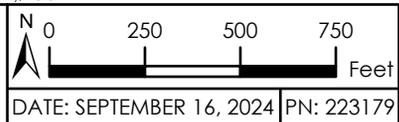
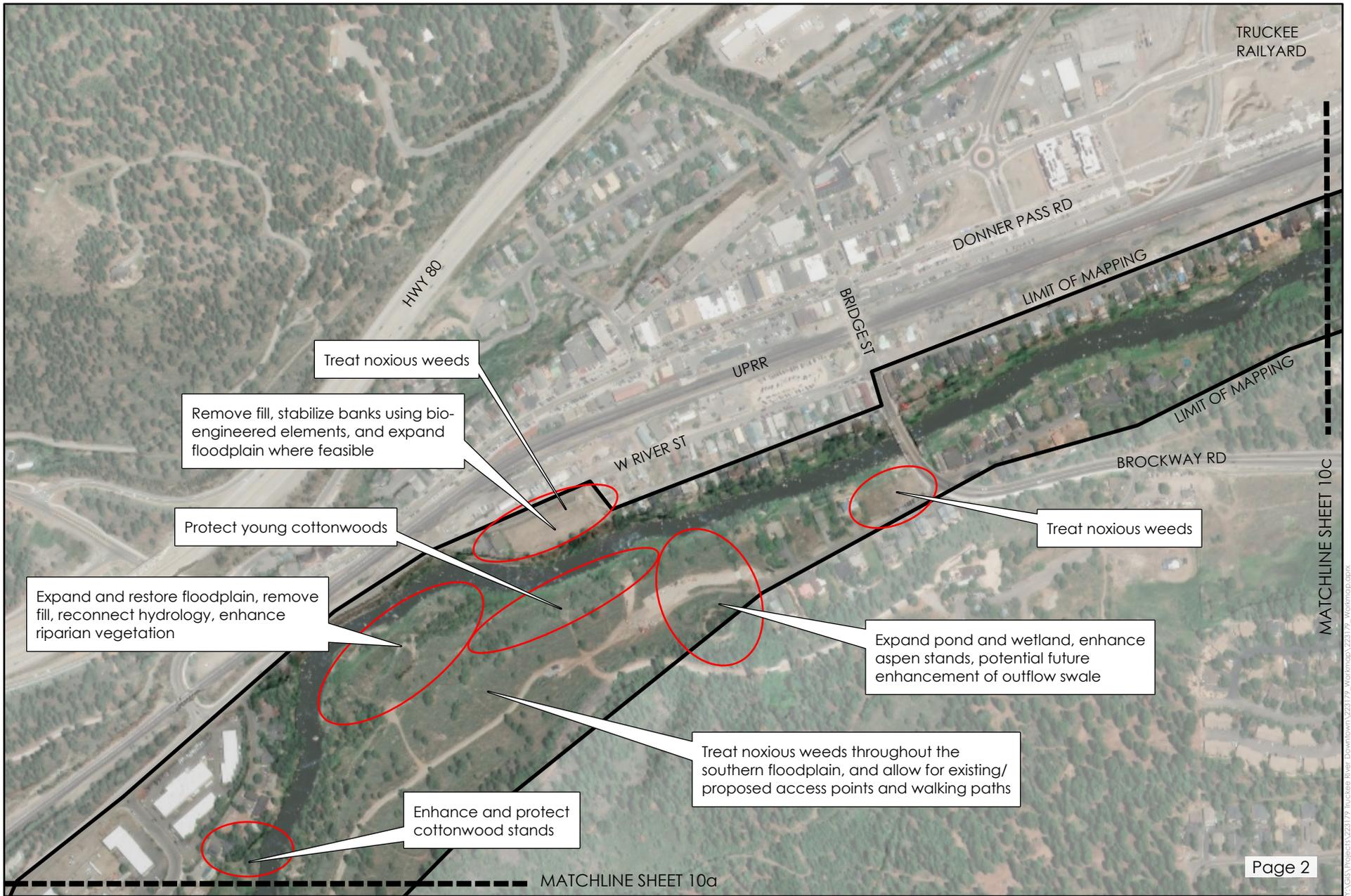
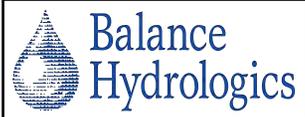


Figure 10a
Scale: 1:6,000

Enhancement Potential
Truckee River Downtown
Placer and Nevada Counties,
California



DATA SOURCES: Sources: Esri, Airbus DS, USGS, NGA, NASA, CGIAR, N Robinson, NCEAS, NLS, OS, NMA, Geodatastyrelsen, Rijkswaterstaat, GSA, Geoland, FEMA, Intermap and the GIS user community, Maxar



Ecological Enhancement Recommendations:
C.S. Ecological Surveys and Assessments

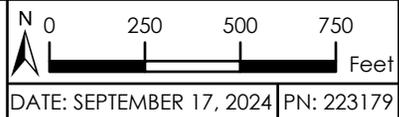
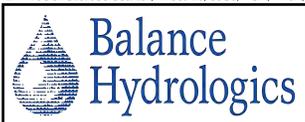


Figure 10b
Scale: 1:6,000

Enhancement Potential
Truckee River Downtown
Placer and Nevada Counties,
California



DATA SOURCES: Sources: Esri, Airbus DS, USGS, NGA, NASA, CGIAR, N Robinson, NCEAS, NLS, OS, NMA, Geodatastyrelsen, Rijkswaterstaat, GSA, Geoland, FEMA, Intermap and the GIS user community, Maxar



Ecological Enhancement Recommendations:
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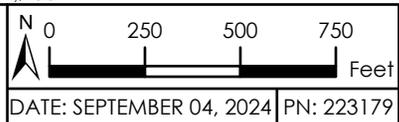


Figure 10c
Scale: 1:6,000

Enhancement Potential
Truckee River Downtown
Placer and Nevada Counties,
California

Stabilize banks

Where it is infeasible to remove historical fill but streambanks are unstable and delivering fine sediment to the channel, bank stabilization should take place, and should consist of bio-engineered bank stabilization approaches, such as living cribwalls or other planted boulder and log structures. Bio-engineered approaches improve riparian and aquatic habitat and are often more effective than simple armoring, as they draw on the long-term root strength of trees and other vegetation, often combined with structural elements such as large boulders where infrastructure must be protected.

Enhance, expand, and restore moderately functional floodplains and riparian areas

Where the river corridor currently experiences overbank flooding but cottonwood recruitment and other floodplain processes are lacking, minor modifications could be made to improve these functions. Localized grading to lower high points and removing historical artifacts such as placed boulders or concrete would allow for more frequent inundation of side channels, reworking of sediment, and exposure of fresh surfaces to allow for recruitment and germination of the next generations of cottonwood and willows.

Manage access and protect sensitive riparian communities

The Truckee River Downtown Corridor is within a built environment and is a central defining feature for the Town and community. Restoring ecological processes and improving habitat and water quality here should not exclude public access to the river. Rather, public access can be incorporated into restoration actions with enhancement of stabilized access points and avoidance of sensitive communities and processes.

Using principles of “eco-revelatory design” in this context allows ecological processes to be highlighted, which encourages interaction with and education about these processes and promotes stewardship of the riparian corridor. This may include interpretive and educational signage but can also be achieved simply through the design itself. For example, restoration projects can prohibit access to certain sensitive areas like aspen and cottonwood stands by planting shrubby and thorny species. Large trees with rootwads can be felled with intact branches along streambanks to limit undesired trampling or erosion. Use of natural materials such as boulders and logs to create stable paths or steps to desirable locations such as grassy floodplains or gravel bar beaches acknowledges the sensitivity of these locations, with minimal disruption to the resource and limited need for hard or visually jarring features such as fences. This type of nature-based design has proven successful along the Truckee River as part of joint access control and floodplain enhancement efforts by Placer County, CalTrans, the Tahoe City PUD, and the

Truckee River Watershed Council. Eco-revelatory design principles can also allow for artistic expression, especially where more hardened features like fencing may be required.

Stormwater and River Monitoring

The Town's current stormwater management program includes monitoring of outfalls for nuisance runoff during dry conditions and turbidity measurement upstream and downstream of the Town limits, but no sampling of stormwater runoff from within the town limits is currently taking place. During the early 2010s the Town partnered with Placer County in carrying out the Truckee River Water Quality Monitoring Program (TRWQMP) but has since discontinued many of the elements of that program. Around the same time the Truckee River Watershed Council conducted a multi-year monitoring program consisting of sediment transport measurement, loading calculations, river bed conditions monitoring, and bioassessment to evaluate conditions under the Middle Truckee River TMDL.

Repeating past methods would provide consistency for trend detection and comparison to past conditions, and would consist of the following actions, in addition to the Town's ongoing stormwater management program:

- Sampling of stormwater at outfalls during runoff events
- Riverbed conditions monitoring and mapping of fine sediment deposition
- Bioassment and benthic macroinvertebrate surveys
- Measurement of fine sediment transport and calculation of fine sediment loading from target subwatersheds within the town corridor
- Analysis of turbidity data being collected upstream and downstream of the Study Area

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