

3.0 RESTORATION NEEDS

The restoration needs are presented as a basis for the development of restoration alternatives. Restoration needs were initially identified in the SCR (MOUP CT 2002). Additional information describing the identification of restoration needs can be found in the SCR. Where appropriate, the SCR restoration needs have been updated, based on a review of newly available information.

3.1 RESTORATION OBJECTIVES

The general restoration objectives presented below were provided by the MOUP. Restoration alternatives are evaluated, in large part, in terms of their relative abilities to achieve the following restoration objectives:

- Restore, replace or acquire the equivalent of injured resources with lost services within the 11-Mile Reach to levels consistent with applicable baseline conditions; and
- Provide for restoration actions that are protective of human health and the environment.

An additional objective is to improve the physical conditions within the floodplain. Examples of this objective include: improving the quality of in-stream and riparian habitat within the 11-Mile Reach. Although in most areas the diminished quality of the physical habitat is not linked to the presence of hazardous substances, improvements in habitat quality will reduce physical stressors to brown trout and potentially reduce the negative effects associated with surface water quality.

It should be noted that, although included in the MOUP general objectives, the RAR does not consider acquisition or replacement. Consistent with the DOI NRD regulations, acquisition or replacement can be considered along with primary restoration, as a means to restore lost uses and services. However, evaluation of acquisition or replacement is beyond the scope of the RAR. Per the Work Plan, the RAR is intended to provide a reasonable range of alternatives for restoring impaired resources within the 11-Mile Reach. Given the general nature of these restoration objectives, and the RAR focus on restoration measures to be implemented within the 11-Mile Reach, it is important to clearly define restoration needs.

3.2 APPROACH FOR IDENTIFYING RESTORATION NEEDS

The SCR served as a basis for identifying and evaluating the nature and extent of injuries to natural resources of the UARB based on comparisons to regulatory definitions and expected baseline (Reach 0) conditions. This injury determination step was the first step in the approach for identifying restoration needs.

The SCR provides an understanding of the cause of mining related injuries to natural resources within the UARB by identifying the current sources of hazardous substances and the pathways for exposure. On-going releases from the California Gulch NPL Site were identified to be the largest contributor of metals responsible for injuries to the aquatic resources. The sources identified to be contributing metals to the surface and groundwaters of the California Gulch drainage, are being addressed through Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) Response Actions, and are beyond the scope of the RAR. Mine sites in the UAR headwaters upstream of Leadville (e.g., St. Kevin's Gulch) and on Lake Fork (e.g., Dinero Tunnel) also contribute measurable metals loads to the 11-Mile Reach. Additional reduction in metals loading from these upstream sources would have a beneficial effect on water quality and the aquatic biota of the 11-Mile Reach.

It is recognized that without additional metals-loading control measures, restoration measures within the 11-Mile Reach will not restore surface water quality and will provide limited benefit to the aquatic biological resources. At this time, the exact schedule for completion of all California Gulch NPL Site Response Actions, and the time frame to achieve full effectiveness, are unknown. However, based on the types of source control measures implemented, it is expected that water quality in the UARB will continue to improve. A lessening of maximum concentrations of dissolved metals in California Gulch during spring runoff should occur over the next few years, as source-area engineering controls and associated revegetation efforts mature. Low-flow metals concentrations should also continue to decline over a somewhat longer time frame. With time, it is expected that these source control measures should also be effective in reducing dissolved metals concentrations in the shallow alluvial groundwater within California Gulch. Consideration of additional restoration actions for improving 11-Mile Reach water quality would not be sensible until the planned Response Actions for the California Gulch NPL Site have been fully implemented and have achieved maximum effectiveness. Restoration measures to control the ongoing releases from the Dinero Tunnel and St. Kevin's Gulch Mine Sites, as well as other potential mine-site sources outside the current NPL boundaries, should also be implemented. The ongoing metals contributions from upstream sources were considered when identifying restoration needs.

Understanding the relationship between an identified resource injury and any reduction in the baseline of services provided by the resource was the second step of the approach to determining restoration needs. For example, based on the SCR, injury to surface water was initially determined relative to the frequency and extent of exceedences of the relevant water-quality criteria for the period of record. The impacts of water-quality exceedences on resource conditions were ultimately considered in terms of a potential for reduction in services provided by surface water, both in terms of limitations of the uses of the surface water (e.g., agricultural waters and/or drinking water) and the impacts on dependent resource components (e.g., fish). Although an injury was defined for surface water, it may not result in a quantifiable reduction in all resource services.

Although it is possible to understand the relationship between mining impacts and a diminished resource, quantification of a reduction in the past or current level of resource services attributable solely to an identified injury is beyond the scope of the SCR. This is due in large part to the complexities of sorting the cumulative effects of mining impacts from non-mining impacts. In the UARB, there are several baseline factors related to land use and water management (e.g., trans-mountain water diversions) that have modified the UARB ecosystem over the past 130 years. Although the relative role of non-mining impacts could not be quantified, impacts were identified and considered.

Also considered was whether a resource is recovering. The evaluation of recovery considered temporal changes in the nature and extent of injury, as well as whether or not uses and services are recovering and will achieve the expected baseline. Evidence of, or expectations for, resource recovery were important to evaluating the need for and extent of future restoration activities. The RAR considers information pertinent to the ability of the UARB resources to recover from the effects of the 100+ year history of mining impacts (43 CFR § 11.82[d]). Changes in water quality due to recent upstream source control activities, the long period of time since initial release, and ongoing Response Actions are factors that contribute to resource recovery and are apparent in an evaluation of spatial and temporal trends. Conversely, short-term impacts from restoration activities or long-term changes in land use may adversely affect recovery trends. Although the natural resources of the UARB are recovering in certain areas, it is important to identify where mining impacts in the 11-Mile Reach will negatively affect or preclude resource recovery.

USEPA has been conducting remediation work on selected fluvial mine-waste deposits in the 11-Mile Reach (USEPA 2003a) and has recently investigated the concentration and toxicity of metals in irrigated lands, within and adjacent to the 11-Mile Reach (USEPA 2003b). New information on these

USEPA activities within the 11-Mile Reach has become available since the time of the SCR development (USEPA 2003b). USEPA's remediation to date includes the addition of amendments, revegetation efforts, and some limited bank stabilization measures. The effectiveness of USEPA's remediation in terms of improving environmental conditions within specific portions of the 11-Mile Reach, as well as new data regarding risks to wildlife and livestock from irrigated lands, have been evaluated and were fully considered in this RAR.

Overall, USEPA's study (USEPA 2003b) is consistent with the analysis conducted in support of the SCR (See SCR Appendix J - Characterization of the Potential for Injury to Mammalian Wildlife), which identified a limited potential for unacceptable risks to livestock associated with discrete areas of elevated soil/vegetation. Further study would be required to assess the role of elevated metals concentrations on livestock in these localized areas. Such studies would involve an evaluation of the ranching practices utilized by landowners (e.g., irrigation practices, feeding, and use of nutritional supplements) in conjunction with additional livestock health and environmental data. Conducting the appropriate studies would require several years. Also, it is not clear if the potential effects to livestock would be assessed as an injury to natural resources. Setting these issues aside, the RAR considers restoration alternatives that may be beneficial to those portions of the floodplain identified by USEPA as potentially problematic. However, it should be noted that the primary benefit from both a terrestrial natural resource and agricultural-use perspective would come from the restoration measures proposed for the discrete fluvial mine-waste deposits.

As noted above, accurate quantification of any reduction in services attributable solely to one specific cause of injury is difficult under many circumstances. It is particularly difficult for the UARB when considering the long duration since the initial release of mine waste and the concurrent shifts in land-use patterns and resource management. In order to accurately measure a reduction in services attributable solely to mining impacts, it would be necessary to sort and quantify the role of all of the overlapping natural and anthropogenic influences on the UARB. Such an effort goes beyond the level of understanding that could be garnered from existing information and may not be possible given the dynamic nature of the system, even with years of study. Instead, resources that would benefit from restoration are identified and addressed from a practical level of understanding. This understanding is based on knowledge of the sources and pathways for exposure, comparison of the 11-Mile Reach conditions with control areas, and the experience of the authors. Although a reduction in services was not quantified through this process, it was identified. Correspondingly, the need for restoration of a resource

was identified and, based on an understanding of the causes of the reduced service(s), specific geographic areas were targeted for restoration measures.

3.3 RESTORATION NEEDS

The following restoration needs were initially identified in the SCR. Where identified, they have been updated based on information available since the release of the SCR in 2002.

3.3.1 FLUVIAL MINE-WASTE DEPOSITS

Aside from the impacts of poor water quality due to upstream metals loading, the primary source of injury within the 11-Mile Reach is the numerous discrete floodplain deposits of mine waste. These deposits have resulted in direct injury to the underlying soil and floodplain vegetation, and pose a pathway for exposure of terrestrial wildlife. The potential for these deposits to influence metals concentrations in both surface water and groundwater is limited by the shallow thickness of the deposits and corresponding small loading potential, relative to the large volume of surface and groundwater moving through the valley. Furthermore, SCR analyses indicate that even large-scale erosion of the deposits would not have a measurable effect on water quality. However, even though not measurably influencing water quality, pathways for floodplain fluvial mine-waste deposits to contribute metals to the surface and shallow groundwater systems exist. Key factors in evaluating the current and future potential for individual fluvial mine-waste deposits to contribute metals to the surface and shallow groundwater systems are the potential for erosion and the metals concentration of each deposit. These factors were considered, along with the defined injuries to soils and plants and the potential for direct exposure of wildlife, when identifying target restoration areas.

Based on the findings of the SCR, it is evident that the different characteristics of the individual fluvial mine-waste deposits should be considered when developing restoration alternatives. An understanding of these characteristics was important when prioritizing the need for restoration and developing and evaluating restoration alternatives. For these reasons, a methodology to classify the fluvial mine-waste deposits was developed. USEPA has conducted physical and chemical analyses of the fluvial mine-waste deposits within the 11-Mile Reach (URS Operating Services, Inc. 1997, 1998). This

information served as a starting point for prioritizing the individual deposits. The primary criteria for the prioritization were:

- Erosion Potential - As defined by distance from or contact with the active channel based on a review of recent aerial photographs and available reports.
- Vegetation Cover – Based on review of recent aerial photography and limited site reconnaissance.
- Volume of Material – Based on recent work by USEPA to map the surface area and average depth of the individual deposits.
- Average Zinc Concentration – Based on a compilation of various USEPA sampling efforts. Categories of average zinc concentrations were developed as an indication of the potential metals toxicity to plants and wildlife, and to generally characterize the potential for a deposit to contribute metals loads to the water resources. The ranges are not meant to define any specific aspect of metals loading potential or toxicity, but to serve as a general tool for prioritization when coupled with other information.

Information related to the above criteria was analyzed using a Geographic Information System (GIS), and the results were quantified using the following scoring system:

- **Vegetation Class Score:**
 - 1: > 50 percent cover
 - 2: 10-50 percent cover
 - 3: < 10 percent cover
- **Erosion Potential Score:**
 - 1: Isolated from river
 - 2: In 500-year floodplain
 - 3: In contact with Arkansas River channel
- **Deposit Volume:**
 - 1: < 10,000 cu. ft.
 - 2: 10,000-50,000 cu. ft.
 - 3: > 50,000 cu. ft.
- **Average Zinc Concentration:**
 - 1: < 1,000 mg/Kg Zinc
 - 2: 1,000-5,000 mg/Kg Zinc
 - 3: > 5,000 mg/Kg Zinc

A priority ranking of the deposits for restoration was then conducted by dividing the range of possible scores (4 to 12) into three equal categories. These categories were then identified as a high (10-12), moderate (7-9), or low (4-6) priority. Figure 3-1 details the mine-waste deposit prioritization by Reach. A detailed tabulation of the GIS analysis and additional information on the methodology was presented as Appendix H of the SCR.

Since 1998, USEPA has conducted treatment on 47 of the 153 fluvial mine-waste deposits within the 11-Mile Reach. USEPA released the 2002 Interim Monitoring Report in October 2002 (USEPA 2002a). This report contains the Final Assessment Report on the Effectiveness of Biosolids and Lime Treatment as Soil Amendments for Fluvial Tailings Along the Upper Arkansas River (USEPA 2002b). The Final Assessment Report evaluated the effectiveness of biosolids cake and lime amendments one year after treatment. The success of the treatments to reduce the availability of metals, increase deposit pH and promote growth of vegetation was evaluated. The results of the evaluation concluded that the amendments were successful in improving soil quality, allowing growth of vegetation and the recovery of the microbial community. Soil toxicity was also reduced. However, results indicated that treating the deposits with biosolids cake and agricultural grade lime did not dilute total concentrations of metals and effects such as reductions in the production of plant root biomass and bioaccumulation of constituents of concern (COCs) in the food chain may still occur.

USEPA's work is still in progress and detailed information as to the performance of any given treatment approach on long-term effectiveness, plant community effects and dietary exposure risk is not yet available. However, USEPA continues to modify and re-amend the deposits based on field observations, and additional amendments were added to many of the deposits in the summer of 2003. Specific treatment summaries for individual deposits were provided to the CT on behalf of USEPA. This information is detailed below by reach and priority.

Reach 1

Reach 1 metal concentrations in fluvial mine-waste deposits exceed toxicity thresholds for plants, and plant growth has substantially been reduced on most sites where fluvial mine-waste deposits occur. Of the 24 deposits along Reach 1, 14 had poor vegetation cover, 9 deposits had fair vegetation cover, and 1 deposit had good vegetation cover. Fluvial mine-waste deposits cover a surface area of approximately 18 acres, with a volume of approximately 32,845 cu. yds. Of the 24 deposit groups in this reach, 11 are

ranked as high priority for restoration, 11 are ranked as moderate priority and 2 are ranked as low priority. Figure 3-2 details the locations and priorities of the mine-waste deposits within Reach 1.

USEPA has conducted treatments on 16 of the 24 deposits within Reach 1, including all of the high priority deposits (13.46 acres), and 1.84 acres of moderate priority deposits (Tables 3-1 and 3-2). Treatments in Reach 1 generally involved the integration of a variety of combinations of organic matter (biosolids, wood chips, fish pond sediments) and lime (agricultural grade limestone, kiln dust, dolomite chips) with the fluvial deposits. The treatments also included reseeded.

**TABLE 3-1
REACH 1 HIGH PRIORITY
USEPA MINE-WASTE DEPOSIT TREATMENT SUMMARY¹**

High Priority Deposit	Treatment	Year(s)	Acreage
AB	100 dt/a biosolids compost + cow manure compost + 100 t/a agricultural grade limestone. Incorporated to approximately 1 foot using an excavator. 10 t/a wood chips, 35 t/a fish pond sediments, and 20 t/a dolomite added to portions of AC during 2003.	1999 2003	0.38
AC	100 dt/a biosolids compost + cow manure compost + 100 t/a agricultural grade limestone. Incorporated to approximately 1 foot using an excavator. 10 t/a wood chips, 35 t/a fish pond sediments, and 20 t/a dolomite added to portions of AC during 2003.	1999 2003	0.71
AD	100 dt/a biosolids + cow manure compost + 100 t/a agricultural grade limestone. Incorporated to approximately 1 foot using an excavator.	1999	0.80
AE	100 dt/a biosolids + cow manure compost + 100 t/a agricultural grade limestone. Incorporated to approximately 1 foot using an excavator.	1999	2.37
CA	100 dt/a biosolids pellets + 100 t/a agricultural grade limestone. Incorporated to approximately 1 foot using an excavator. 10 t/a wood chips, 35 t/a fish pond sediments, and 20 t/a dolomite added during 2003.	1999 2003	0.88
CD	100 dt/a biosolids pellets + 100 t/a agricultural grade limestone. Incorporated to approximately 1 foot using an excavator. 10 t/a wood chips, 35 t/a fish pond sediments, and 20 t/a dolomite added during 2003.	1999 2003	1.64
CJ	100 dt/a biosolids pellets + 100 t/a agricultural grade limestone. Incorporated to approximately 1 foot using an excavator. 10 t/a wood chips, 35 t/a fish pond sediments, and 20 t/a dolomite added during 2003.	1999 2003	0.48
CE	100 dt/a biosolids pellets + 100 t/a agricultural grade limestone. Incorporated to approximately 8 inches using an excavator.	1999	0.55
CL	100 dt/a biosolids cake + 100 t/a 3/8 inch- agricultural grade lime. Incorporated to approximately 1 foot with Metrogrow disc. Sugar beet lime added and raked in (shallow) during Summer 2001. 10 t/a wood chips, 35 t/a fish pond sediments, and 20 t/a dolomite added during 2003.	1998 2003	2.43
CO	100 dt/a biosolids cake + 100 t/a 3/8 inch- agricultural grade lime. Incorporated to approximately 1 foot with Metrogrow disc. Sugar beet lime added and raked in (shallow) during Summer 2001. 10 t/a wood chips, 35 t/a fish pond sediments, and 20 t/a dolomite added during 2003.	1998 2003	2.34
CS	100 dt/a biosolids pellets + 100 t/a agricultural grade limestone. 10 t/a wood chips, 35 t/a fish pond sediments, and 20 t/a dolomite added during 2003.	1999 2003	0.88
Total Acres of Reach 1 High Priority Treated Deposits			13.46

¹Treatment information provided to CT by Jan Christner, URS Greiner on behalf of USEPA.

**TABLE 3-2
REACH 1 MODERATE PRIORITY
USEPA MINE-WASTE DEPOSIT TREATMENT SUMMARY¹**

Moderate Priority Deposit	Treatment	Year(s)	Acreage
AA	100 dt/a biosolids compost + cow manure compost + 100 t/a agricultural grade limestone. Incorporated to approximately 1 foot using an excavator. 10 t/a wood chips, 35 t/a fish pond sediments, and 20 t/a dolomite added to portions of AC during 2003.	1999 2003	0.10
CK	100 dt/a biosolids pellets + 100 t/a agricultural grade limestone. Incorporated to approximately 1 foot using an excavator. 10 t/a wood chips, 35 t/a fish pond sediments, and 20 t/a dolomite added during 2003.	1999 2003	0.31
CN	100 dt/a biosolids cake + 100 t/a 3/8 inch- agricultural grade lime. Incorporated to approximately one foot with Metrogrow disc. Sugar beet lime added and raked in (shallow) during Summer 2001. 10 t/a wood chips, 35 t/a fish pond sediments, and 20 t/a dolomite added during 2003.	1998 2003	0.40
CP	100 dt/a biosolids pellets + 100 t/a agricultural grade limestone. 10 t/a wood chips, 35 t/a fish pond sediments, and 20 t/a dolomite added during 2003.	1999 2003	0.13
CR	100 dt/a biosolids pellets + 100 t/a agricultural grade limestone. 10 t/a wood chips, 35 t/a fish pond sediments, and 20 t/a dolomite added during 2003.	1999 2003	0.90
Total Acres of Reach 1 Moderate Priority Treated Deposits			1.84

¹Treatment information provided to CT by Jan Christner, URS Greiner on behalf of USEPA.

Reach 2

In Reach 2, metal concentrations in fluvial mine-waste deposits exceed toxicity thresholds for plants, and plant growth has been substantially reduced on most sites where fluvial mine-waste deposits occur. Of the 35 deposits along Reach 2, 2 have poor vegetation cover, 19 deposits have fair vegetation cover, and 14 deposits have good vegetation cover. Fluvial mine-waste deposits cover a surface area of approximately 9.3 acres, with a volume of approximately 8,644 cu. yds. Of the 35 deposit groups in Reach 2, 3 are ranked as high priority for restoration, 27 are ranked as moderate priority, and 5 are ranked as low priority. Figure 3-3 details the locations and priorities of the mine-waste deposits within Reach 2.

USEPA has not conducted any treatment of the mine-waste deposits within Reach 2. However, test plot studies were conducted by the United States Department of Agricultural (USDA) in 1998 on the high priority deposit FA (1.17 acres) and by Colorado State University/ASARCO in 1997-1999 on the high priority deposit FB (2.47 acres).

Reach 3

In Reach 3, metal concentrations in fluvial mine-waste deposits exceed toxicity thresholds for plants, and plant growth has been substantially reduced on most sites where fluvial mine-waste deposits occur. Of the 94 deposits along Reach 3, 26 have poor vegetation cover, 56 have fair vegetation cover, and 11 have good vegetation cover (vegetation cover of deposit RF was not evaluated). Fluvial mine-waste deposits cover a surface area of approximately 37.6 acres, with a volume of approximately 58,456 cu. yds. Of the 94 deposit groups in this reach, 13 are ranked as high priority for restoration, 69 are ranked as moderate priority, and 12 are ranked as low priority. Figure 3-4 details the locations and priorities of the mine-waste deposits within Reach 3.

USEPA has conducted treatments on 31 of the 94 deposits within Reach 3, including 5.74 acres of high priority deposits, 10 acres of moderate priority deposits and 1.06 acres of low priority deposits. Treatments generally involving the integration of a variety of combinations of organic matter (biosolids, wood chips, fish pond sediments) and lime (agricultural grade limestone, kiln dust, dolomite chips) with the fluvial deposits have been utilized for approximately 17 of the 38 acres within Reach 3. The treatments also included reseeded (Tables 3-3-3-5).

**TABLE 3-3
REACH 3 HIGH PRIORITY
USEPA MINE-WASTE DEPOSIT TREATMENT SUMMARY¹**

High Priority Deposit	Treatment	Year(s)	Acreage
LB	115 dt/a biosolids pellets + 105 t/a fine grained agricultural grade limestone. 10 t/a wood chips, 35 t/a fish pond sediments, and 20 t/a dolomite added during 2003.	2000 2003	0.29
LI	20 dt/a biosolids pellets + 40 dt/a compost + 80 t/a fine grained lime kiln dust. 10 t/a wood chips, 35 t/a fish pond sediments, and 20 t/a dolomite added during 2003.	2000 2003	0.26
LN	30 dt/a biosolids pellets + 50 dt/a compost + 105 t/a fine grained lime kiln dust. 10 t/a wood chips, 35 t/a fish pond sediments, and 20 t/a dolomite added to the very south end of LN during 2003.	2000 2003	1.06
LV	30 dt/a biosolids pellets + 50 dt/a compost + 105 t/a fine grained lime kiln dust. 10 t/a wood chips, 35 t/a fish pond sediments, and 20 t/a dolomite added during 2003.	2000 2003	0.25
MB	100 dt/a biosolids cake + 100 t/a 3/8 inch- agricultural grade lime. 10 t/a wood chips, 35 t/a fish pond sediments, and 20 t/a dolomite added during 2003.	1998 2003	0.73
MQ	100 dt/a biosolids cake + 100 t/a 3/8 inch- agricultural grade lime	1998	0.93
NI	100 dt/a compost + 100 t/a 3/8 inch- agricultural grade lime	1999	1.60
RB	100 dt/a biosolids cake + 100 t/a 3/8 inch- agricultural grade lime. 10 t/a wood chips, 35 t/a fish pond sediments, and 20 t/a dolomite added during 2003.	1998 2003	0.62
Total Acres of Reach 3 High Priority Treated Deposits			5.74

¹Treatment information provided to CT by Jan Christner, URS Greiner on behalf of USEPA.

**TABLE 3-4
REACH 3 MODERATE PRIORITY
USEPA MINE-WASTE DEPOSIT TREATMENT SUMMARY¹**

Moderate Priority Deposit	Treatment	Year(s)	Acreage
LA	115 dt/a biosolids pellets + 105 t/a fine grained agricultural grade limestone. 10 t/a wood chips, 35 t/a fish pond sediments, and 20 t/a dolomite added during 2003.	2000 2003	0.14
LC	46 dt/a biosolids pellets + 40 dt/a compost + 90 t/a fine grained lime kiln dust. 20 lb/a native seed ² . 600 lb/a phosphate on east half only. 10 t/a wood chips, 35 t/a fish pond sediments, and 20 t/a dolomite added during 2003.	2000 2003	1.02
LD	46 dt/a biosolids pellets + 40 dt/a compost + 30 t/a fine grained lime kiln dust. Half plot 20 lb/a native seed ² . Half plot 20 lb/a perennial rye seed. 10 t/a wood chips, 35 t/a fish pond sediments, and 20 t/a dolomite added during 2003.	2000 2003	0.50
LH	30 dt/a biosolids pellets + 60 dt/a compost + 120 t/a fine grained lime kiln dust.	2000	0.37
LK	46 dt/a biosolids pellets + 40 dt/a compost + 30 t/a fine grained lime kiln dust. 5 t/a native hay with seed. 10 t/a wood chips, 35 t/a fish pond sediments, and 20 t/a dolomite added during 2003.	2000 2003	0.41
LM	30 dt/a biosolids pellets + 55 dt/a compost + 115 t/a fine grained lime kiln dust.	2000	0.38
LO	60 dt/a biosolids pellets + 25 dt/a compost + 105 t/a fine grained lime kiln dust. 10 t/a wood chips, 35 t/a fish pond sediments, and 20 t/a dolomite added during 2003.	2000 2003	0.47
LP	70 dt/a biosolids pellets + 30 dt/a compost + 125 t/a fine grained lime kiln dust. 10 t/a wood chips, 35 t/a fish pond sediments, and 20 t/a dolomite added during 2003.	2000 2003	0.36
LQ	30 dt/a biosolids pellets + 50 dt/a compost + 100 t/a fine grained lime kiln dust. 10 t/a wood chips, 35 t/a fish pond sediments, and 20 t/a dolomite added during 2003.	2000 2003	0.14
LS	35 dt/a biosolids pellets + 60 dt/a compost + 120 t/a fine grained lime kiln dust.	2000	0.99
ME	100 dt/a biosolids cake + 100 t/a 3/8 inch- agricultural grade lime. 10 t/a wood chips, 35 t/a fish pond sediments, and 20 t/a dolomite added during 2003.	1998	0.88
MI	100 dt/a compost + 100 t/a 3/8 inch- agricultural grade lime	1999	0.23
MP	100 dt/a biosolids cake + 100 t/a 3/8 inch- agricultural grade lime	1998	0.11
NB	100 dt/a compost + 100 t/a 3/8 inch- agricultural grade lime	1999	0.81
NG	100 dt/a compost + 100 t/a 3/8 inch- agricultural grade lime	1999	1.01
NH	100 dt/a compost + 100 t/a 3/8 inch- agricultural grade lime	1999	0.82
NL	100 dt/a compost + 100 t/a 3/8 inch- agricultural grade lime	1999	0.32
RA	100 dt/a biosolids cake + 100 t/a 3/8 inch- agricultural grade lime. 10 t/a wood chips, 35 t/a fish pond sediments, and 20 t/a dolomite added during 2003.	1998 2003	1.04
Total Acres of Reach 3 Moderate Priority Treated Deposits			10

¹Treatment information provided to CT by Jan Christner, URS Greiner on behalf of USEPA.

**TABLE 3-5
REACH 3 LOW PRIORITY
USEPA MINE-WASTE DEPOSIT TREATMENT SUMMARY¹**

Low Priority Deposit	Treatment	Year(s)	Acreage
LL	46 dt/a biosolids pellets + 40 dt/a compost + 30 t/a fine grained lime kiln dust. No seed.	2000	0.12
LR	30 dt/a biosolids pellets + 50 dt/a compost + 100 t/a fine grained lime kiln dust.	2000	0.03
MG	100 dt/a compost + 100 t/a 3/8 inch- agricultural grade lime	1999	0.52
MH	100 dt/a compost + 100 t/a 3/8 inch- agricultural grade lime	1999	0.16
MK	100 dt/a compost + 100 t/a 3/8 inch- agricultural grade lime	1999	0.23
Total Acres of Reach 3 Low Priority Treated Deposits			1.06

¹Treatment information provided to CT by Jan Christner on behalf of USEPA.

Reach 4

In Reach 4, some small fluvial mine-waste deposits exist, but they have not been quantified with respect to chemical properties and plant cover. Not enough information exists to draw conclusions about injury to vegetation at locations where deposits occur. However, only several small accumulations of mine waste were observed in Reach 4 and they all have some degree of vegetation. Observation indicates that these areas cover substantially less than 2 acres. However, for the purpose of alternatives development, a total area of 2 acres is conservatively assumed.

USEPA has not conducted any treatment of the mine-waste deposits within Reach 4.

3.3.2 AGRICULTURAL LANDS

The SCR identified elevated metals concentrations in surficial floodplain soils peripheral to the fluvial mine-waste deposits and in irrigated meadows as a mining impact (See SCR Appendix J - Characterization of the Potential for Injury to Mammalian Wildlife). Irrigation and drainage ditches in the 11-Mile Reach and vicinity are shown in Figure 3-5. One of the resources utilized in the SCR was the Ecological Risk Assessment for the Terrestrial Ecosystem of the California Gulch NPL Site (ERA) (Weston and Terra 1997). This ERA contained only limited data, and risks to herbivores did not include an estimation of the risk from plant ingestion. Although defined injuries to terrestrial natural resources (i.e., soils, vegetation and terrestrial wildlife) could not be directly linked to the presence of metals in

these soils, in certain settings they may have the potential to impact vegetation and/or the health of wildlife and livestock. Elevated metals concentrations in floodplain soils are of potential concern for the following reasons:

- Soils with elevated metal concentrations may be phytotoxic to plants which reduces habitat quality and/or the availability of forage for herbivores;
- Herbivores foraging in areas of elevated metal concentrations may be exposed both by ingestion of plant tissue and by direct ingestion of soil; and
- Metals in plant tissue can be ingested by terrestrial insects and can become a source of exposure for insectivorous birds.

Since the release of the SCR in 2002, USEPA published an addendum to the ERA: Evaluation of Risks to Plants and Herbivores in the Upper Arkansas River Flood Plain (USEPA 2003b). This addendum provides an evaluation of the potential for mine-waste related phytotoxicity and risks to herbivorous mammals (wildlife and livestock) that may forage in the area. The addendum presents new data collected to evaluate surficial soil and vegetation within the 500-year floodplain and in irrigated meadows.

In the addendum, USEPA identified three categories of potential phytotoxicity:

- ≤ 0.5 Non-Phytotoxic to Mildly Phytotoxic
- $0.5 \text{ to } \leq 1$ Moderately Phytotoxic
- >1 Highly Phytotoxic

The summary statistics for exposure and risk to herbivores revealed that risks were limited to very localized areas and usually dominated by ingestion of soil, with plant ingestion contributing significant risk at only two sampling stations. Zinc was the primary chemical at the two stations where plant intake was above a level of concern. Lead was the chemical in soil that had the highest predicted risk, with contributions from zinc and mercury at some locations. In all instances, the contribution of plant ingestion to the total Hazard Quotient (HQ) was negligible compared to that of soil ingestion. In their assessment, USEPA identified only marginal risks to herbivores associated with some limited areas. Unacceptable risks were generally not identified at a scale more consistent with the grazing range of the species evaluated. When risks were evaluated in terms of total exposure within a reach, none of the reaches were identified as resulting in an HQ of >1 .

The sample locations identified as posing unacceptable risks to herbivores (i.e., $HQ > 1$) were compared with USEPA's analysis of potential phytotoxic effects due to surficial soil metals concentrations. The number of locations of potentially high phytotoxicity is greater than the number of locations with a $HQ > 1$. When locations of potentially high phytotoxicity were compared with locations of risks to herbivores, the areas of herbivore risk were most often included in the areas of potentially high phytotoxicity. Although no obvious signs of phytotoxicity were observed in the field for these areas, and cover was similar to that in Reach 0, the areas exhibiting potentially high phytotoxicity and/or $HQs > 1$ for deer and elk were conservatively adopted for the purpose of identifying restoration needs.

In order to quantify the acreages of agricultural lands predicted by USEPA to have potentially high phytotoxicity and/or $HQ > 1$ by subreach, information from several figures in the USEPA Risk Assessment Addendum (USEPA 2003b) were digitized. Areas of predicted high phytotoxicity were captured as polygons from Figure 6-1, and HQ point locations were digitized from Figure 7-1 (USEPA 2003b). Most of the points with $HQ > 1$ were located within the predicted high phytotoxicity areas. Two of the points with $HQs > 1$ were located outside of the predicted high phytotoxicity areas. These two sample locations were converted to polygons by using the average distance to the nearest neighboring sample locations. Using the UARB GIS, the spatial intersection of the predicted phytotoxicity areas, areas with $HQ's > 1$, the 500-year floodplain, the subreach zones, and the mine-waste deposit areas was produced. The result of the spatial intersection is a set of polygons that contain information about predicted phytotoxicity, $HQ's$, floodplain type, mine-waste deposit identifier, and subreach zone. The location of predicted high phytotoxicity in relation to mine-waste deposits is shown in Figure 3-6. The mapped fluvial mine-waste deposits were not included in the irrigated area calculations because specific restoration alternatives are being developed for the deposits. Summary statistics for the areas of high phytotoxicity and/or areas with $HQ > 1$ are presented for each reach in Tables 3-6 through 3-8.

Reach 1

In Reach 1 the areas of the 500-year floodplain irrigated agricultural lands identified as having the greatest potential for phytotoxicity are in subreach 1A (2.7 acres). Subreach 1A also contains 1.4 acres within the non-floodplain area characterized as potentially highly phytotoxic. The areas of the non-floodplain irrigated agricultural lands identified as having the greatest potential for phytotoxicity and as posing unacceptable risks to grazing animals are in subreach 1C (26 acres). Subreach 1B contains 2.4 acres within the 500-year floodplain area characterized as potentially highly phytotoxic and/or as posing

unacceptable risks to grazing animals and 1.9 acres within the non-floodplain area characterized as potentially highly phytotoxic and as posing unacceptable risks to grazing animals (Table 3-6). Areas USEPA has identified as having an HQ of greater than 1 for deer and elk are combined with areas exhibiting the greatest potential for phytotoxicity (Figure 3-6). These acreages are exclusive of the mapped fluvial deposits.

**Table 3-6
Summary of USEPA Predicted High Phytotoxicity and/or HQ >1 Areas in Reach 1**

Subreach	Type	Acres
1A	Floodplain	2.7
	Non-floodplain	1.4
1B	Floodplain	2.4
	Non-floodplain	1.9
1C	Floodplain	--
	Non-floodplain	26
Total		34.4

Reach 2

In Reach 2, the areas of the floodplain and non-floodplain irrigated agricultural lands identified as having the greatest potential for phytotoxicity and/or as posing unacceptable risks to grazing animals are almost evenly split between subreaches 2A and 2B. Subreach 2A contains 4.7 acres of potentially high phytotoxic soils within the 500-year floodplain and 6.2 acres of potentially high phytotoxic soils in the non-floodplain. Subreach 2B contains 7.6 acres of potentially high phytotoxic soils within the 500-year floodplain and 3.6 acres of potentially high phytotoxic soils in the non-floodplain (Figure 3-6).

Two areas identified by USEPA within Reach 2 as having an HQ of greater than 1 for deer and elk are located outside of the areas of potentially high phytotoxicity (Figure 3-6). Subreach 2A contains 20.8 acres with a HQ > 1 in the non-floodplain. Subreach 2B contains 21.2 acres with a HQ > 1 within the 500-year floodplain and 2 acres in the non-floodplain.

Table 3-7 summarizes the acreages of potentially high phytotoxicity and/or HQ >1 in Reach 2. These acreages are exclusive of the mapped fluvial deposits.

Table 3-7
Summary of USEPA Predicted High Phytotoxicity and/or HQ >1 Areas in Reach 2

Subreach	Type	Acres
2A	Floodplain	4.7
	Non-floodplain	27
2B	Floodplain	28.8
	Non-floodplain	5.6
Total		66.1

Reach 3

In Reach 3 the areas of the 500-year floodplain irrigated agricultural lands identified as having the greatest potential for phytotoxicity and/or as posing unacceptable risks to grazing animals are in subreach 3A (19.9 acres). In addition, subreach 3A contains 3.5 acres of potentially phytotoxic non-floodplain soils. Subreach 3B contains 8.9 acres within the 500-year floodplain and 37.9 acres of non-floodplain soils having the greatest potential for phytotoxicity and/or posing unacceptable risks to grazing animals (Figure 3-6). Table 3-8 summarizes the acreages of potentially high phytotoxicity and/or HQ >1 in Reach 2. These acreages are exclusive of the mapped fluvial deposits.

Table 3-8
Summary of USEPA Predicted High Phytotoxicity and/or HQ >1 Areas in Reach 3

Subreach	Type	Acres
3A	Floodplain	19.9
	Non-floodplain	3.5
3B	Floodplain	8.9
	Non-floodplain	37.9
Total		70.2

Reach 4

Floodplain vegetation appears to be in good condition within Reach 4. USEPA phytotoxicity analyses were not conducted for Reach 4.

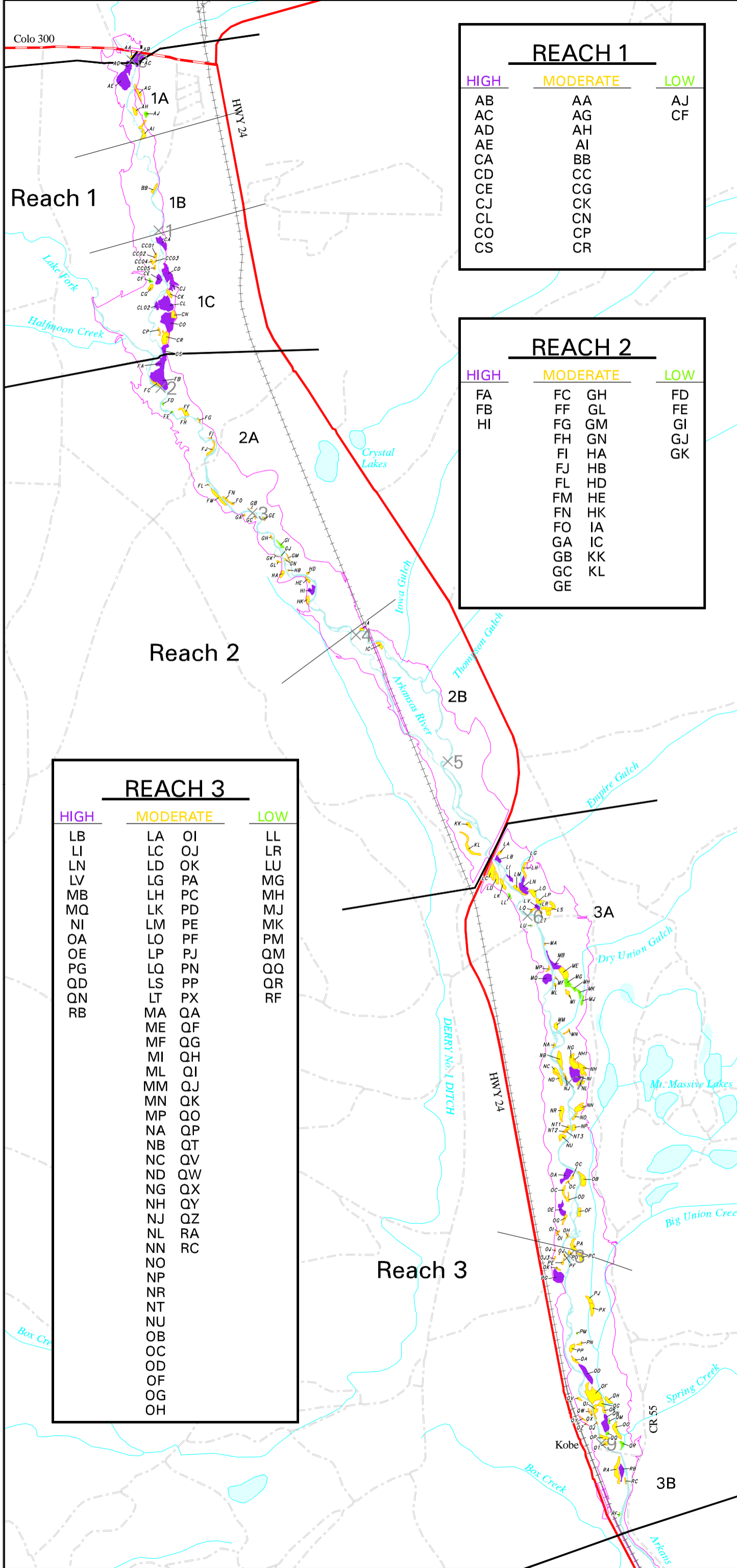
3.3.3 CHANNEL MORPHOLOGY, IN-STREAM HABITAT AND RIPARIAN AREAS

At the direction of the parties overseeing the execution of the Work Plan, natural resource areas and agricultural lands that would benefit from restoration measures due to impacts other than from mining have also been identified. As discussed in the SCR, specifically for Reach 3, flow augmentation and grazing appear to have had the largest negative impacts on the conditions of the riverbanks and riparian habitat. Residual mining impacts appear to be limited to riparian vegetation and bank stability at the location of the mine-waste deposits. Areas that would benefit from improvements in the riparian area vegetation were initially identified based on review of data, aerial photographs, site reconnaissance, and land-use patterns. These areas appear to be predominately within Reach 3 and the most downstream portions of Reach 2, although portions of Reach 1 should also be considered.

Portions of the stream channel within the 11-Mile Reach downstream of Lake Fork appear to have been altered, possibly by the deposition of coarse sediments from hydraulic mining, and more recently by augmented flows. In these areas (predominantly Reach 3), the channel appears to be broad, shallow, and therefore mainly riffle habitat. A lack of pool habitat was also identified in subreaches 1A and 1C. Homogeneous habitat is a concern because it offers little cover for larger fish and does not provide holding areas for fingerling fish during runoff or periods of augmented flow. Improvements in in-stream habitat and riparian vegetation in these areas may provide direct benefits to the fishery and may also reduce physical stressors that can compound the effects of metals toxicity. As improvements in water quality occur, such restoration measures would mitigate the potential for physical habitat to serve as a limiting factor for further recovery of the fishery.

Although the relationship to stream productivity cannot be quantified, restoration measures aimed at improving the quality of in-stream habitat and riparian vegetation would be beneficial to the fishery and other aquatic biota and would enhance ongoing restoration of the fishery associated with any improvements in the water quality of the Arkansas River.

Finally, although not a restoration measure, the need to better control flow augmentation has been a common theme in reports and conversations with various stakeholders. Even though progress has been made, additional measures to return and maintain the system closer to natural flow patterns could enhance any restoration measures ultimately implemented. Flow augmentation could be managed to enhance bank stability measures and the brown trout fishery. It is also recognized that, at times, flow augmentation can have a positive benefit in the form of dilution of in-stream metal concentrations.



REACH 1

HIGH	MODERATE	LOW
AB	AA	AJ
AC	AG	CF
AD	AH	
AE	AI	
CA	BB	
CD	CC	
CE	CG	
CJ	CK	
CL	CN	
CO	CP	
CS	CR	

REACH 2

HIGH	MODERATE	LOW
FA	FC	GH
FB	FF	GL
HI	FG	GM
	FH	GN
	FI	HA
	FJ	HB
	FL	HD
	FM	HE
	FN	HK
	FO	IA
	GA	IC
	GB	KK
	GC	KL
	GE	

REACH 3

HIGH	MODERATE	LOW
LB	LA	OI
LI	LC	OJ
LN	LD	OK
LV	LG	PA
MB	LH	PC
MQ	LK	PD
NI	LM	PE
OA	LO	PF
OE	LP	PJ
PG	LQ	PN
QD	LS	PP
QN	LT	PX
RB	MA	QA
	ME	QF
	MF	QG
	MI	QH
	ML	QI
	MM	QJ
	MN	QK
	MP	QO
	NA	QP
	NB	QT
	NC	QV
	ND	QW
	NG	QX
	NH	QY
	NJ	QZ
	NL	RA
	NN	RC
	NO	
	NP	
	NR	
	NT	
	NU	
	OB	
	OC	
	OD	
	OF	
	OG	
	OH	

EXPLANATION

Hydrology

- River or Stream
- Lake or Open Water
- 500- Year Floodplain
- × 1 River Mile (from confluence with California Gulch)

Transportation

- Minor Road
- Medium Duty Road
- Highway
- Railroad

Deposit Action Priority

- High Priority
- Moderate Priority
- Low Priority

Other Features

- Reach Boundary
- Subreach Boundary

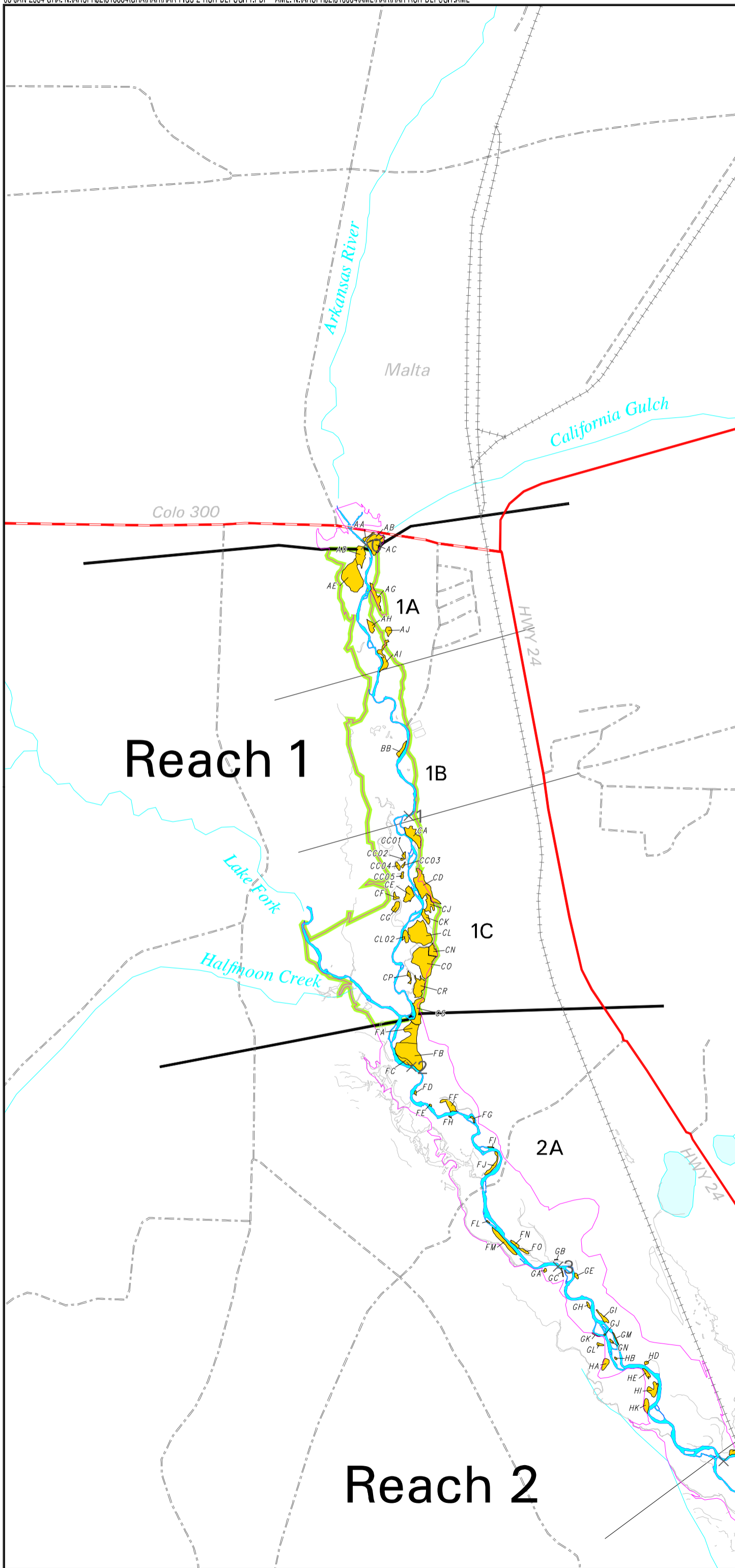
SCALE IN FEET

UPPER ARKANSAS RIVER BASIN
RESTORATION ALTERNATIVES REPORT

FIGURE 3-1
MINE-WASTE DEPOSIT PRIORITY

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EXPLANATION

Hydrology

- River or Stream
- Lake or Open Water
- 500- Year Floodplain
- Reach 1
- × 1 River Mile (from confluence with California Gulch)

Transportation

- Minor Road
- Medium Duty Road
- Highway
- Railroad

Other Features

- Mine- Waste Deposit
- Reach Boundary
- Subreach Boundary

SCALE IN FEET

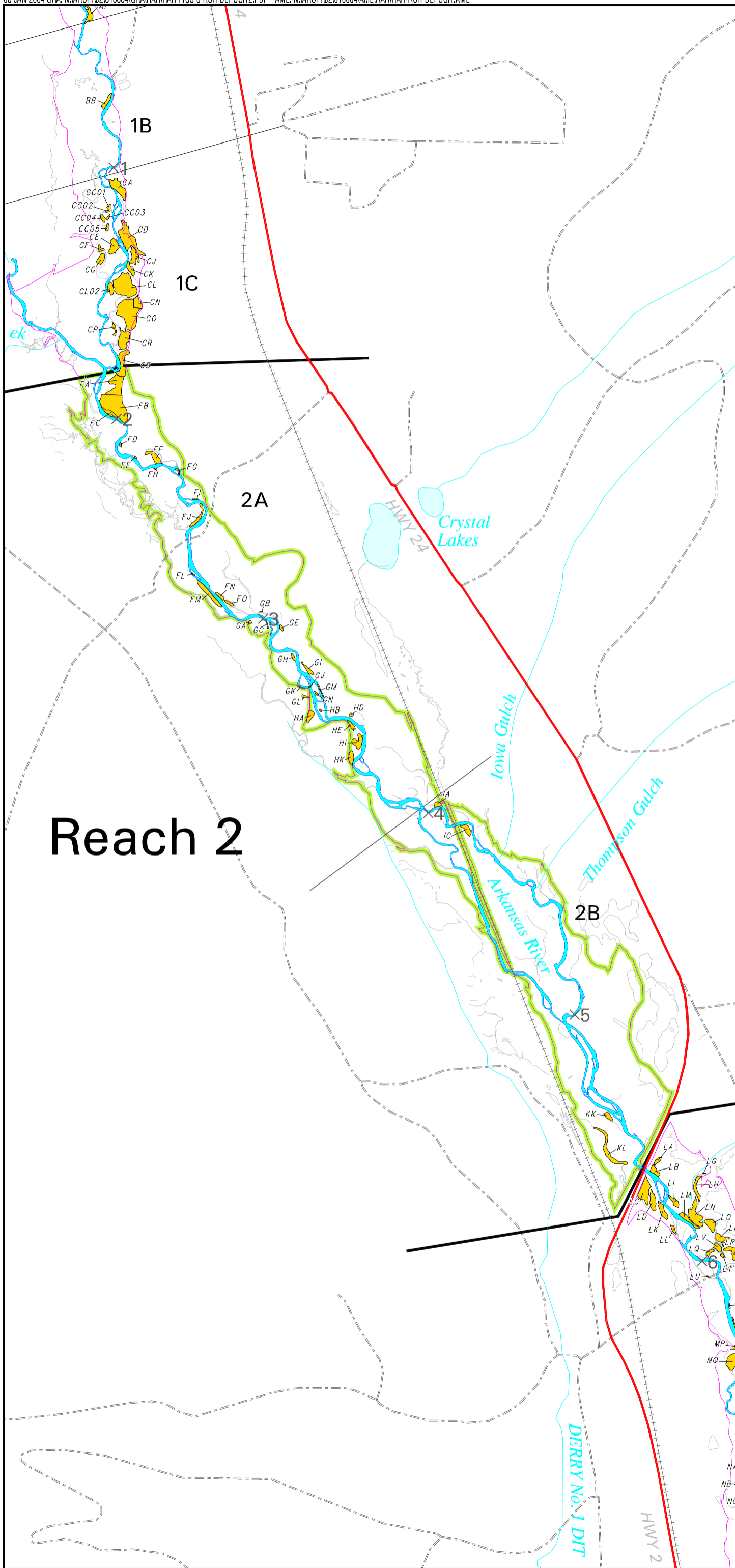
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UPPER ARKANSAS RIVER BASIN
RESTORATION ALTERNATIVES REPORT

FIGURE 3-2
MINE-WASTE DEPOSIT
LOCATIONS
CALIFORNIA GULCH
TO LAKE FORK
(REACH 1)

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EXPLANATION

Hydrology

- River or Stream
- Lake or Open Water
- 500- Year Floodplain
- Reach 2
- × 1 River Mile (from confluence with California Gulch)

Transportation

- Minor Road
- Medium Duty Road
- Highway
- Railroad

Other Features

- Mine- Waste Deposit
- Reach Boundary
- Subreach Boundary

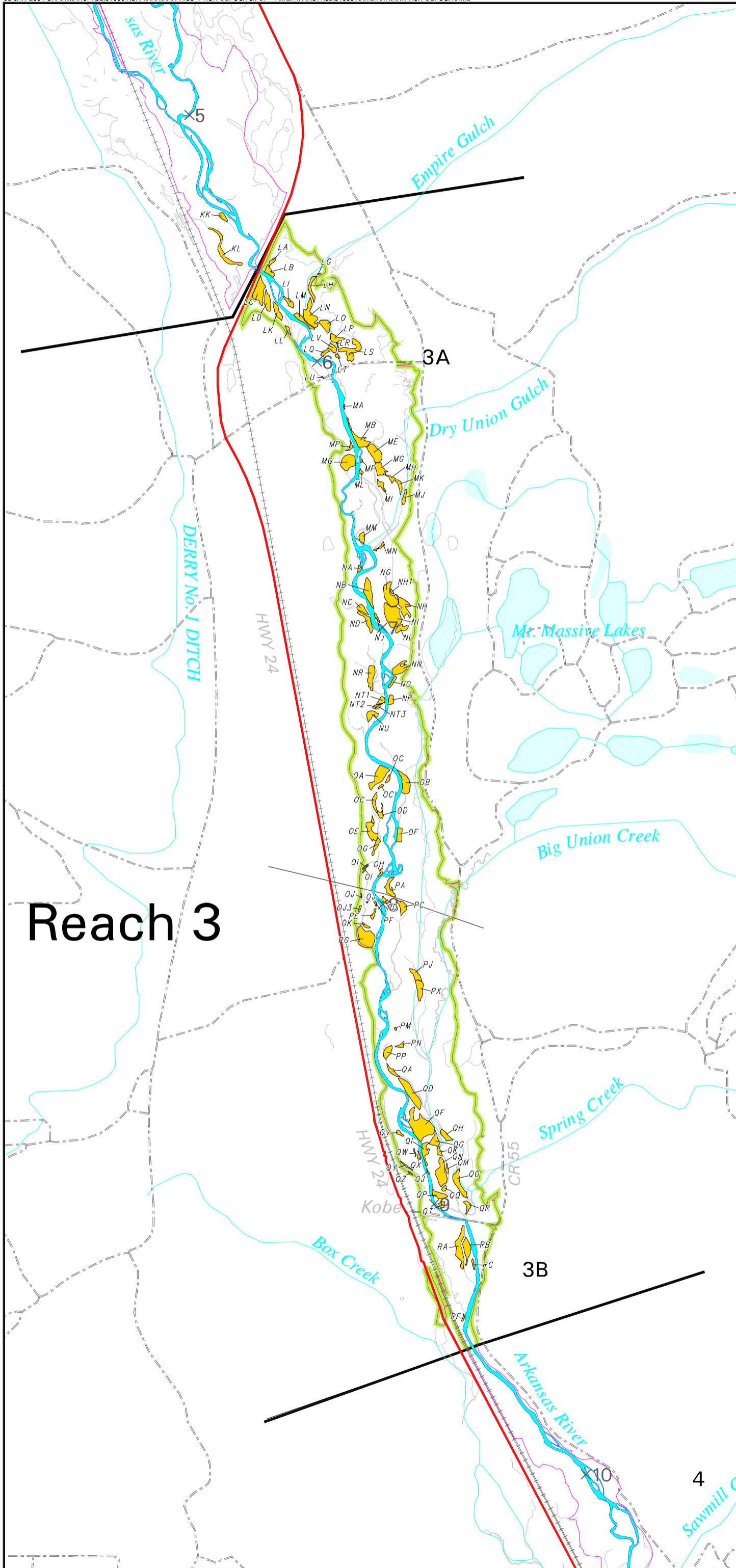
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FIGURE 3-3
MINE-WASTE DEPOSIT
LOCATIONS
LAKE FORK
TO HWY 24 BRIDGE
(REACH 2)

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EXPLANATION

Hydrology

- River or Stream
- Lake or Open Water
- 500- Year Floodplain
- Reach 3
- × 1 River Mile (from confluence with California Gulch)

Transportation

- Minor Road
- Medium Duty Road
- Highway
- Railroad

Other Features

- Mine- Waste Deposit
- Reach Boundary
- Subreach Boundary

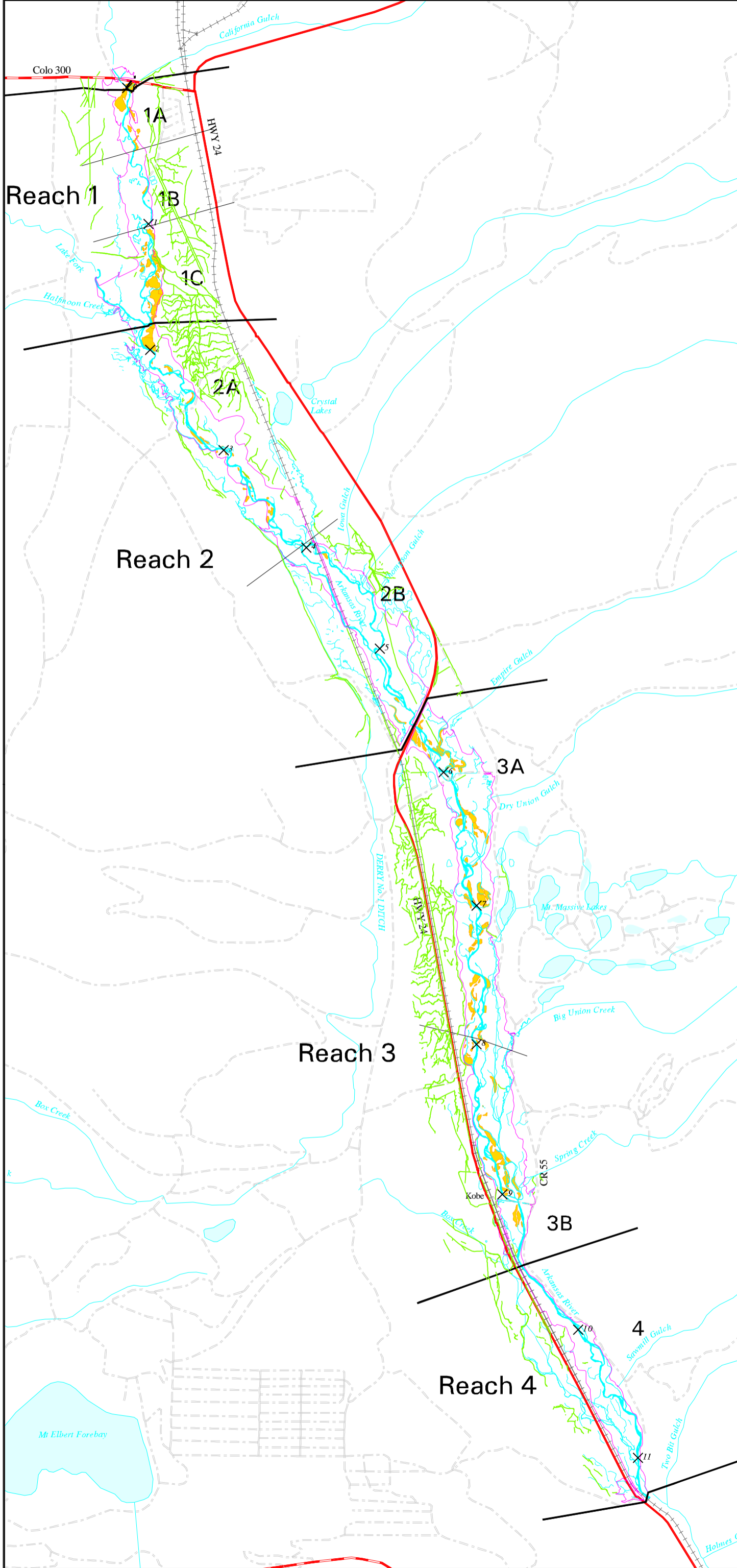
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SCALE IN FEET

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RESTORATION ALTERNATIVES REPORT

FIGURE 3-4
MINE-WASTE DEPOSIT
LOCATIONS
HWY 24 BRIDGE
TO NARROWS BELOW KOBE
(REACH 3)

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EXPLANATION

Hydrology

- Ditch
- River or Stream
- Lake or Open Water
- 11- Mile Reach
- 500- Year Floodplain
- X 1 River Mile (from confluence with California Gulch)

Transportation

- Minor Road
- Medium Duty Road
- Highway
- + + + + Railroad

Other Features

- Mine- Waste Deposit
- Reach Boundary
- Subreach Boundary

N

SCALE IN FEET

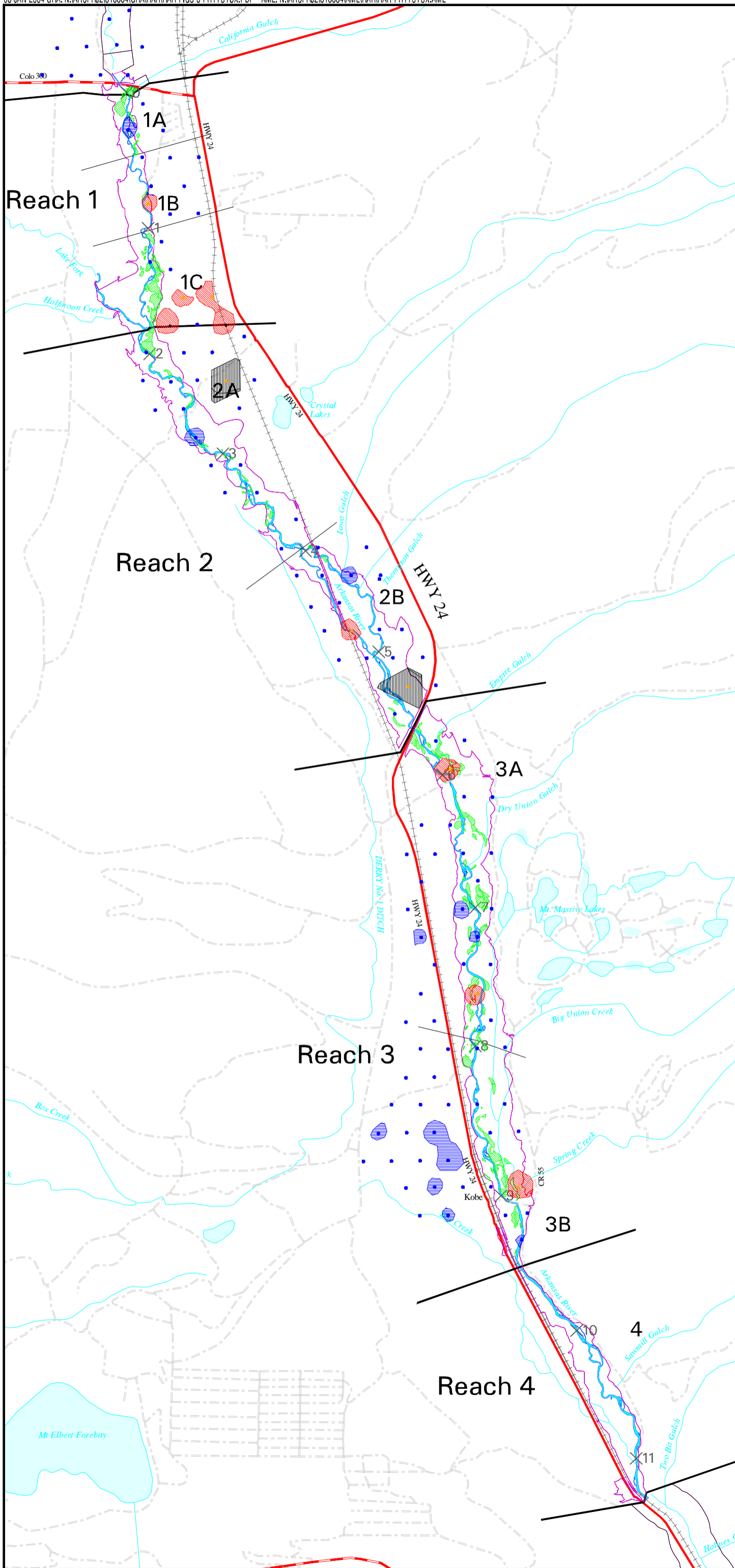
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UPPER ARKANSAS RIVER BASIN
RESTORATION ALTERNATIVES REPORT

**FIGURE 3-5
IRRIGATION AND
DRAINAGE DITCHES
IN THE 11-MILE REACH
AND VICINITY**

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EXPLANATION

Hydrology

- River or Stream
- Lake or Open Water
- 11- Mile Reach
- 500- Year Floodplain
- River Mile (from confluence with California Gulch)

Transportation

- Minor Road
- Medium Duty Road
- Highway
- Railroad

Other Features

- Predicted area of high phytotoxicity and HQ > 1 (67.6 Ac)
- Predicted area of high phytotoxicity and HQ <= 1 (59.4 Ac)
- Predicted area of HQ > 1 and not high phytotoxicity (44.0 Ac)
- HQ <= 1
- HQ 2 to 4
- HQ > 5
- Mine-Waste Deposit
- Reach Boundary
- Subreach Boundary

NOTES:
 Predicted phytotoxicity and HQ data from:
 "Ecological Risk Assessment for the
 Terrestrial Ecosystem, California Gulch
 NPL Site, Leadville, Colorado. July 2003

Acreages are exclusive of Mine Waste
 Deposits

N

 SCALE IN FEET

 3000 0 3000

UPPER ARKANSAS RIVER BASIN
 RESTORATION ALTERNATIVES REPORT

FIGURE 3-6
 MAP OF PREDICTED
 PATTERN OF PHYTOTOXICITY
 (ADAPTED FROM USEPA, 2003b)

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