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Application of the Hydrology Protocol to STSIU Drainages

Chino Mines, Vanadium, New Mexico

November 2012

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1. Introduction and Background

On December 23, 1994 Freeport-McMoRan Chino Mines Company (Chino) and the New Mexico Environment Department (NMED) entered into an Administrative Order on Consent (AOC) to address the possible environmental impacts within the Chino Mine Investigation Area, Grant County, New Mexico (the Site). The Smelter Tailing Soils Investigation Unit (STSIU) is one of the investigation units addressed under the AOC. Surface water in STSIU has been determined to be a media of concern for consideration under the Feasibility Study (FS). NMED selected the Pre-FS RAC for surface water based upon the State of New Mexico Standards for Interstate and Intrastate Surface Waters (§20.6.4 NMAC) for risk to aquatic life. The Pre-FS RAC for all constituents are based on §20.6.4 NMAC, including all approaches and tools listed in the Code which provide options for site-specific application. These pre-FS RAC are considered as Applicable or Relevant and Appropriate Requirements (ARARs) for the purposes of the FS and subsequent remedial actions for the Site, subject to adjustment in the Record of Decision.

Previous Site investigations have concluded that the majority of STSIU surface waters are likely ephemeral based on observations of water persistence and lack of aquatic habitat within drainages (Newfields 2006 and Newfields 2007). New Mexico's 303 (d) and 305 (b) Integrated Report also indicates Whitewater Creek, the receiving water to most STSIU drainages, may be ephemeral but is currently listed under §20.6.4.98 NMAC (unclassified intermittent water). Similarly, STSIU waters are not included in a classified Water Quality Standards segment (§20.6.4.101-899 NMAC) and are therefore considered unclassified waters of the State (§20.6.4.98 NMAC) with the following presumed designated uses: livestock watering, wildlife habitat, marginal warmwater aquatic life, and primary contact. Because water quality standards for unclassified waters vary depending on hydrology, it is important to determine the correct hydrologic regime (e.g., ephemeral, intermittent or perennial) to assure that the appropriate uses and corresponding use-specific criteria are applied to a particular water body.

To facilitate evaluations of hydrologic regime for the purpose of supporting expedited Use Attainability Analyses (UAA), NMED's Surface Water Quality Bureau (SWQB) developed a Hydrology Protocol (HP) (NMED, (2011)). The HP was approved as an appendix to NMED's Water Quality Management Plan and Continuing Planning Process (WQMP/CPP) by the New Mexico Water Quality Control Commission on May 10, 2011. The WQMP/CPP, including the HP, was submitted to the Environmental

Protection Agency (EPA) for review and approval, and EPA's approval was issued on December 23, 2011.

ARCADIS, on behalf of Chino, prepared and submitted a work plan (WP) titled *Application of the Hydrology Protocol to Smelter Tailings Soils Investigation Unit Drainages* to NMED in May 2011 that described a study plan for application of the HP to STSIU sub-drainages. Chino received NMED comments to this work plan on June 8, 2011, and submitted a revised WP that incorporated these comments in July 2011. Results from the application of this study plan are described herein.

2. Purpose and Objectives

This report describes results from the Level 1 application of NMED HP as described in the above referenced WP. Information obtained from this effort is intended to support determinations regarding the appropriate hydrologic classification of surface waters through an expedited UAA process, as described in section §20.6.4.15 (2) NMAC. Objectives of this study include:

1. Determine appropriate hydrologic regime for STSIU surface waters based on application of the HP;

2. Propose hydrologic classifications through an expedited UAA for STSIU drainages where sufficient information supports a hydrologic classification and associated designated use classification.

3. Site Setting

The STSIU area is located in an arid region of southwestern New Mexico, with a climate that is characterized by low humidity and wide ranges in daily and annual temperatures (NMED 2008; Chino 2008). The average annual precipitation is 17.5 inches per year (WRCC, 2004), with most of the rainfall occurring during the monsoon season (July – September) as brief thunderstorms, sometimes of high intensity.

Portions of STSIU are relatively flat with a lower elevation of approximately 5,700 feet above sea level. The STSIU is partially located within the San Vicente Basin, a sub-drainage within the Mimbres watershed. The San Vicente basin is a broad lowland area characterized by dry washes and gullies with sandy bottoms (NMED 2008). Areas east of Whitewater Creek increase in topographic relief, rising to an elevation of approximately 7,000 feet above sea level. Numerous high-gradient drainages originate

within this mountainous area and flow into Whitewater Creek or Lampbright Draw. STSIU soils have little organic material and are generally rocky and thin. They are derived from non-mineralized sources which consist primarily of poorly sorted, unconsolidated to highly consolidated sand, gravel and silty gravel. Sediments in drainage channels share similar characteristics because they are derived from upland soils.

4. Overview of Study

Application of the HP was conducted in accordance with the approved WP and NMED guidance (NMED 2011). As described by NMED (2011), the protocol is comprised of hydrological, geomorphic, and biological indicators of the persistence of water and is organized into two levels of evaluations. This study employed the Level 1 evaluation that is required for the expedited UAA process described in 20.6.4.15.C NMAC. Level 1 evaluations include office procedures and field application of the HP. Office procedures were conducted during the first quarter of 2011, and field work was conducted from June 12 – 15, 2011.

The original HP results summary report was submitted to NMED in February 2012. NMED comments regarding the original HP report were received by Chino in April 2012. Additional office based assessment was conducted during the second quarter of 2012 in response to the NMED comments, and Chino submitted a response to comments on August 17, 2012. This revised report incorporates our responses, and changes, based on NMED comments.

4.1 Level 1 Office Procedures

Level 1 office procedures were conducted prior to initiating field evaluations with the objective to gather as much physical and geographic information about the drainages and region prior to beginning field work. Many of these reviews were discussed in the WP and include:

- Aerial photographs
- Drainage profiles
- Previous Site investigations
- Flow data

- Precipitation

4.1.1 Sample Reach Selection

The above information, in conjunction with Site knowledge, was used to target general locations of sample reaches, as described in the referenced WP. In addition, NMED review and comments on the WP supplemented the identification of appropriate survey locations. In total, 21 locations in 12 sub-drainages were identified for HP application in the revised WP (Table 1).

The sample locations were tentatively selected prior to field application of the HP, recognizing that actual locations might be modified during field evaluations depending on local geomorphic or hydrologic features to assure reaches were representative of the waterbody. The number of individual reaches within a particular drainage varied according to drainage length and local watershed features to capture potential geomorphic or hydrologic gradients within drainages.

4.1.2 Drought Conditions

Local weather and precipitation data were reviewed to assure severe drought conditions were not occurring during field application of the HP. In accordance with the HP guidance, the 12-month Standardized Precipitation Index (SPI) was used as a basis to gauge the drought conditions; drought conditions are defined as any time the SPI is less than -1.5, indicating severely to extremely dry conditions (NDMC 1995 as cited in NMED 2011). The SPI is an index based on the probability of recording a given amount of precipitation, and the probabilities are standardized so that an index of zero indicates the median precipitation amount ((http://lwf.ncdc.noaa.gov/oa/climate/research/prelim/drought/spi.html).

During the field application of the HP (June 2011), the 12-month SPI value for the Site area was -1.1 (Figure 1), indicating dry conditions but within the SPI range recommended by NMED (2011) for HP application.

Additional review of precipitation at the Fort Bayard climatic station (USC00293265) was also conducted to assess the long-term historic precipitation conditions and the potential implication on the hydrologic regimes of the STISU drainage basins being assessed. The Fort Bayard station is located within 10 miles from STISU drainage basins, and monthly precipitation data are available on a near continuous basis from the late 1800s through early 2011 (Figure 2). It should first be noted that the recent

period has had generally greater than average precipitation. Therefore, the precipitation and flow regime observations made at the time of the HP assessment in 2011 are at least representative of the general precipitation conditions observed over the last century, and possibly reflective of wetter conditions.

4.1.3 Precipitation

Prior to initiating field evaluations, ARCADIS verified with local Chino staff and through precipitation records that no major rainfall events occurred within at least 48 hours.

4.1.4 Flow Gauges

Historical and recent flow data from a regional United States Geologic Survey (USGS) flow gauge, located on the Mimbres River approximately 20 km northeast of the STSIU watersheds, was evaluated to provide additional background information on regional flow and drought conditions during field surveys. During field evaluations in June 2011, the average daily flow on the Mimbres River was 3.7 cubic feet per second (CFS). This flow rate falls within lower flow ranges historically observed. In particular, 15.3% of average daily flows from 1978 to present were lower than 3.7 cfs, and 84.7% of average daily flows during this timeframe were greater than 3.7 cfs. Thus, while baseflow conditions were low during the field survey, they were not historically anomalous (Figure 3).

4.1.5 Mine Influence on Hydrologic Regimes

The potential for influence from mining activities on the hydrologic regime of the STSIU drainages was investigated and concluded that the existing hydrologic characteristics of the drainages are representative of the historic conditions and not the result of mining activities. The possible exception to this conclusion is Rustler Canyon as described below

Mine Pit Groundwater Influence

The Santa Rita pit groundwater capture zone was clearly delineated as part of the Site-Wide Stage 1 Abatement Final Investigation Report (Golder 2008). The pit capture zone delineation is the result of an extensive hydrogeologic investigation and has been previously accepted by NMED. Figure 4 presents a map that depicts this pit capture zone and the delineated subwatershed drainages that were assessed as part of the Chino STSIU HP study. As indicated in Figure 4, Rustler Canyon is the only STSIU

subwatershed that could be influenced by the pit groundwater capture. This HP study, however, is not recommending a formal classification or re-classification for Rustler Canyon drainages as explained in Section 5.1 of this report.

The delineated pit capture zone provides evidence that the hydrology of the drainages outside of Rustler Canyon are not impacted by mining activities because the Santa Rita pit represents the only source of potential historical mining impacts that could have affected the natural STSIU hydrology.

Regional Springs

Historic references of springs in both the STSIU drainage basins and the surrounding area were reviewed to further assess possible influence from mining activities on the local groundwater (Figure 4), which could indicate hydrologic influence from mining in the STSIU drainages. Recent observations of springs and review of historical references from Paige (1916) and Sivinski and Tonne (2011), do not indicate that mining activities have influenced the presence or disappearance of springs in the STSIU drainages. Springs have been observed presently and historically in STSIU drainages including Drainage C, Drainage B, and Martin Canyon, and continue to express water indicating they have not been impacted by mining activities.

The springs referenced by Sivinski and Tonne (2011) (Apache Tejo Spring, Cold Spring, Kennecott Warm Spring, and Kennecott Cold Spring) are not located within STSIU drainages that were assessed in this HP study. Cold Spring is a well, locally referred to as Cold Spring 2 well, and is located within the 2C cattle ranch near Faywood Hot Springs, approximately 6 miles south of the STSIU area. Kennecott Warm Spring is located approximately 5 miles south of the STSIU area (Figure 4). Apache Tejo Warm Spring is located within the STSIU area but is outside of any STSIU drainages assessed during the HP study (Figure 4). All hydrologic designations proposed based on the results of this HP study apply to drainages that are at a significantly higher elevation and that are not hydrologically connected to these springs. Springs are, by definition, isolated areas of groundwater emergence and are not characteristic of regional groundwater conditions, especially the groundwater conditions at distances of miles away from the springs themselves.

4.2 Level 1 Field Evaluations

ARCADIS applied the HP to STSIU drainages during June 12 – 15, 2011, following NMED review and comments on the WP. NMED recommendations, including

additional survey locations, were incorporated into a revised WP and into Level 1 field evaluations. This field evaluation timeframe is consistent with NMED recommendations and was selected to avoid the monsoonal season, which typically occurs during mid - July through early September in this region.

The HP was applied to STSIU drainages by field crews consisting of a minimum of two staff members. Staff from NMED also participated in field evaluations at sample reaches located in Rustler Canyon. Additionally, Chino staff provided navigational assistance for accessing drainages and Site knowledge regarding local watershed features, recent weather and historical presence of water. In total, the HP was applied to 24 sample reaches across 9 sub-watersheds (Figure 4). As described in the work plan, the field crew performed one field replicate at a pre-determined reach location, consistent with recommendations in NMED SWQB's Quality Assurance Project Plan. Three reaches not identified in the WP were selected in the field to capture localized watershed features (one reach in the B-drainage [B-7 DS] and two reaches in Rustler Canyon [RC-14B and RC2-22B]).

4.2.1 Sample Reach Selection

Before selecting a reach for the survey, local watershed features were noted while driving to the site to verify that the selected reach was representative of the drainage being characterized. This provided an overview of the collective watershed and potential geomorphic or hydrologic gradients within the drainage. This information aided in determining how uniform, or representative, reaches were of the collective watershed.

After arriving to a pre-determined reach location, the field crew walked a distance of the channel generally greater than, or equal to, 300 meters to confirm that significant geomorphic or hydrologic gradients do not occur in order to meet the hydrology protocol requirements for representative sample reaches (i.e., 40 times the average stream width or 150 meters, whichever is larger). Prior to establishing sample reaches, reach homogeneity was verified by evaluating basin slope, presence of significant tributary inflows, potential changes in substrate type (e.g., sand, gravel, cobble, boulders and bedrock), compositional shifts in vegetation, gradients in vegetation density, anthropogenic influences such as road crossings or diversions, and various biological indicators included in the field form. Overall, most locations selected *a priori* were judged as adequately representative of the corresponding drainages, as described below.

5. Results

Documentation for Level 1 HP Evaluations consists of a Cover Sheet, Drainage Profile and Plan View, Field Sheet and photographs for each sample reach evaluated. These are provided in Appendices A - G, and are organized by each sub-watershed evaluated. A brief description of each level of documentation is provided below.

1. *Cover Sheet*: Contains documentation of information collected through application of the HP. As described by NMED (2011), "the cover sheet is necessary for the expedited UAA process and is designed to explain how the supporting documentation from the Level 1 Evaluation is consistent with the UAA conclusion, namely that the stream is ephemeral and the attainment of Clean Water Act Section 101(a)(2) aquatic life and recreational uses is not feasible due to the factor identified in 40 CFR 131.10(g)(2): *natural, ephemeral, intermittent, or low flow conditions or water levels prevent the attainment of the use."* For this assessment, all reaches within an identified sub-watershed are included in a single cover sheet and appendix.

2. *Drainage Profile and Plan View*: Aerial photographs of each drainage depicting the location of each sample reach, delineation of sub-watershed boundaries, and drainage profiles.

3. *Hydrology Determination Field Sheet:* Contains scores for each attribute (or indicator) and a total numeric score for each sample reach evaluated. Other general information including date, project, evaluators, Site, assessment unit, 12-month SPI value, and field coordinates of the sample reach is also recorded on Field Sheets. NMED guidance provides a four-tiered weighted scale for evaluating and scoring each attribute; general definitions, as provided in NMED (2011), are described below:

   Strong: The characteristic is easily observable (i.e., observed within less than one minute of searching).

   Moderate: The characteristic is present and observable with minimal (i.e., one or two minutes) searching.

   Weak: The characteristic is present but you have to search intensely (i.e., ten or more minutes) to find it.

Poor: The characteristic is not observed.

4. *Photo-Documentation:* Photographs of each sample reach and watershed were taken, as appropriate, to document the rationale behind scoring of attributes and subsequent hydrologic determinations.

5.1 Summary of Level 1 Field Evaluation Scoring

The drainages evaluated during Level 1 field evaluations were scored as ephemeral (except Rustler Canyon, as described below) based on the absence of water, lack of aquatic habitat and evidence of prolonged dryness, consistent with NMED scoring criteria (Appendices A-G). Table 2 provides a summary of all HP scoring attributes for the drainages evaluated.

Rustler Canyon Reaches

Drainages within Rustler Canyon were the only STSIU reaches where water and aquatic life uses were observed during field application of the HP. Although the majority of streambeds within Rustler Canyon did not contain water, and flow was not observed, water was present as isolated pools in portions of the bedrock channels. Periphyton, filamentous algae and riparian vegetation (e.g., cat tails) were observed in these pools along with macroinvertebrates (e.g., snails), indicating a hydrologic classification of at least intermittent according to NMED (2011). These isolated pools, and associated aquatic life uses, were not observed in all Rustler Canyon reaches, as described in Appendix G, reflecting the localized persistence of water within this sub-watershed. This is reflected by an HP score of 2 in an upper reach of the west fork of Rustler (RC2-22; Figure 4). Given the extent of water observed during the dry season, coupled with the hydrologic and biological indicators described above, it appears that these pools persist for extended periods of time consistent with an intermittent classification. Based on these observations, formal classification and/or re-classification of surface water reaches in Rustler Canyon are not proposed at this time.

5.1.1 Ephemeral Sub-Watersheds

During field application of the HP, an ephemeral classification was reached for most drainages after scoring the first 6 indicators (water in channel, fish, benthic macroinvertebrates, filamentous algae/periphyton, differences in vegetation and absence of rooted upland plants in streambed). In accordance with NMED (2011), if the evaluated drainage has a score of less than or equal to 2 after the first six

indicators are scored, the drainage is determined to be ephemeral, therefore, further evaluation of additional indicators is unnecessary. Of the 24 reaches evaluated, 17 reaches were determined as ephemeral after the first six indicators were evaluated and scored (three additional reaches were determined as ephemeral based on evaluation and scoring of all Level 1 HP indicators). The following provides a general description of how these 6 indicators were evaluated during field application of the HP.

Indicator 1.1 – Water in Channel

With the exception of reaches in Rustler Canyon, as described above, water was not observed in channels during field evaluations. As described by NMED (2011), a good rule of thumb for differentiating between ephemeral and intermittent is if they have any water in them during the dry season or during a drought. No evidence of recent base flows or high flows (e.g., sediment/soil moisture or drift lines in the bank or floodplain) or standing pools of water were observed in drainages (except Rustler Canyon). Areas of depressions within channels, typically associated with pool habitats, were devoid of water in all drainages except Rustler.

Indicator 1.2 – Fish

Fish were not observed in any sample reach evaluated.

Indicator 1.3 – Benthic Macroinvertebrates

With the exception of reaches in Rustler Canyon, benthic macroinvertebrates, or physical evidence of benthic macroinvertebrates, were not observed. The dry channels were searched for potential mussels and aquatic snail shells (in sandy channel margins), caddisfly casings (under cobbles [when cobble was present]) and mayfly or stonefly casings (on cobble and channel-side vegetation). During macroinvertebrate searches, it was also noted that soil/sediment moisture was absent with the exception of select reaches in Rustler Canyon.

Indicator 1.4 – Presence of Filamentous Algae and Periphyton

Similar to the above indicators, filamentous algae and periphyton were not observed in drainages outside of Rustler Canyon. This includes no observations of desiccated periphyton or algae outside of Rustler Canyon.

Indicator 1.5 – Differences in Vegetation

Differences in vegetation were generally attributed to vegetation densities rather than compositional differences in vegetation, with the exception of Rustler Canyon where a few compositional differences were observed. Species of oak, cat claw, juniper, bunch grass, mesquite, agave, prickly pear cactus and cholla cactus were occasionally observed in greater densities on, and around, banks of some reaches relative to surrounding upland areas. Vegetation species growing in upland areas of surveyed watersheds were noted and compared to species growing along the banks and within channels to determine potential compositional differences.

Indicator 1.6 – Absence of Rooted Upland Plants in Streambed

As described by NMED (2011), the absence of rooted plants in a streambed can be related to flow regime since flow can deter plant establishment by scouring available substrate and removing seeds or preventing aeration to roots. However, NMED (2011) also notes that the presence of rooted vegetation in a streambed can be limited by local watershed features such as high gradient sand bedded streams located within flashy watersheds. In these flashy systems, rooted vegetation may be limited by highly erosive flows and/or depth of scour in response to substantial rainfall events (NMED 2011). Such conditions distinguished the majority of STSIU drainages. In addition, bedrock- and boulder-dominated streambeds were routinely observed in upper reaches of drainages. This streambed type can also limit the presence of rooted plants as a result of a lack of substrate necessary for plant growth. These limitations were considered when scoring Indicator 1.6 during field evaluations, and are described in Appendices A – G through field notes and photo-documentation.

5.1.2 Other Scoring Considerations

It was determined, after visiting a number of bedrock and boulder formed channels, that the application and evaluation of the “entrenchment ratio” was inappropriate at such locations. In channels flowing through material that is transported by the river itself, the channel geometry can be viewed as self-formed. That is, sediment transport in alluvial rivers builds and maintains a dynamically stable channel geometry and floodplain that reflects both the quantity and timing of water and the volume and caliber of sediment delivered from the watershed (Leopold et al. 1964; Emmett and Wolman 2001). Accordingly, Leopold (1994) describes alluvial rivers as the architect of their own geometry. In these alluvial situations the measurement of an “entrenchment ratio” is reflective of the relative supply and magnitude of the sediments from upstream versus the capacity of the channel to transport that sediment.

In many situations observed during the application of the HP, however, the channel was not an alluvial river and the bed and banks were not formed of sediments supplied and transport under the current hydrologic environment but rather were composed of bedrock and large boulders. In bedrock and boulder formed channels where it was necessary to proceed beyond Indicators 1.1 to 1.6, the “entrenchment ratio” indicator was not included in the total score.

5.1.3 Quality Control (QC)

Consistent with recommendations in SWQB’s Quality Assurance Project Plan, one field replicate was included in the current study to evaluate potential variability in HP evaluations conducted by different field crew. The field replicate was applied at a pre-determined study reach (D1-2) by different field crew at separate times. Overall, scores for each HP indicator were identical between the two evaluations, indicating consistency in the interpretation of HP scoring criteria.

5.2 Critical Habitat Considerations

Critical habitat for the Chiricahua leopard frog (CLF) has been officially designated or has been observed in some of the drainages that scored as ephemeral during the Level 1 field observations described above. Based on these habitat observations, formal classification and/or re-classification of these surface water reaches are not proposed at this time. This includes portions of Subwatershed C, Subwatershed B, and all of Martin Canyon.

5.2.1 Subwatershed B and Subwatershed C Exclusions

Bolton Spring (Subwatershed C) and Ash Spring (Subwatershed B) and the associated migration pathway between them (Figure 4) have been designated as critical habitat for the Chiricahua leopard frog (CLF) by the USFWS. As described by the USFWS, the primary constituent elements of CLF critical habitat consist of breeding, habitats, and dispersal habitats (USFWS 2012).

Based on the USFWS description of CLF critical habitat and observations, it is appropriate to exclude Bolton and Ash Springs from an ephemeral designation because these areas are designated as breeding habitat that typically hold areas of isolated surface water and thus function as potential breeding habitat.

An ephemeral designation for drainage areas that are not hydrologically connected to Bolton or Ash Springs outside of storm events is appropriate for the non-breeding dispersal habitat based on the USFWS description. Specifically, USFWS states the dispersal and non-breeding habitat can consist of upland or ephemeral areas that can provide a corridor for movement of frogs between breeding sites (i.e., the two springs). Accordingly, designation of a section of drainage as critical habitat does not preclude an ephemeral designation because the critical habitat can, by definition, consist of ephemeral drainage channels.

Figure 4 presents the portions of Subwatershed B and Subwatershed C associated with Ash Spring and Bolton Spring that are proposed to be excluded from an ephemeral designation based on the above interpretation of the CLF critical habitat (i.e., exclusion areas). To provide additional buffer and a point of geographic reference, each exclusion area is proposed to extend from the point of each spring downstream to the nearest confluence. A specific summary of each exclusion area is provided below.

Bolton Spring: The point of Bolton Spring (approximately 32.713419 N, 108.071980 W) downstream in Bolton Canyon to the confluence with subwatershed drainage C (a distance of approximately 0.42 miles [0.68 kilometers]). The confluence with subwatershed drainage C provides an appropriate geographic reference, and this exclusion area is consistent with the USFWS critical habitat (Figure 4). In addition, limiting the exclusion area to the confluence of subwatershed drainage C is consistent with the ephemeral designation determined at HP sample reach C-4, which is located in subwatershed drainage C at the confluence point with Bolton Canyon.

Ash Spring: The point of Ash Spring (approximately 32.715625 N, 108.071980 W) downstream to the confluence with subwatershed B drainage (a distance of approximately 1.13 miles [1.82 kilometers]). This exclusion area extends beyond the entire segment of USFWS critical habitat in the Ash Spring drainage and extends further downstream to the nearest confluence to provide a point of geographic reference (Figure 4).

5.2.2 Martin Canyon

Based on comments received from NMED, CLF tadpoles have been historically documented in pools along portions of the Martin Canyon drainage, although no official USFWS habitat designation has been made for any portion of Martin Canyon, and CLF frogs have not been documented in any portion of Martin Canyon during more recent

surveys (Jennings, 2007). Evidence of pools were not observed during the Level 1 field evaluation; however, based on comments received from NMED regarding historic observations of CLF in Martin Canyon, a formal classification or re-classification of Martin Canyon is not currently proposed.

6. Conclusions and Hydrologic Classification Recommendations

Based on the Level 1 hydrology determinations described above and in Appendices A – G, adequate information is available to support ephemeral hydrologic classifications for all of the STSIU drainages evaluated, with the exception of Rustler Canyon, Martin Canyon, and portions of Subwatersheds B and C.

Presently, an ephemeral classification is not supported for the Rustler Canyon drainages due to the presence of water and associated aquatic life uses observed during the Level 1 field evaluations. Ephemeral classification is not proposed at this time in Martin Canyon and stream segments associated with Ash Spring (Subwatershed B) and Bolton Spring (Subwatershed A) because of potential CLF breeding habitat. Consequently, no change in classification for these locations is being proposed.

In drainages outside of those areas described above, an ephemeral hydrologic classification was determined by the Level 1 hydrology determinations, which is consistent with observations and suggestions from previous Site investigations, and is based on evidence of prolonged dryness and lack of aquatic habitat. It can be concluded from these results that flow only occurs in these STSIU drainages in direct response to significant precipitation events. Accordingly, an ephemeral classification would reflect the hydrologic regime of these drainages and correspond to the limited aquatic life uses that can be expected to occur during short periods of water persistence. The STISU drainages where ephemeral classification would be appropriate are:

Subwatershed Drainage A and tributaries thereof;

Subwatershed Drainage B and tributaries thereof (excluding the portion associated with Ash Spring previously delineated);

Subwatershed Drainage C and tributaries thereof (excluding the portion associated with Bolton Spring previously delineated);

Subwatershed Drainage D and tributaries thereof (Drainages D-1, D-2 and D-3);

Subwatershed Drainage E and tributaries thereof (Drainages E-1, E-2 and E-3).

As indicated in Figure 4, ephemeral designations determined for these STSIU drainages also apply to associated tributary drainages because reaches assessed during the HP study were determined to be representative of the collective subwatershed. As described in the approved WP, the primary drainage channel within each subwatershed was selected for the HP assessment, which provides a strong indication of hydrologic conditions of lower order, hydrologically-connected tributary drainages that have the same or less flow persistence as the downgradient primary drainage channel given the absence of springs.

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TABLE 1
Summary of Sample Locations by Sub-Watershed

FREEPORT-MCMORAN CHINO MINES COMPANY
VANADIUM, NEW MEXICO
SMELTER/TAILING SOILS IU HYDROLOGY PROTOCOL

Sub -Watershed	Number of Sample locations	Rationale
Sub-Watershed C	4	Upstream sample location placed at change in basin slope near the 4,600 feet downstream maker. Second sample location placed at change in basin slop immediately downstream from tributary inflow. Third sample location placed downstream from second large tributary inflow. Downstream sample placed to capture entire basin drainage area.
Martin Canyon	3	Upstream sample location placed at change in basin slope near the headwaters at 2,900 feet downstream marker. Middle sample location placed in flatter gradient section with more prominent vegetation. Downstream sample placed to capture entire basin drainage area.
Sub-Watershed A	2	Upstream sample location placed immediately downstream from larger tributary inflow at location with more prominent vegetation. Downstream sample placed to capture entire basin drainage area. No significant variation in basin slope.
Sub-Watershed B	2	Upstream sample location placed downgradient of change in average basin slope. Downstream sample placed to capture entire basin drainage area.
Sub-Watershed D1	2	Upstream sample location placed downgradient of change in average basin slope. Downstream sample placed to capture entire basin drainage area.
Rustler Canyon	2	Upstream sample location placed downgradient of change in average basin slope and immediately downstream from large tributary inflow. Downstream sample placed to capture entire basin drainage area.
Rustler Canyon 2	1	Sample location placed in un-named tributary west of Rustler Canyon at the 7,000 feet downstream marker.
Sub-Watershed D2	1	Sample location placed at downstream end of basin to capture entire watershed. Also place near change in average basin slope.
Sub-Watershed D3	1	Sample location placed at downstream end of basin to capture entire watershed. Also placed near change in average basin slope.
Sub-Watershed E1	1	Average basin slope consistent throughout reach. Sample location placed at northern end of basin near Hurley and areas of interest.
Sub-Watershed E2	1	Average basin slope consistent throughout reach. Sample location placed at northern end of basin near Hurley and areas of interest. Also located downstream from tributary inflow.
Sub-Watershed E3	1	Average basin slope consistent throughout reach. Sample location placed at northern end of basin near Hurley and areas of interest.

TABLE 2
LEVEL 1 HYDROLOGY PROTOCOL TOTAL SCORES

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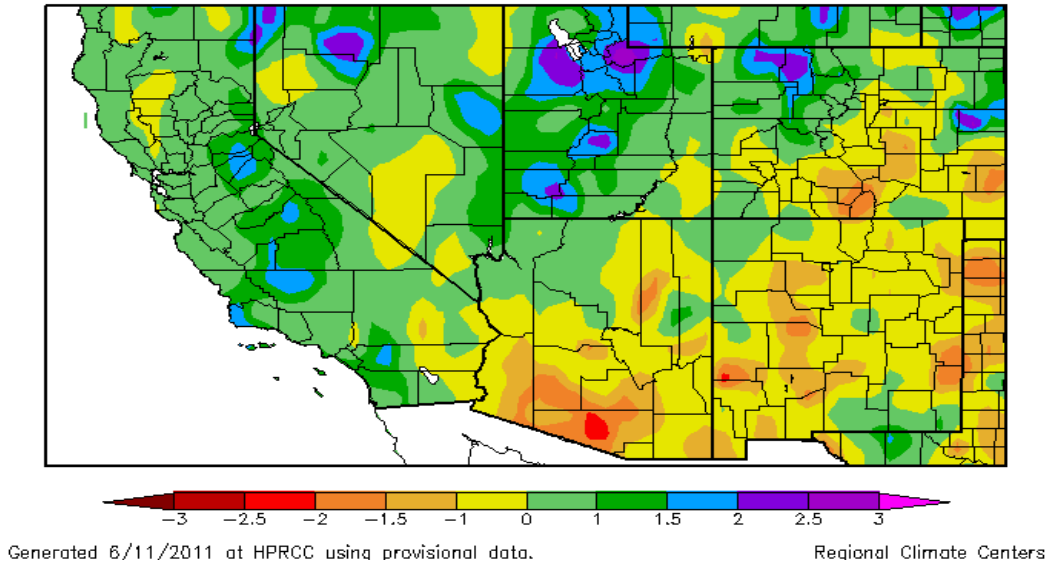
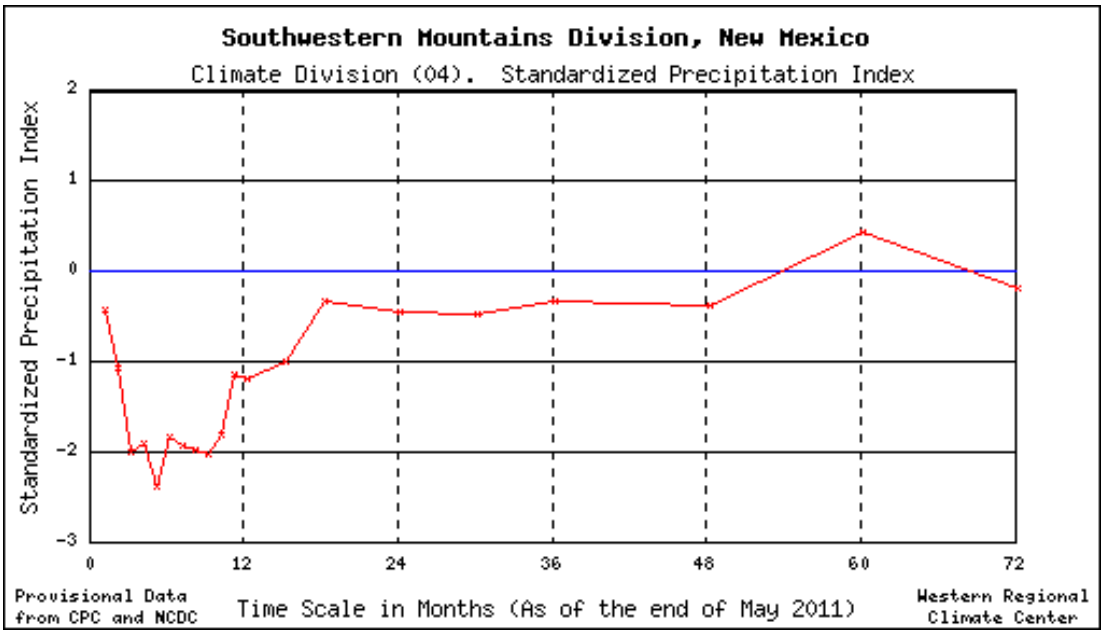
VANADIUM, NEW MEXICO
SMELTER/TAILING SOILS IU HYDROLOGY PROTOCOL

	Level 1 Indicators															Supplemental Indicators		
HP Sample Locations	1.1 Water in Channel	1.2 Fish	1.3 Benthic Macroinvertebrates	1.4 Filamentous Algae/ Periphyton	1.5 Differences in Vegetation	1.6 Absence of Rooted Upland Plants in Streambed	Subtotal (#1.1 - #1.6)	1.7 Sinuosity	1.8 Floodplain and Channel Dimensions	1.9 In-Channel Structure: Riffle-Pool Sequence	Subtotal (#1.1 - #1.9)	1.10 Particle Size or Stream Substate Sorting	1.11 Hydric Soils	1.12 Sediment on Plants and Debris	Total Point (#1.1 - #1.12)	1.13 Seeps and Springs	1.14 Iron Oxidizing Bacteria/Fungi	Total plus Supplemental Points (#1.1 - #1.14)
A-Drainage (A-10)	0	0	0	0	0	2	2	--	--	--	2	--	--	--	2	--	--	2
A-Drainage (A-9)	0	0	0	0	1	0	1	--	--	--	1	--	--	--	1	--	--	1
B-Drainage (B-7)	0	0	0	0	1	1	2	--	--	--	2	--	--	--	2	--	--	2
B-Drainage (B-7-DS)	0	0	0	0	1	1	2	--	--	--	2	--	--	--	2	--	--	2
B-Drainage (B-8)	0	0	0	0	1	2	3	1	1.5	0	5.5	1.5	Absent = 0	0	7	Absent = 0	Absent = 0	7
C-Drainage (C-19)	0	0	0	0	1	1	2	--	--	--	2	--	--	--	2	--	--	2
C-Drainage (C-4)	0	0	0	0	1	2	3	0	1.5	0	4.5	1.5	Absent = 0	0	6	Absent = 0	Absent = 0	6
C-Drainage (C-5)	0	0	0	0	0	2	2	--	--	--	2	--	--	--	2	--	--	2
C-Drainage (C-6)	0	0	0	0	1	2	3	1	1.5	0	5.5	1.5	Absent = 0	0	7	Absent = 0	Absent = 0	7
D1-Drainage (D1-1)	0	0	0	0	0	1	1	--	--	--	1	--	--	--	1	--	--	1
D1-Drainage (D1-2)*	0	0	0	0	1	0	1	--	--	--	1	--	--	--	1	--	--	1
D2-Drainage (D2-3)	0	0	0	0	0	2	2	--	--	--	2	--	--	--	2	--	--	2
D3-Drainage (D3-23)	0	0	0	0	0	2	2	--	--	--	2	--	--	--	2	--	--	2
E1-Drainage (E1-16)	0	0	0	0	0	0	0	--	--	--	0	--	--	--	0	--	--	0
E2 Drainage (E2-17)	0	0	0	0	0	1	1	--	--	--	1	--	--	--	1	--	--	1
E3-Drainage (E3-18)	0	0	0	0	0	0	0	--	--	--	0	--	--	--	0	--	--	0
Martin Canyon (MC-11)	0	0	0	0	1	1	2	--	--	--	2	--	--	--	2	--	--	2
Martin Canyon (MC-12)	0	0	0	0	1	1	2	--	--	--	2	--	--	--	2	--	--	2
Martin Canyon (MC-13)	0	0	0	0	1	1	2	--	--	--	2	--	--	--	2	--	--	2
Rustler Canyon (RC-14A)	2	0	1	1	1	2	7	0	N.A.	1	8	0	Present = 3	0	11	Present = 1.5	Absent = 0	12.5
Rustler Canyon (RC-14B)	2	0	2	2	2	2	10	0	N.A.	1	11	0	Present = 3	0	14	Present = 1.5	Absent = 0	15.5
Rustler Canyon (RC2-22)	0	0	0	0	1	1	2	--	--	--	2	--	--	--	2	--	--	2
Rustler Canyon (RC2-22B)	2	0	2	2	0	2	8	1	N.A.	0	9	0	Absent = 0	0	9	Absent = 0	Absent = 0	9
Rustler Canyon (RC-15)	0	0	0	1	2	2	5	1	1.5	1	8.5	3	Absent = 0	0.5	12	Absent = 0	Absent = 0	12

Notes
-- indicators not scored based on subtotal
* field replicate taken at this sample location - results were identical

12-Month SPI: 6/1/2010 – 5/31/2011





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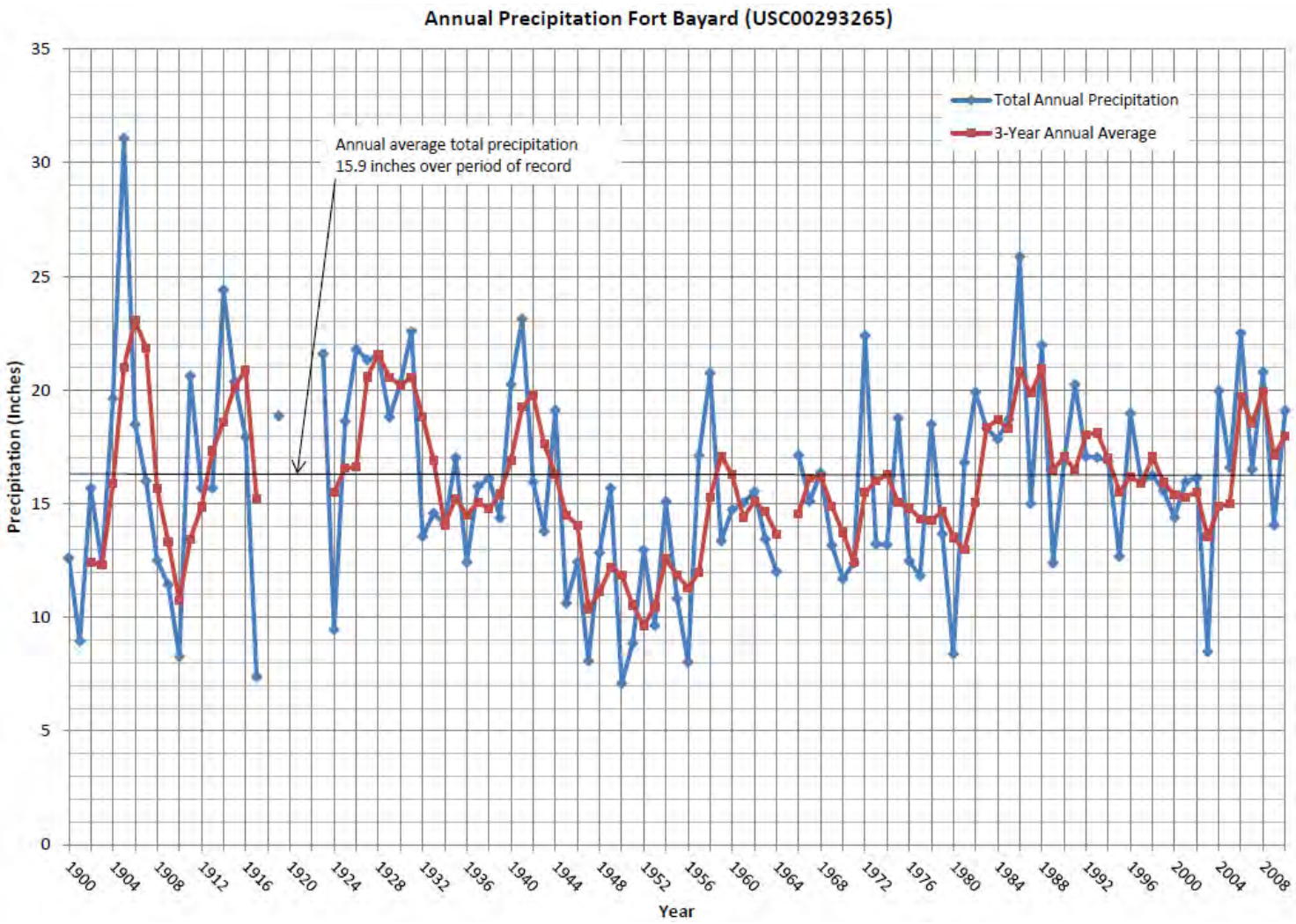
VANADIUM, NM

Application of Hydrology Protocol to STSIU Drainages

12-MONTH STANDARDIZED PRECIPITATION INDEX (SPI) OBSERVED DURING HP APPLICATION

ARCADIS

FIGURE
1



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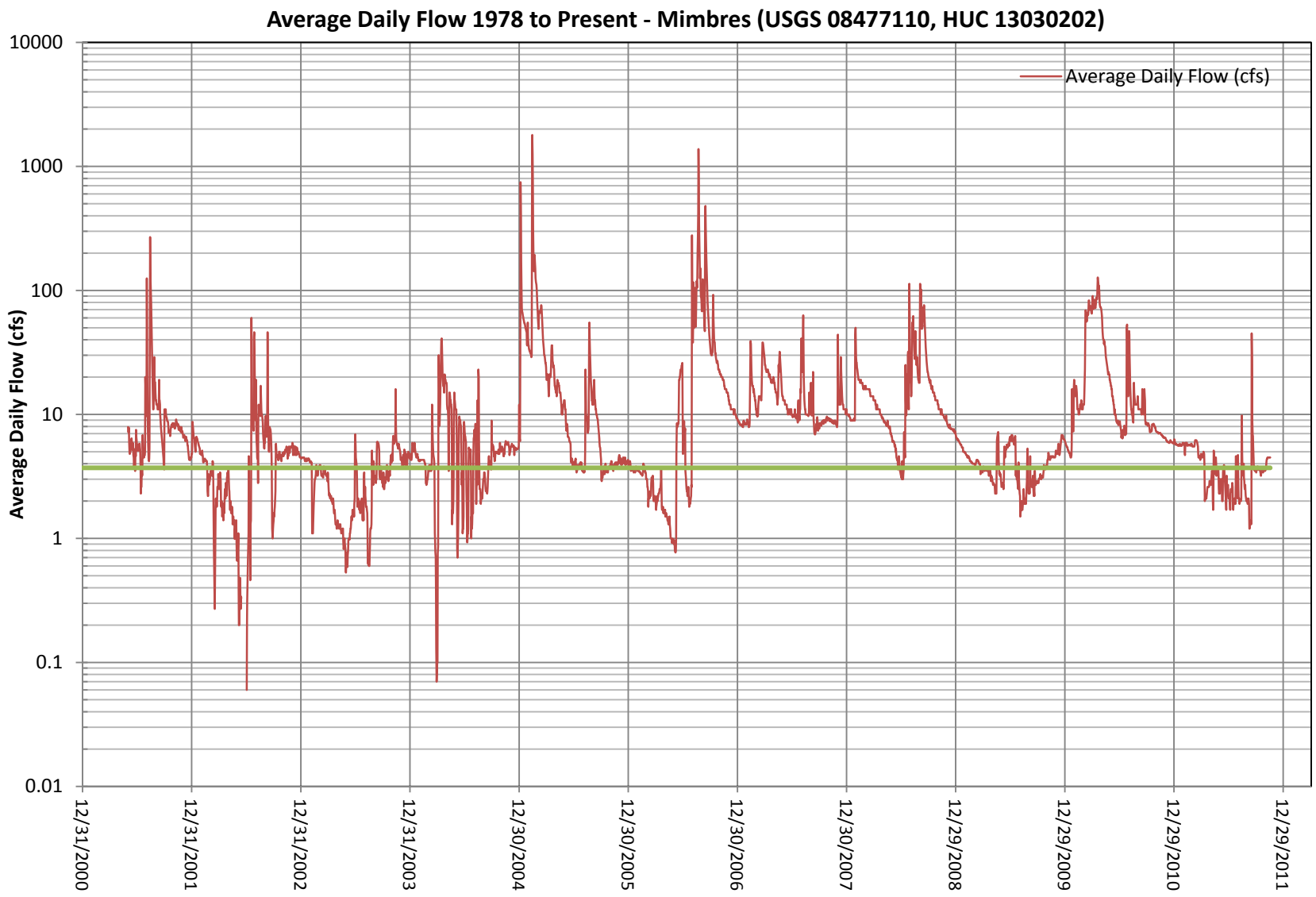
VANADIUM, NM

Application of Hydrology Protocol to STSIU Drainages

Historical Average Precipitation Fort Bayard

ARCADIS

Figure
2



Note:
Average daily flow during the field survey (3.7 cfs) has been extrapolated over the historical flow data to demonstrate that the condition is not historically anomalous

FREEPORT-MCMORAN CHINO MINES COMPANY
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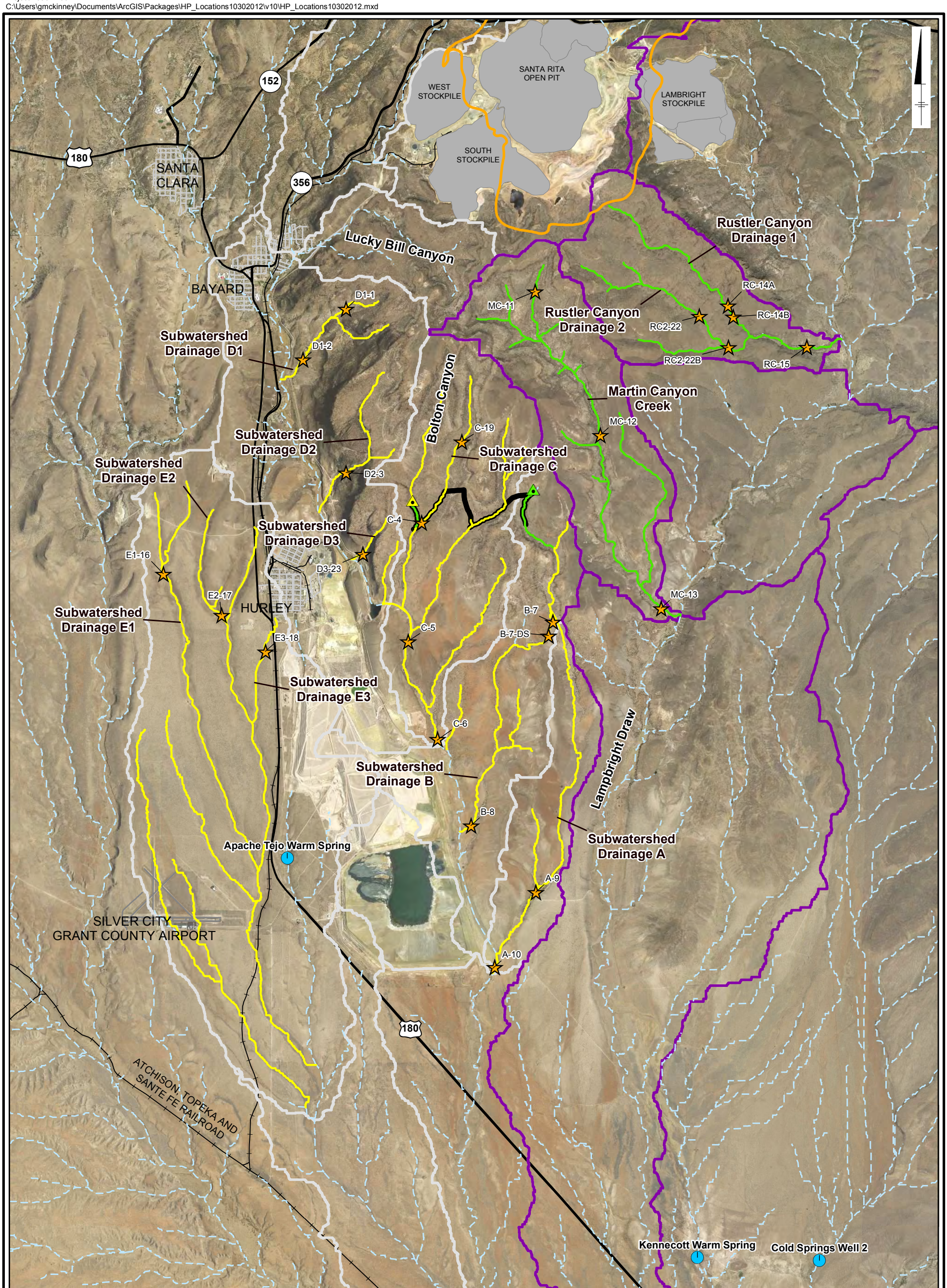
Application of Hydrology Protocol to STSIU Drainages

HISTORICAL AVERAGE DAILY FLOW FOR MIMBRES RIVER

ARCADIS

FIGURE
3

CITY: Lakewood DIV/GROUP: IM DB: MLM LD: PIC: PM: TM: TR:
Project #63524.001
C:\Users\gmckinney\Documents\ArcGIS\Packages\HP_Locations10302012\v10\HP_Locations10302012.mxd



LEGEND:

- 2011 Hydrology Protocol Sample Location
- Pit Capture Zone from Golder (2008)
- Ephemeral Drainages
- Non-Ephemeral Drainages
- Other Drainages
- USFWS Proposed Critical Habitat Transect
- Lampbright Subwatershed Boundaries
- Hanover-Whitewater Subwatershed Boundaries
- Stockpiles
- Highway
- Railroad
- Town Roads
- Ash Spring
- Bolton Springs

0 1 2 Miles
GRAPHIC SCALE

FREEPORT-MCMORAN CHINO MINES COMPANY
VANADIUM, NEW MEXICO

APPLICATIONS OF HYDROLOGY PROTOCOL TO STSIU DRAINAGES

HYDROLOGY PROTOCOL SAMPLE LOCATIONS

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FIGURE
4