FREEPORT-MCMORAN

Freeport-McMoRan Cobre Mining Company
P.O. Box 10
Bayard, NM 88023

RECEIVED
NOV 30 2015
MINING & MINERALS DIVISION

November 23, 2015

Certified Mail #70150640000775396493
Return Receipt Requested

Mr. James Hollen
Mining Act and Reclamation Program
Mining and Minerals Division
1220 South St. Francis Drive
Santa Fe, NM 87505

Dear Mr. Hollen:

Re: Freeport-McMoRan Cobre Mining Company -
Supplemental Responses to Agency, Permit No. GR002RE Revision 14-1

Freeport-McMoRan Cobre Mining Company (Cobre) submitted a permit application dated August 22, 2014 for the referenced mining permit to change the approved permit boundary in order to facilitate the construction of a haul road (CHR) between Cobre and Freeport-McMoRan Chino Mines Company. The application also included a Closeout Plan (CP) describing the proposed reclamation of the CHR. In a letter dated March 27, 2015 the Mining and Minerals Division (MMD) provided its comments, comments from the Hopi Tribe, and the comments of other agencies and the public to Cobre. Cobre responded to the March 27, 2015 comments in a letter dated July 27, 2015.

In a letter dated November 2, 2015, MMD requested additional information from Cobre in order to make a technical determination that the CP is approvable, as required by 19.10.5.506(G).

Below, Cobre provides responses to MMD's letter dated November 2, 2015. The responses below clarify information previously submitted to MMD either in the application dated August 22, 2014 or Cobre's letter dated July 27, 2015. MMD's comments are abbreviated below in italics.

1. *Cobre's response to MMD does not provide a cost estimate for removing culvert diversions where practicable.*

   Cobre's response:
   Sixteen culverts have been designed for the Cobre portion of the CHR, fifteen for storm water conveyance and one for the forest access road near Hanover Creek. Cobre has determined it is practicable to remove only the culverts at the forest access road and at Hanover Creek. The culvert at the forest access road is designed to facilitate continued public access to forest lands north of Cobre while the CHR is in use and does not need to be maintained after reclamation. Removal of the culvert at Hanover Creek is consistent with the requirements of the 404 Nationwide Permit for the road crossing at Hanover Creek. Removal of both culverts will not impair future uses of Cobre property. Cost estimates for removal of these culverts were included in the August 22, 2014 application.
   South of the crossing at Hanover Creek, a two-track service road will be maintained within the footprint of the CHR after reclamation. The two-track service road is required in order to manage

Cobre property in the vicinity of the reclaimed CHR. The fourteen culverts for the ephemeral drainages under the reclaimed CHR are needed in order for the two-track road to remain.

2. *MMD requires further description of the proposed culverts . . .MMD asserts that this information is critical toward . . . compliance with 19.10.5.508(B)(4). Cobre must provide additional final design specifications and watershed metrics/calculations .to show that the culvert design[s] will pass the peak run-off specified in 508.B(4) and (5) NMAC.*

Cobre's response:
Please see Attachment 1, "Plan and Profile" Sheets 3-1 through 3-7 for the CHR, by Engineers Inc. These drawings indicate the exact location, the size, length and other design criteria for each culvert along the entire length of the haul road. (Sheets 3-2 through 3-7 are for the Cobre portion of the CHR and Sheet 3-1 is for the Chino portion of the haul road.)

Also enclosed is a signed "Drainage Report" from Engineers Inc. substantiating that the culverts will pass the 100-year 24-hour precipitation event.

A culvert is a closed conduit under a roadway or embankment used to maintain a designated flow from a natural channel in order to maintain the natural drainage system and to convey a designated flow without causing damaging backwaters or overtopping (flooding) and therefore is not traditionally characterized as a diversion. Nonetheless, Cobre complies with the 19.10.5.508(B)(4) and (5) NMAC regulations for culverts assumed to be diversions, as indicated in Table 1 below.

Table 1	
MMD Regulation	**Cobre Response**
19.10.5.508.B(4) Hydrologic Balance *Operations shall be planned and conducted to minimize negative impact to the hydrologic balance in both the permit and potentially affected areas.*	Cobre will minimize impacts to the hydrologic balance by complying with the applicable portions of 19.10.5.508.(B)(4)(a)-(d).
(a) *Operations shall be designed so that non-point source surface releases of acid or other toxic substances shall be contained within the permit area, and that all other surface flows from the disturbed area are treated to meet all applicable state and federal regulations.*	No acids or other toxic substances will be used or stored within the CHR. NMED has determined that the CHR is a non-discharging (groundwater) facility. Only storm water flows will be released from the CHR area. These flows must comply with the 2015 EPA National Pollutant Discharge Elimination System Multi-Sector General Permit for Stormwater Discharges Associated with Industrial Activity (MSGP). The MSGP includes requirements for monitoring, recordkeeping and reporting and requires the permittee to "select, design, install, and implement control measures (including best management practices) to minimize pollutant discharges that address the selection and design considerations in Part 2.1.1, meet the non-numeric effluent limits in

	Part 2.1.2, meet limits contained in applicable effluent limitations guidelines in Part 2.1.3, and meet the water quality-based effluent limitations in Part 2.2." (MSGP Section 2.1) The water quality-based effluent limitations include applicable water quality standards in the state. The control measures include berms and drainage ditches that will direct surface flows from the disturbed area to sediment traps (see enclosed Engineer's Inc. Plan and Profile Sheets) to settle solids prior to discharge. These controls and compliance with the MSGP will ensure that surface flows from the disturbed area will meet all applicable state and federal regulations.
(b) *The disturbed areas shall not contribute suspended solids above background levels, or where applicable the Water Quality Control Commission's standards, to intermittent and perennial streams.*	Please see Page 6 of the August 22, 2014 application. In a memo dated December 12, 2014 to MMD, the NMED Surface Water Quality Bureau stated that the Hanover Creek is an unclassified intermittent stream and the drainages under the CHR are ephemeral. The Bureau further stated it "does not recognize any impairment to surface water within the expanded [Cobre] permit and design limit boundaries described in the application." As described above, the 2015 MSGP ensures compliance with the applicable water quality standards in the state.
(c) *To provide data to determine background levels for surface water entering the permit area, appropriate monitoring shall be conducted on drainages leading into the permit area.*	As described above, the MSGP requires that discharges meet the applicable water quality standards of the state and therefore background monitoring does not apply.
(d) *All diversions of overland flow shall be designed, constructed and maintained to minimize adverse impacts to the hydrologic balance and to assure the safety of the public.*	The CHR is designed with culverts in drainages to allow for water to flow under the road. Any storm water that reaches the surface of the haul road will be directed to sediment traps and other BMPs to remove, to the extent practicable, suspended solids and will then be released to nearby drainages. Therefore, the design of the Cobre Haul road minimizes adverse impacts to the hydrologic balance. Please see the attached Engineer's Inc. Plan

	and Profile Sheets.
19.10.5.508.B(5) *When stream diversions are to be diverted, the stream channel diversion shall be designed, constructed, and removed in accordance with the following:* *(a) . . . the combination of channel, bank, and flood plain configurations shall be adequate to safely pass the peak run-off of a . . .100 year, 24-hour precipitation event for permanent diversions;* *(b) the design and construction of all intermittent and perennial stream channel diversions shall be certified as meeting the 19.10 NMAC by a professional engineer ...As built drawings shall be retained on-site...* *(c) When no longer needed, temporary stream diversions shall be removed and the disturbed area reclaimed.*	(a) As described in the attached "Drainage Report" prepared by Engineer's Inc., the culverts (which for purposes of this application are presumed diversions) are designed to pass the 100-year 24- hour precipitation event. (b) Please see the attached "Plan and Profile" sheets which have been stamped by a professional engineer registered in NM. (c) As described above, all culverts except those at the Forest Service access road and Hanover Creek are needed to maintain the two-track service road. Please see the Closeout Plan submitted with the August 22, 2014 application for the estimated cost to removal of this culvert.

3. *Cobre's [July 27, 2015] response to MMD Comment No. 11 doesn't completely address certain aspects of the comment. MMD's comment was geared toward understanding how Cobre intends to comply with 508.B(7) to prevent sediments from extending beyond the toe of the steep, angle of repose outslopes of the CHR. Because the road will be continually maintained and regraded. . .this is anticipated to cause the toe to extend out beyond its currently proposed design limits. . . how does Cobre intend to hold these angle of repose outslope materials at the toe and not increase disturbance acreage beyond the edge of the outslopes?*

   Cobre's response:
   19.10.5.508.B(7) "Minimization of Mass Movement" requires that all "man-made piles such as waste dumps, topsoil stockpiles and ore piles shall be constructed and maintained to minimize mass movement".

   Cobre believes that 19.10.5.508.B(7) does not apply to the CHR, since it is not a mine waste dump. However, to address MMD's question about the management of sediments from the CHR, enclosed are two drawings from Engineers Inc which provide the general design of the sediment traps along the haul road. During operations, grading of the CHR will not result in continual addition of material to the safety berms and therefore spillage of material onto the outslopes. Rather grading will maintain the road surface material on the CHR surface. The CHR is designed so that only precipitation incident to the slopes will flow down the slope. The minimal sediment that may be generated from this incident precipitation will be contained within the initial BMPs constructed as the surface is cleared and grubbed for road construction. Further, inspection of the CHR outslopes and BMPs is required under the MSGP.

4. *Cobre's response to MMD [3/7/15] Comment No. 12... indicates that grade changes along the CHR will be minimized and the channels along the CHR will be adequate to prevent flooding situations across the roadbed and that it will direct stormwater to BMP's and outfalls identified in the SWPPP;. . . MMD cannot make any determinations . . .pursuant to [Cobre] complying with 19.10.5.508(A), or 508 (B)4, 508((B)(9), or 508 (D). Cobre must address the requirements of 19.10.508 and simply referencing the SWPPP is insufficient. MMD will need specific information addressing stormwater BMPs, either extracted from the SWPPP, or some other source dealing specifically with stormwater controls related to the CHR.*

Please see Cobre's response to Comment 2. above regarding how Cobre complies with 19.10.5.508(A) and (B)4.

Cobre complies with the applicable parts of 19.10.5.508 (B)9 and 19.10.5.508(D) NMAC as indicated in Table 2 below.

Table 2	
MMD Regulation	**Cobre Response**
19.10.508.B(9) Roads *Roads shall be constructed and maintained to control erosion.*	*Cobre complies with each subpart of 19.10.508.(B)(9) as described below.*
(a)** **Drainage control structures shall be used as necessary to control runoff and to minimize erosion, sedimentation and flooding. Drainage facilities shall be installed as road construction progresses and shall be capable of safely passing a 10-year, 24 hour precipitation event unless site-specific characteristics indicate a different standard is appropriate and is included in the approved permit. Culverts and drainage pipes shall be constructed and maintained to avoid plugging, collapsing, or erosion.	*Please see Attachment 1, "Plan and Profile" Sheets 3-1 through 3-7 for the CHR, by Engineers Inc., which provide the design of the CHR. Grade changes have been minimized to prevent significant channelization and erosion on the road The installation of the culverts will prevent flooding over the road from the upstream natural drainages. The attached "Drainage Report" prepared by Engineer's Inc. demonstrates that the culverts will be capable of passing a 100-year, 24-hour precipitation event.*
(b) *Roads to be constructed in or across intermittent or perennial streams require site-specific designs to be submitted with the permit application.*	*Currently Hanover Creek is considered intermittent. Please see Appendix B of the August 22, 2014 application and Attachment 1 of this letter for the design of the road over Hanover Creek.*
c) *Roads to be made permanent must be approved by the surface owner and be consistent with the approved post-mining land use.*	*The CHR will be reclaimed when no longer needed to facilitate mining. Please see the Closeout Plan submitted with the August 22, 2014 application. Upon reclamation only a two-track road will remain. It will be located only on Cobre property and a small portion of BLM property. BLM has approved these uses in Cobre's MPO Amendment No. 5.*
19.10.508.D. Erosion Control *Reclamation of disturbed lands must result in a condition that*	*Please see the Closeout Plan, submitted with the August 22, 2014 application, which*

controls erosion. Revegetated lands must not contribute suspended solids above background levels to intermittent and perennial streams.	*includes cost estimates for erosion control and vegetation.*

5. *. . . regarding the diversion of stormwater runoff from the CHR. . . Please address the pertinent requirements of 508 by referencing specific conditions and details from the MSGP and the SWPPP.*

   Cobre's Response: Please see response to 4. above.

6. *Cobre's response to MMD's [3/7/15] Comment No. 15 in regard to salvaging and storage of topsoil . . .from the CHR indicates Cobre will salvage soil only in volumes greater than 300 yd^3 . . .with no further explanation of . . .controls . . .to ensure proper storage and protection of this material. Cobre must explain the reasoning for storing topsoil adjacent to the CHR and why there is no consideration of stockpiling salvaged topsoil elsewhere. . . . . . . Cobre must provide an estimate of how much topsoil will be salvaged. . . .*

   Cobre's Response:
   As explained in Cobre's July 27, 2015 letter to MMD, salvaged soil will be used for final re-grading during reclamation of the CHR and therefore, storage adjacent to the Cobre Haul Road minimizes unnecessary haulage of this material. The topsoil that is salvaged will be protected and stabilized by being stored at angle of repose and through naturally occurring revegetation. The storage of this material will be placed into Cobre's database for as-built designs and signs will be posted at the location of the salvaged topsoil. Chino estimates that approximately16,000 cubic yards of soils may be salvageable, however, this is likely a high estimate given the bedrock fragments along the CHR and the existing topography.

7. *Cobre's response to MMDs' [3/7/15] Comment No. 20 indicates Cobre will clear and grub timber and brush. . . and, as appropriate, will place grubbed timber and brush in piles . . . around the perimeter of the CHR for use during operations. Please explain what operational uses Cobre plans for this material and describe why this material should not be stored with topsoil and other overburden materials. . . MMD believes that storing this material in piles along the perimeter of the CHR could represent an attractive nuisance and could lure wildlife to these piles, and ultimately, onto the CHR corridor.*

   Cobre's Response:
   Timber and brush cleared from the CHR will be used as needed in conjunction with coarse rock at the toe of the CHR as additional erosion control to minimize sediment transport during and immediately after construction of the CHR. Please refer to the Bureau of Land Management's "Environmental Assessment, Freeport-McMoRan Cobre Mining Company Mine Plan of Operations Amendment No. 5", which concluded the CHR will not result in significant adverse impacts to wildlife.

8. *Cobre's response to MMD 3/7/15 Comment No. 26 indicates Cobre will provide BLM approval documents. 19.10.5.506.J(4) requires BLM to approve/acknowledge the CHR CP before MMD can issue permit.*

   Cobre's Response:
   Cobre will provide under separate cover a copy of the approval documents by BLM.

9. *In order for MMD to understand the adequacy of the CHR design and to interpret whether or not the proposed haul road will effectively divert storm water, MMD must have additional cross sections and designs depicting the more complex areas where drainages are diverted under the CHR.*

Cobre's Response:
Please see the enclosed drawings from Engineers' Inc.

Cobre also wishes to respond to the letter dated September 4, 2015 from NMDCA to MMD regarding the cultural resources survey conducted in 2012 for Cobre's anticipated permitting activities. In that letter NMDCA indicated that archaeological sites LA 169572 and LA 173559 are the same. NMDCA also identified two additional sites – LA 129206 and LA 126590 – that were not identified in the 2012 cultural resources survey conducted for the CHR and Cobre's return to operating status.

- Cobre agrees that sites LA 169572 and LA 173559 are the same (the Jim Fair Mine). The discrepancy results from a duplicative entry of the site by Dos Rios Consultants into the database referenced by NMDCA.

- The 2012 cultural resources study conducted by Dos Rios Consultants was comprehensive and addressed the entire area for the proposed CHR. Sites LA 129206 and LA 126590 represent the Clifford Shaft and the Kearney Mine respectively. Both are outside of the CHR footprint.

Cobre appreciates your review of the above responses. Should you have any further questions, please do not hesitate to contact me at (575) 912-5773 or Kariann Sokulsky at (575) 912-5386.

Sincerely,

Tom L. Shelley

Tom L. Shelley, Manager
Freeport-McMoRan Cobre Mining Company

TS:kes
Attachment 1: Engineers Inc Plan & Profile Sheets 3-1:3-7, Cobre Haul Road
Attachment 2: Engineers Inc "Final Drainage Report" November 2015
Attachment 3: Engineers Inc Sediment Trap Drawings 2-7:2-8

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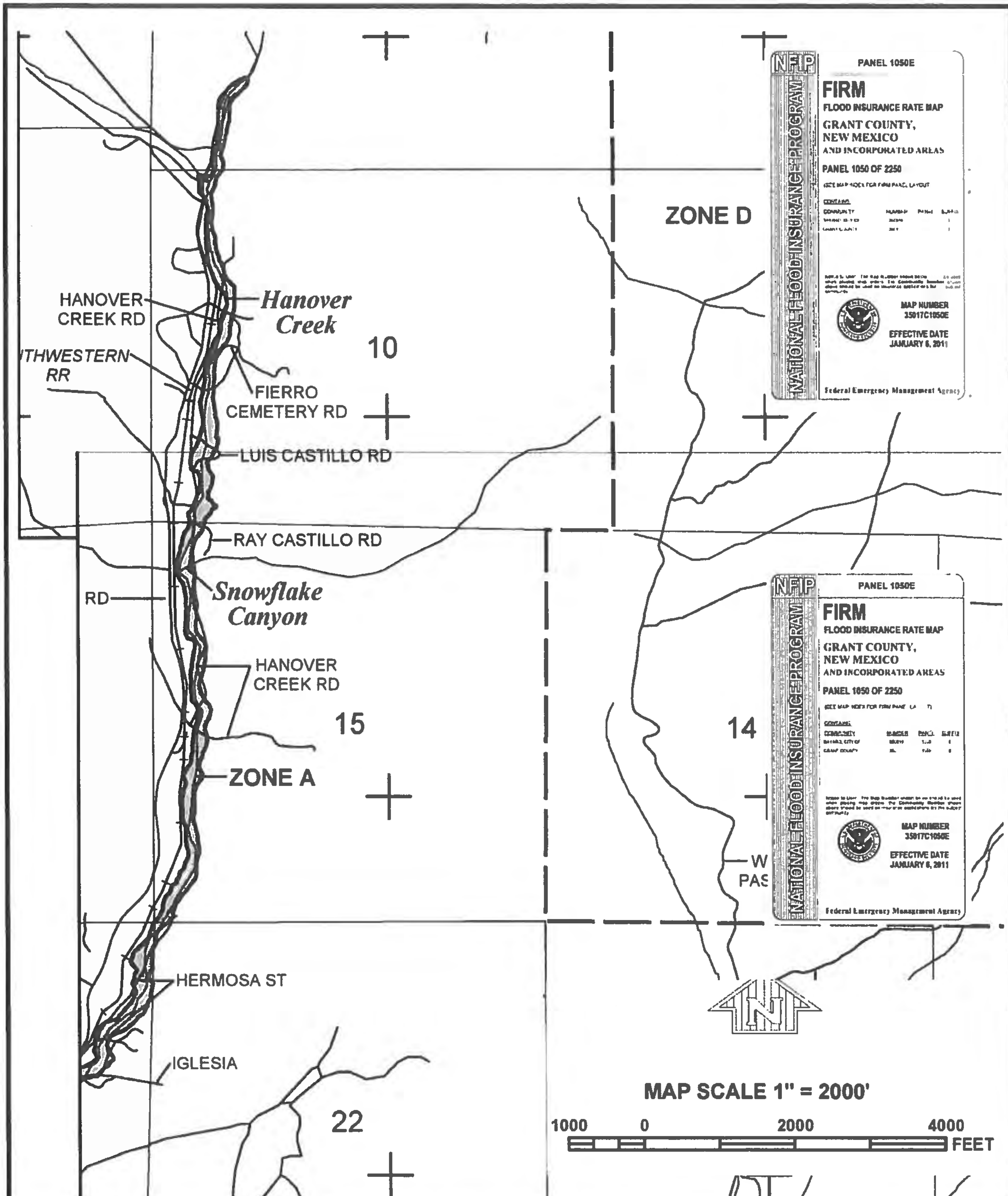
APPENDIX A

ENGINEERS INC

Figure 1

Site Description Map

FREEPORT-McMoRAN COPPER & GOLD

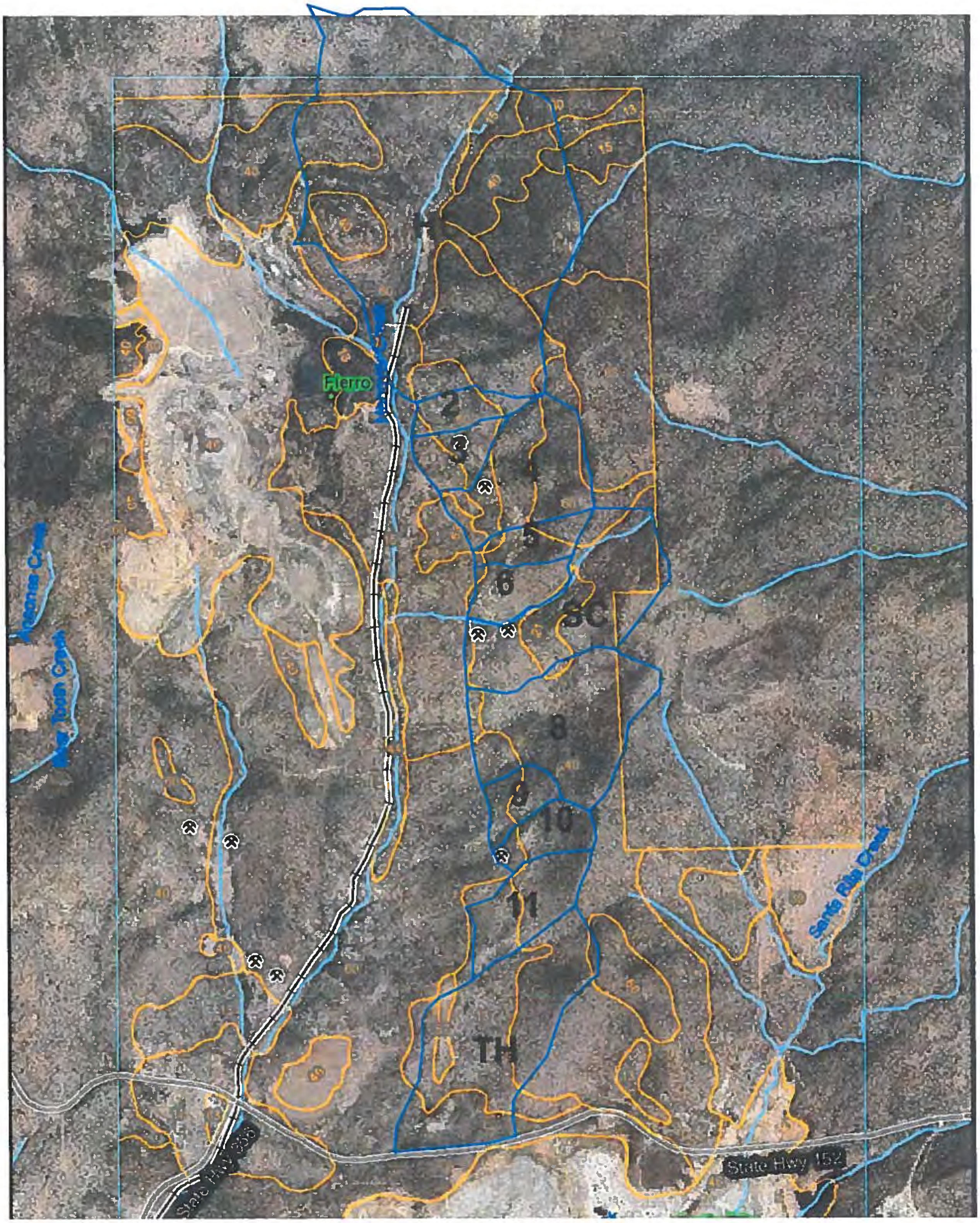


ENGINEERS INC

Figure 2

Flood Hazard Boundary Map

FREEPORT-MCMORAN COPPER & GOLD

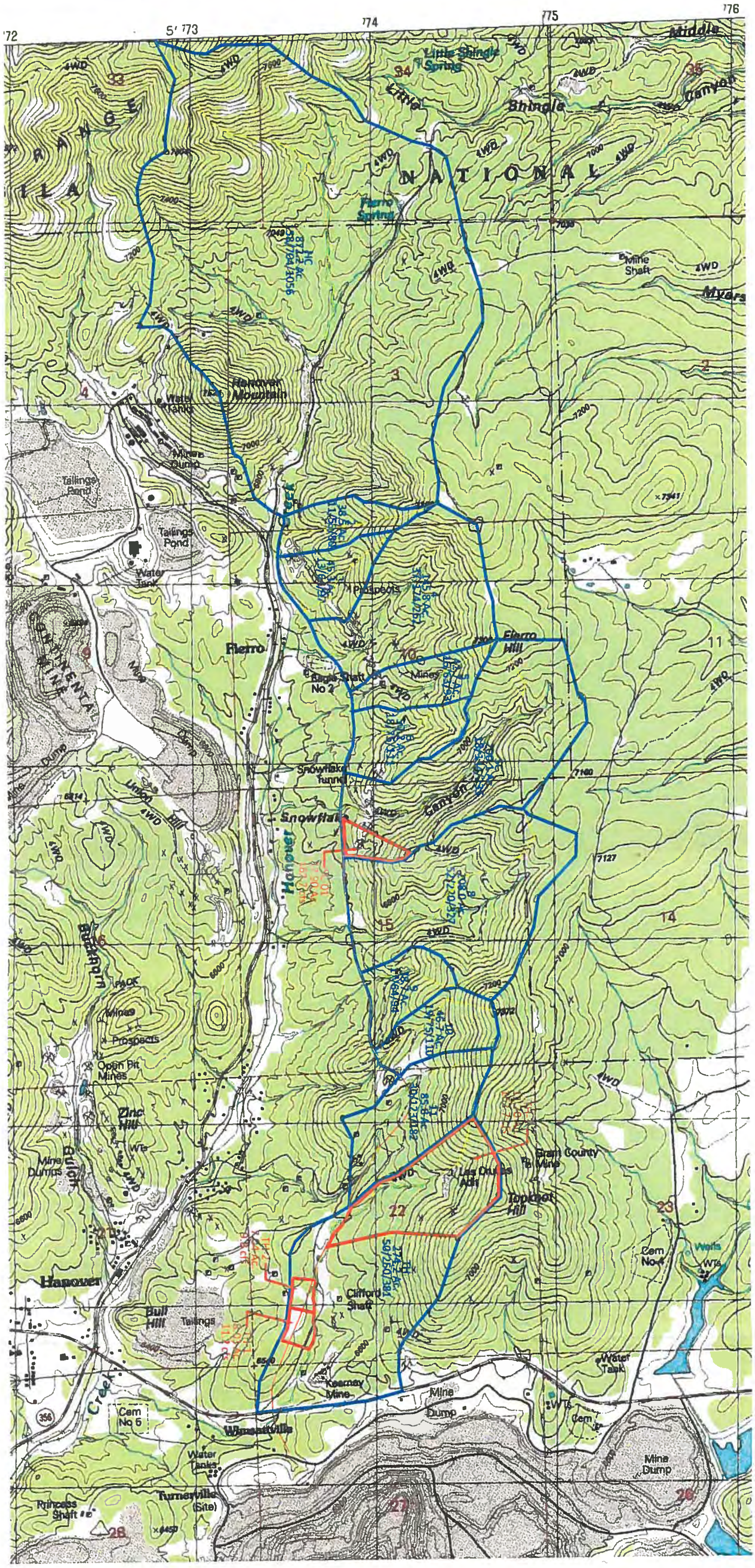


ENGINEERS INC

Figure 3

Soils Map

FREEPORT-MCMORAN COPPER & GOLD



LEGEND

HC BASIN NAME

124.0 Ac. BASIN AREA

2/40/80 2-YR/25-YR/100-YR PEAK FLOWS

P:\Freeport McMoRan Copper\FMI 2011\FMI1110P Chino Cobre Hwy 152 Crossing\Design-Survey\Drainage\Updated Drainage report Nov. 2015\BASIN MAP LAYOUT REV 11-15.dwg

FULL SIZE SHEET SCALE: 1" = 1000'
HALF SIZE SHEET SCALE: 1" = 2000'

SHEET	(SEAL)	TITLE		PROJECT	REVISIONS	
1		DRAINAGE BASIN MAP FIGURE 4	ENGINEERS INC 301 W. COLLEGE AVE. SUITE 1 SILVER CITY, NEW MEXICO 88061 (575) 538-5396 (OFFICE) (575) 538-5410 (FAX)	CHINO/COBRE HWY 152 AND THE USFS ROAD CROSSING GRANT COUNTY, NEW MEXICO	11-17-15 EJN	DATE 8/30/11 JOB # FMI1110P DWG. BY

APPENDIX B

United States Department of Agriculture

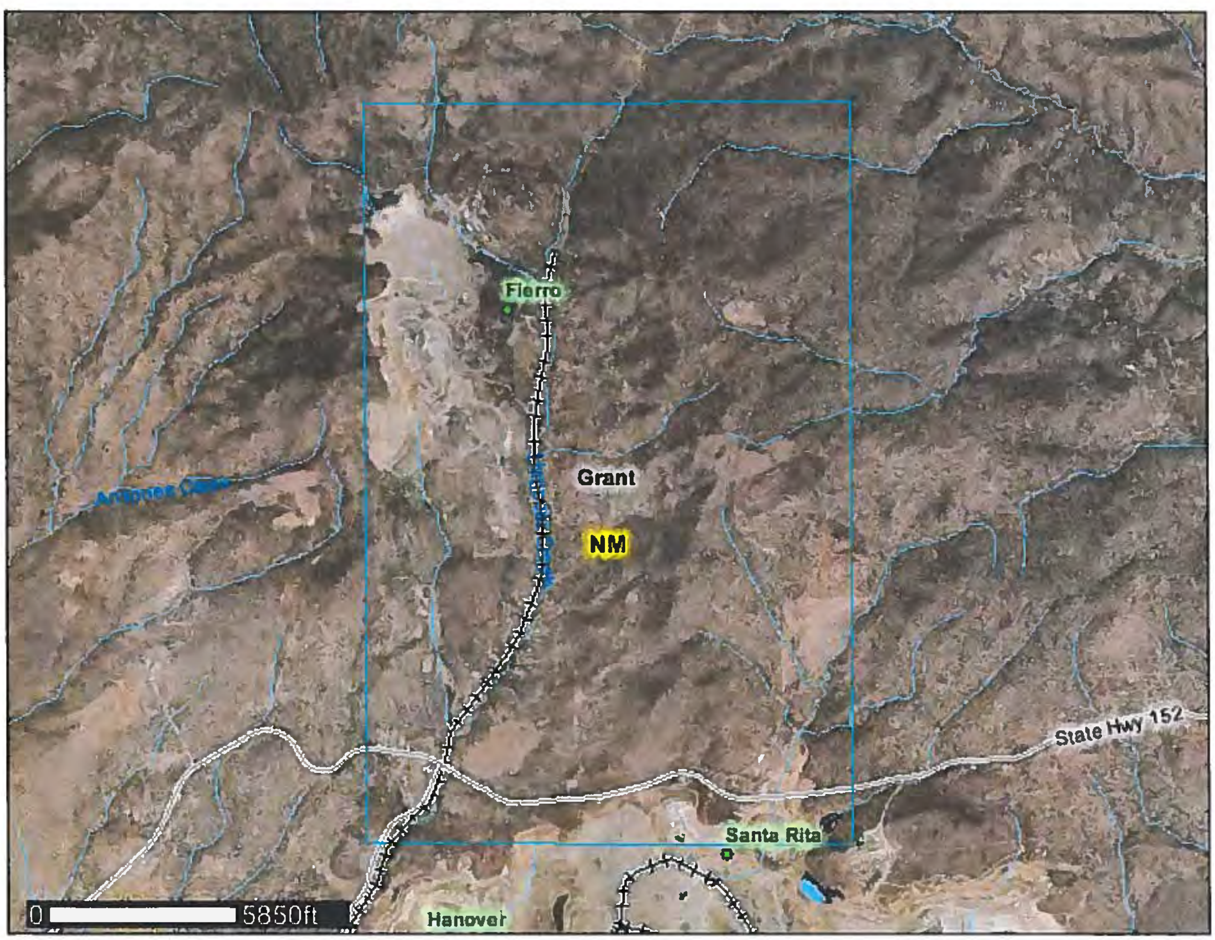
NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for Gila National Forest, New Mexico, Parts of Catron, Grant and Sierra Counties; and Grant County, New Mexico, Central and Southern Parts

Chino/Cobre Haul Road



August 27, 2011

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://soils.usda.gov/sqi/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (http://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://soils.usda.gov/contact/state_offices/).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Soil Data Mart Web site or the NRCS Web Soil Survey. The Soil Data Mart is the data storage site for the official soil survey information.

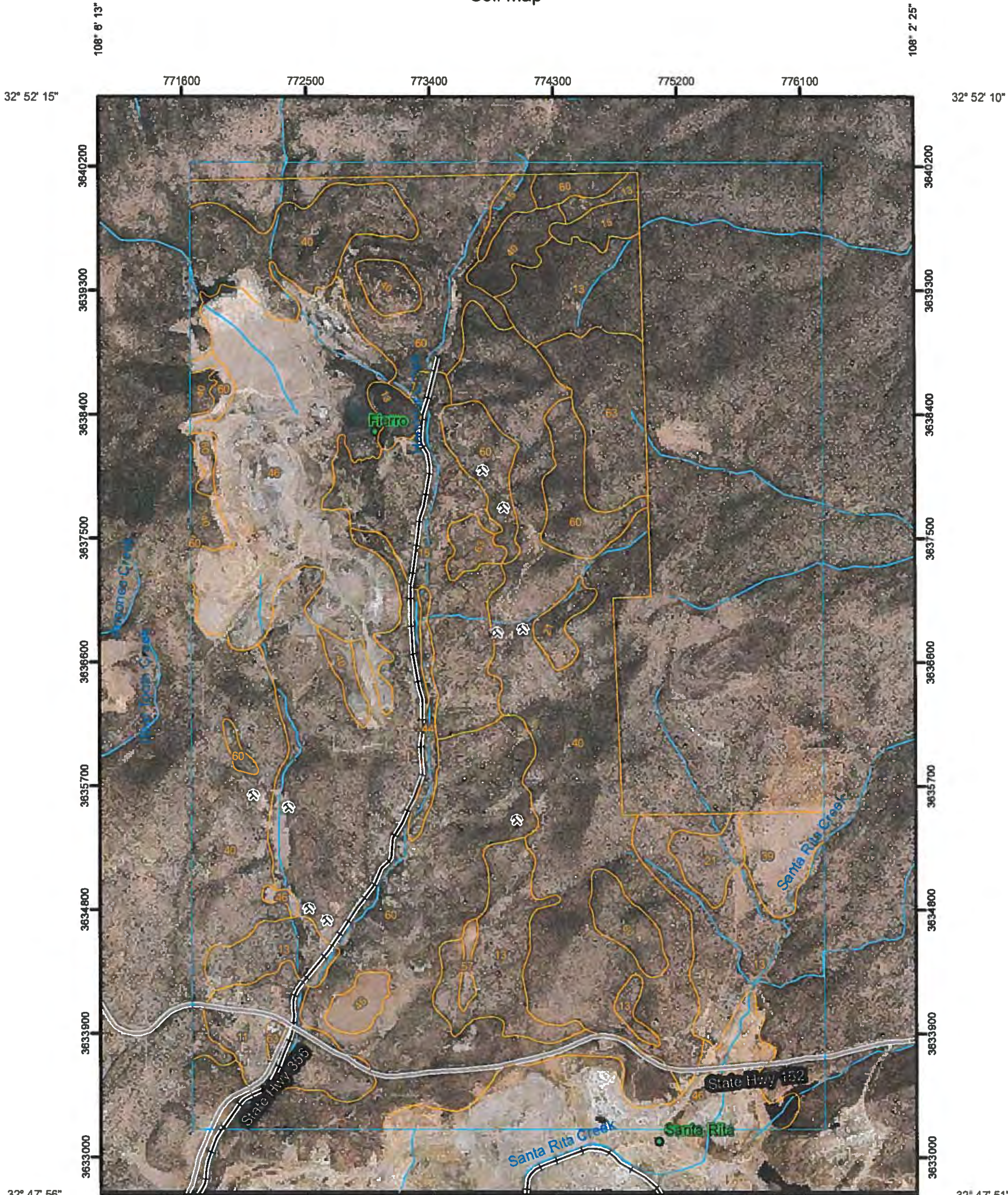
The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination, write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.

Contents

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Custom Soil Resource Report
Soil Map



Map Scale: 1:38,100 if printed on A size (8.5" x 11") sheet.

N

Meters: 0, 350, 700, 1,400, 2,100

Feet: 0, 1,000, 2,000, 4,000, 6,000

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

- Soil Map Units

Special Point Features

- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other

Special Line Features

- Gully
- Short Steep Slope
- Other

Political Features

- Cities

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads

MAP INFORMATION

Map Scale: 1:38,100 if printed on A size (8.5" × 11") sheet.

The soil surveys that comprise your AOI were mapped at 1:48,000.

Please rely on the bar scale on each map sheet for accurate map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: UTM Zone 12N NAD83

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Gila National Forest, New Mexico, Parts of Catron, Grant and Sierra Counties
Survey Area Data: Not available

Soil Survey Area: Grant County, New Mexico, Central and Southern Parts
Survey Area Data: Version 9, Dec 9, 2008

Your area of interest (AOI) includes more than one soil survey area. These survey areas may have been mapped at different scales, with a different land use in mind, at different times, or at different levels of detail. This may result in map unit symbols, soil properties, and interpretations that do not completely agree across soil survey area boundaries.

Date(s) aerial images were photographed: Data not available.

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Gila National Forest, New Mexico, Parts of Catron, Grant and Sierra Counties (NM622)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
No soil data available for this soil survey area.			
Subtotals for Soil Survey Area		—	—
Totals for Area of Interest		7,970.3	100.0%

Grant County, New Mexico, Central and Southern Parts (NM662)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
11	Dagflat-Santa Fe complex, 1 to 25 percent slopes	162.0	2.0%
13	Encierro-Rock outcrop complex, 15 to 35 percent slopes	812.6	10.2%
15	Gaddes-Santa Fe-Rock outcrop complex, 15 to 45 percent slopes	405.4	5.1%
21	Jonale sandy clay loam, 15 to 35 percent slopes	86.2	1.1%
39	Oro Grande-Rock outcrop complex, 5 to 15 percent slopes	81.8	1.0%
40	Oro Grande-Rock outcrop complex, 25 to 75 percent slopes	1,640.9	20.6%
44	Paymaster-Ellicott complex, 1 to 3 percent slopes	41.1	0.5%
46	Pits-Dumps association, extremely steep	1,004.9	12.6%
57	Sampson-Dagflat complex, 3 to 12 percent slopes	13.2	0.2%
60	Santa Fe-Rock outcrop complex, 20 to 45 percent slopes	1,848.9	23.2%
63	Santana-Rock outcrop complex, 1 to 25 percent slopes	203.4	2.6%
Subtotals for Soil Survey Area		**6,300.3**	**79.0%**
Totals for Area of Interest		**7,970.3**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Grant County, New Mexico, Central and Southern Parts

11—Dagflat-Santa Fe complex, 1 to 25 percent slopes

Map Unit Setting

Elevation: 4,500 to 8,000 feet
Mean annual precipitation: 12 to 16 inches
Mean annual air temperature: 45 to 55 degrees F
Frost-free period: 120 to 180 days

Map Unit Composition

Dagflat and similar soils: 45 percent
Santa fe and similar soils: 30 percent

Description of Dagflat

Setting

Landform: Hillslopes, plains
Landform position (two-dimensional): Shoulder, footslope
Landform position (three-dimensional): Head slope, side slope, riser, rise
Down-slope shape: Convex, linear
Across-slope shape: Convex, linear
Parent material: Mixed alluvium and/or colluvium derived from igneous, metamorphic and sedimentary rock

Properties and qualities

Slope: 1 to 15 percent
Depth to restrictive feature: 20 to 40 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 1.0 mmhos/cm)
Available water capacity: Low (about 4.6 inches)

Interpretive groups

Land capability (nonirrigated): 7s
Ecological site: Loamy (R038XB104NM)

Typical profile

0 to 8 inches: Loam
8 to 31 inches: Sandy clay loam
31 to 35 inches: Bedrock

Description of Santa Fe

Setting

Landform: Hillslopes, mountain slopes
Landform position (two-dimensional): Footslope, shoulder, backslope
Landform position (three-dimensional): Upper third of mountainflank, center third of mountainflank, lower third of mountainflank, head slope, side slope
Down-slope shape: Convex
Across-slope shape: Convex

Parent material: Mixed alluvium and/or colluvium derived from igneous, metamorphic and sedimentary rock

Properties and qualities

Slope: 5 to 25 percent
Depth to restrictive feature: 8 to 20 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 1.0 mmhos/cm)
Sodium adsorption ratio, maximum: 1.0
Available water capacity: Very low (about 1.7 inches)

Interpretive groups

Land capability (nonirrigated): 7e
Ecological site: Hills (R038XB103NM)

Typical profile

0 to 2 inches: Gravelly sandy loam
2 to 18 inches: Very gravelly clay loam
18 to 22 inches: Bedrock

13—Encierro-Rock outcrop complex, 15 to 35 percent slopes

Map Unit Setting

Elevation: 5,500 to 7,000 feet
Mean annual precipitation: 14 to 17 inches
Mean annual air temperature: 48 to 54 degrees F
Frost-free period: 150 to 180 days

Map Unit Composition

Encierro and similar soils: 45 percent
Rock outcrop: 25 percent

Description of Encierro

Setting

Landform: Ridges, hillslopes
Landform position (two-dimensional): Backslope, shoulder, summit, footslope
Landform position (three-dimensional): Side slope, head slope, riser
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Mixed alluvium and/or colluvium derived from igneous, metamorphic and sedimentary rock

Properties and qualities

Slope: 15 to 35 percent
Depth to restrictive feature: 8 to 20 inches to lithic bedrock

Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline to strongly saline (0.0 to 20.0 mmhos/cm)
Sodium adsorption ratio, maximum: 1.0
Available water capacity: Very low (about 1.3 inches)

Interpretive groups
Land capability (nonirrigated): 7s
Ecological site: Hills (R038XB103NM)

Typical profile
0 to 2 inches: Gravelly loam
2 to 9 inches: Gravelly clay
9 to 13 inches: Bedrock

Description of Rock Outcrop

Properties and qualities
Slope: 15 to 35 percent
Depth to restrictive feature: 0 inches to lithic bedrock
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to high (0.06 to 1.98 in/hr)

Interpretive groups
Land capability (nonirrigated): 8s

Typical profile
0 to 60 inches: Bedrock

15—Gaddes-Santa Fe-Rock outcrop complex, 15 to 45 percent slopes

Map Unit Setting
Elevation: 4,000 to 8,000 feet
Mean annual precipitation: 12 to 16 inches
Mean annual air temperature: 46 to 57 degrees F
Frost-free period: 120 to 180 days

Map Unit Composition
Gaddes and similar soils: 55 percent
Rock outcrop: 15 percent
Santa fe and similar soils: 15 percent

Description of Gaddes

Setting
Landform: Alluvial fans, hillslopes, terraces
Landform position (two-dimensional): Shoulder, footslope
Landform position (three-dimensional): Head slope, side slope, tread, riser, rise

Down-slope shape: Linear, convex
Across-slope shape: Linear, convex
Parent material: Mixed alluvium and/or colluvium derived from igneous, metamorphic and sedimentary rock

Properties and qualities

Slope: 15 to 35 percent
Depth to restrictive feature: 20 to 40 inches to paralithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum: 1.0
Available water capacity: Very low (about 2.4 inches)

Interpretive groups

Land capability (nonirrigated): 6e
Ecological site: Hills (R038XB103NM)

Typical profile

0 to 2 inches: Gravelly sandy loam
2 to 22 inches: Gravelly sandy clay loam
22 to 26 inches: Bedrock

Description of Santa Fe

Setting

Landform: Hillslopes, mountain slopes
Landform position (two-dimensional): Footslope, shoulder, backslope
Landform position (three-dimensional): Center third of mountainflank, lower third of mountainflank, upper third of mountainflank, head slope, side slope
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Mixed alluvium and/or colluvium derived from igneous, metamorphic and sedimentary rock

Properties and qualities

Slope: 15 to 45 percent
Depth to restrictive feature: 8 to 20 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum: 1.0
Available water capacity: Very low (about 1.7 inches)

Interpretive groups

Land capability (nonirrigated): 7e
Ecological site: Hills (R038XB103NM)

Typical profile

0 to 2 inches: Gravelly sandy loam

2 to 18 inches: Very gravelly clay loam
18 to 22 inches: Bedrock

Description of Rock Outcrop

Properties and qualities
Slope: 15 to 45 percent
Depth to restrictive feature: 0 inches to lithic bedrock
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)

Interpretive groups
Land capability (nonirrigated): 8s

Typical profile
0 to 60 inches: Bedrock

21—Jonale sandy clay loam, 15 to 35 percent slopes

Map Unit Setting
Elevation: 5,000 to 6,000 feet
Mean annual precipitation: 12 to 16 inches
Mean annual air temperature: 52 to 55 degrees F
Frost-free period: 150 to 180 days

Map Unit Composition
Jonale and similar soils: 100 percent

Description of Jonale

Setting
Landform: Hillslopes
Landform position (two-dimensional): Shoulder, footslope
Landform position (three-dimensional): Head slope, side slope, riser
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Mixed alluvium and/or colluvium derived from igneous, metamorphic and sedimentary rock

Properties and qualities
Slope: 15 to 35 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 40 percent
Gypsum, maximum content: 2 percent

Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum: 2.0
Available water capacity: High (about 9.5 inches)

Interpretive groups
Land capability (nonirrigated): 7e
Ecological site: Breaks (R038XB105NM)

Typical profile
0 to 10 inches: Sandy clay loam
10 to 60 inches: Sandy clay loam

39—Oro Grande-Rock outcrop complex, 5 to 15 percent slopes

Map Unit Setting
Elevation: 5,700 to 7,000 feet
Mean annual precipitation: 12 to 16 inches
Mean annual air temperature: 45 to 57 degrees F
Frost-free period: 150 to 180 days

Map Unit Composition
Oro grande and similar soils: 65 percent
Rock outcrop: 20 percent

Description of Oro Grande

Setting
Landform: Hills, mountain slopes
Landform position (two-dimensional): Toeslope, backslope, footslope, shoulder
Landform position (three-dimensional): Lower third of mountainflank, upper third of mountainflank, center third of mountainflank, crest, nose slope, side slope, head slope
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Residuum weathered from limestone

Properties and qualities
Slope: 5 to 15 percent
Depth to restrictive feature: 7 to 20 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to high (0.06 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 14 percent
Gypsum, maximum content: 3 percent
Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum: 2.0
Available water capacity: Very low (about 1.2 inches)

Interpretive groups
Land capability (nonirrigated): 7s

Ecological site: Gravelly (R038XB102NM)

Typical profile

0 to 9 inches: Very cobbly loam
9 to 13 inches: Very cobbly loam
13 to 17 inches: Bedrock

Description of Rock Outcrop

Properties and qualities

Slope: 5 to 15 percent
Depth to restrictive feature: 0 inches to lithic bedrock
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to high (0.06 to 1.98 in/hr)

Interpretive groups

Land capability (nonirrigated): 8s

Typical profile

0 to 60 inches: Bedrock

40—Oro Grande-Rock outcrop complex, 25 to 75 percent slopes

Map Unit Setting

Elevation: 5,700 to 7,000 feet
Mean annual precipitation: 12 to 16 inches
Mean annual air temperature: 45 to 57 degrees F
Frost-free period: 150 to 180 days

Map Unit Composition

Oro grande and similar soils: 40 percent
Rock outcrop: 30 percent

Description of Oro Grande

Setting

Landform: Hills, mountain slopes
Landform position (two-dimensional): Shoulder, toeslope, backslope, footslope
Landform position (three-dimensional): Upper third of mountainflank, center third of mountainflank, lower third of mountainflank, head slope, crest, nose slope, side slope
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Residuum weathered from limestone

Properties and qualities

Slope: 25 to 75 percent
Depth to restrictive feature: 7 to 20 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to high (0.06 to 1.98 in/hr)
Depth to water table: More than 80 inches

Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 14 percent
Gypsum, maximum content: 2 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 4.0 mmhos/cm)
Sodium adsorption ratio, maximum: 1.0
Available water capacity: Very low (about 1.1 inches)

Interpretive groups

Land capability (nonirrigated): 7e
Ecological site: Hills (R038XB103NM)

Typical profile

0 to 8 inches: Very cobbly loam
8 to 12 inches: Very cobbly loamy sand
12 to 16 inches: Bedrock

Description of Rock Outcrop

Properties and qualities

Slope: 25 to 75 percent
Depth to restrictive feature: 0 inches to lithic bedrock
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to high (0.06 to 1.98 in/hr)

Interpretive groups

Land capability (nonirrigated): 8s

Typical profile

0 to 60 inches: Bedrock

44—Paymaster-Ellicott complex, 1 to 3 percent slopes

Map Unit Setting

Elevation: 5,000 to 7,000 feet
Mean annual precipitation: 12 to 16 inches
Mean annual air temperature: 46 to 57 degrees F
Frost-free period: 120 to 180 days

Map Unit Composition

Paymaster and similar soils: 50 percent
Ellicott and similar soils: 35 percent

Description of Paymaster

Setting

Landform: Alluvial fans, flood plains
Landform position (three-dimensional): Rise, talf
Down-slope shape: Linear
Across-slope shape: Linear, convex
Parent material: Mixed alluvium and/or residuum weathered from sandstone and shale

Properties and qualities

Slope: 1 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: Rare
Frequency of ponding: None
Calcium carbonate, maximum content: 2 percent
Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum: 3.0
Available water capacity: Moderate (about 7.0 inches)

Interpretive groups

Land capability classification (irrigated): 2e
Land capability (nonirrigated): 6e
Ecological site: Loamy (R038XB104NM)

Typical profile

0 to 10 inches: Fine sandy loam
10 to 35 inches: Sandy loam
35 to 60 inches: Extremely gravelly loamy sand

Description of Ellicott

Setting

Landform: Alluvial fans, terraces
Landform position (three-dimensional): Side slope, tread, riser, rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Mixed alluvium derived from igneous and sedimentary rock

Properties and qualities

Slope: 1 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Capacity of the most limiting layer to transmit water (Ksat): High to very high (6.00 to 20.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: Frequent
Frequency of ponding: None
Calcium carbonate, maximum content: 2 percent
Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum: 3.0
Available water capacity: Low (about 4.1 inches)

Interpretive groups

Land capability (nonirrigated): 7w
Ecological site: Sandy (R038XB110NM)

Typical profile

0 to 6 inches: Gravelly sand
6 to 60 inches: Coarse sand, sandy loam

46—Pits-Dumps association, extremely steep

Map Unit Composition

Dumps, mine: 45 percent
Pits: 45 percent

Description of Pits

Setting

Landform: Hillslopes, flats
Landform position (two-dimensional): Footslope, shoulder
Landform position (three-dimensional): Head slope, side slope, riser, talf
Down-slope shape: Convex, concave
Across-slope shape: Convex, concave
Parent material: Mixed alluvium and/or colluvium derived from igneous, metamorphic and sedimentary rock

Properties and qualities

Slope: 3 to 75 percent
Depth to restrictive feature: 0 inches to lithic bedrock
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to high (0.06 to 1.98 in/hr)

Interpretive groups

Land capability (nonirrigated): 8s

Typical profile

0 to 60 inches: Bedrock

Description of Dumps, Mine

Setting

Landform: Hillslopes, flats
Landform position (two-dimensional): Shoulder, footslope
Landform position (three-dimensional): Head slope, side slope, riser, talf
Down-slope shape: Convex, concave
Across-slope shape: Convex, concave
Parent material: Mixed alluvium and/or colluvium derived from igneous, metamorphic and sedimentary rock

Interpretive groups

Land capability (nonirrigated): 8s

Typical profile

0 to 60 inches: Fragmental material

57—Sampson-Dagflat complex, 3 to 12 percent slopes

Map Unit Setting

Elevation: 4,500 to 7,000 feet
Mean annual precipitation: 14 to 17 inches
Mean annual air temperature: 45 to 52 degrees F
Frost-free period: 120 to 180 days

Map Unit Composition

Sampson and similar soils: 50 percent
Dagflat and similar soils: 30 percent

Description of Sampson

Setting

Landform: Alluvial fans, flood plains
Landform position (three-dimensional): Rise, talf
Down-slope shape: Linear
Across-slope shape: Linear, convex
Parent material: Mixed alluvium and/or residuum weathered from sandstone and shale

Properties and qualities

Slope: 3 to 9 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 14 percent
Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum: 1.0
Available water capacity: High (about 10.2 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability (nonirrigated): 4e
Ecological site: Loamy (R038XB104NM)

Typical profile

0 to 1 inches: Loamy sand
1 to 45 inches: Sandy clay loam
45 to 60 inches: Sandy clay loam

Description of Dagflat

Setting

Landform: Hillslopes, plains
Landform position (two-dimensional): Shoulder, footslope
Landform position (three-dimensional): Side slope, head slope, riser, rise

Down-slope shape: Convex, linear
Across-slope shape: Convex, linear
Parent material: Mixed alluvium and/or colluvium derived from igneous, metamorphic and sedimentary rock

Properties and qualities

Slope: 3 to 12 percent
Depth to restrictive feature: 20 to 40 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum: 1.0
Available water capacity: Low (about 4.6 inches)

Interpretive groups

Land capability (nonirrigated): 7s
Ecological site: Loamy (R038XB104NM)

Typical profile

0 to 8 inches: Loam
8 to 31 inches: Sandy clay loam
31 to 35 inches: Bedrock

60—Santa Fe-Rock outcrop complex, 20 to 45 percent slopes

Map Unit Setting

Elevation: 5,500 to 8,000 feet
Mean annual precipitation: 12 to 16 inches
Mean annual air temperature: 46 to 55 degrees F
Frost-free period: 125 to 180 days

Map Unit Composition

Santa fe and similar soils: 55 percent
Rock outcrop: 25 percent

Description of Santa Fe

Setting

Landform: Hillslopes, mountain slopes
Landform position (two-dimensional): Shoulder, footslope, backslope
Landform position (three-dimensional): Upper third of mountainflank, center third of mountainflank, lower third of mountainflank, head slope, side slope
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Mixed alluvium and/or colluvium derived from igneous, metamorphic and sedimentary rock

Properties and qualities

Slope: 20 to 45 percent
Depth to restrictive feature: 8 to 20 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 1.0 mmhos/cm)
Sodium adsorption ratio, maximum: 1.0
Available water capacity: Very low (about 1.5 inches)

Interpretive groups

Land capability (nonirrigated): 7e
Ecological site: Hills (R038XB103NM)

Typical profile

0 to 2 inches: Gravelly sandy loam
2 to 16 inches: Very gravelly clay loam
16 to 20 inches: Bedrock

Description of Rock Outcrop

Properties and qualities

Slope: 20 to 45 percent
Depth to restrictive feature: 0 inches to lithic bedrock
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)

Interpretive groups

Land capability (nonirrigated): 8s

Typical profile

0 to 60 inches: Bedrock

63—Santana-Rock outcrop complex, 1 to 25 percent slopes

Map Unit Setting

Elevation: 5,000 to 7,000 feet
Mean annual precipitation: 12 to 16 inches
Mean annual air temperature: 52 to 55 degrees F
Frost-free period: 150 to 180 days

Map Unit Composition

Santana and similar soils: 45 percent
Rock outcrop: 40 percent

Description of Santana

Setting

Landform: Ridges, hillslopes
Landform position (two-dimensional): Shoulder, summit, backslope, footslope
Landform position (three-dimensional): Side slope, head slope, riser
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Mixed alluvium and/or colluvium derived from igneous, metamorphic and sedimentary rock

Properties and qualities

Slope: 1 to 25 percent
Depth to restrictive feature: 4 to 18 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 7 percent
Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum: 1.0
Available water capacity: Very low (about 1.9 inches)

Interpretive groups

Land capability (nonirrigated): 7s
Ecological site: Hills (R038XB103NM)

Typical profile

0 to 8 inches: Loam
8 to 12 inches: Loam
12 to 16 inches: Bedrock

Description of Rock Outcrop

Properties and qualities

Slope: 1 to 25 percent
Depth to restrictive feature: 0 inches to lithic bedrock
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)

Interpretive groups

Land capability (nonirrigated): 8s

Typical profile

0 to 60 inches: Bedrock

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Soil Types

Soil Map Unit Number and Name		Rating	Undeveloped CN
13	Encierro-Rock Outcrop Complex	D	80
15	Gaddes-Santa Fe-Rock Outcrop Complex	C	73
21	Jonale sandy clay loam	B	58
40	Oro Grande-Rock Outcrop Complex	D	80
57	Sampson-Dagflat Complex	B	58
60	Santa Fe-Rock Outcrop Complex	D	80
63	Santana-Rock Outcrop Complex	D	80

Table 3-1 — Runoff Curve Numbers for Arid and Semiarid Rangelands[1]
Source: USDA SCS, TR-55, 1986

Cover Description		Curve Numbers for Hydrologic Soil Group –			
Cover Type	Hydrologic Condition[2]	A[3]	B	C	D
Herbaceous—mixture of grass, weeds, and	Poor		80	87	93
low growing brush, with brush the	Fair		71	81	89
minor element.	Good		62	74	85
Oak–aspen—mountain brush mixture of oak	Poor				
brush,	Fair		66	74	79
aspen, mountain mahogany, bitter brush, maple,	Good		48	57	63
and other brush.			30	41	48
Piñon, juniper, or both; grass understory.	Poor		75	85	89
	Fair		58	73	80
	Good		41	61	71
Sagebrush with grass understory.	Poor		67	80	85
	Fair		51	63	70
	Good		35	47	55
Desert shrub—major plants include saltbush,	Poor	63	77	85	88
greasewood, creosotebush, blackbrush, bursage,	Fair	55	72	81	86
palo verde, mesquite, and cactus.	Good	49	68	79	84

CN NUMBER

BASIN NAME	SOIL	%	SOIL TYPE	CN	TOTAL
HC	40	50	D	80	
	15	10	C	73	
	60	40	D	80	79
2	60	60	D	80	
	15	30	C	73	
	40	10	D	80	78
3	60	60	D	80	
	15	40	C	73	77
4	60	45	D	80	
	15	10	C	73	
	40	30	D	80	
	63	15	D	80	79
5	60	45	D	80	
	40	45	D	80	
	63	5	D	80	
	15	5	C	73	80
6	40	90	D	80	
	15	10	C	73	79
SC	21	30	B	58	
	60	10	D	80	
	40	55	D	80	
	15	5	C	73	73
8	40	75	D	80	
	15	5	C	73	
	60	15	D	80	
	21	5	B	58	79
9	40	50	D	80	
	60	50	D	80	80
10	40	70	D	80	
	60	30	D	80	80
11	40	55	D	80	
	13	45	D	80	80
TH	40	30	D	80	
	13	40	D	80	
	57	10	B	58	
	60	20	D	80	78

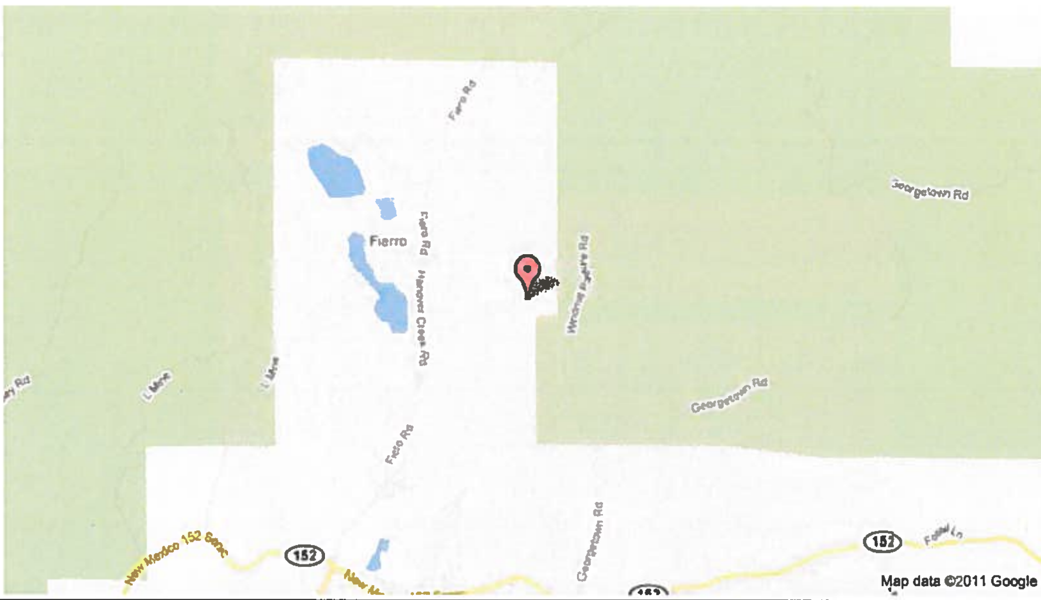
To find the latitude and longitude of a point **Click** on the map, **Drag** the marker, or enter the...

Address: 123 Street, City State/Country Go

Map Center: Get Address - Land Plat Size - Street View - Google Earth 3D - Area Photographs

Try out the Google Earth Plug-in. Google Earth gives you a 3D look of the area around the center of the map, which is usually your last click point, and includes latitude, longitude and elevation information.

Latitude and Longitude of a Point



Note: Right click on a **blue marker** to remove it.

Clear/Reset All Markers | Center Red Marker

Get the Latitude and Longitude of a Point

When you click on the map, move the marker or enter an address the latitude and longitude coordinates of the point are inserted in the boxes below.

Latitude:	32.839212199942395
Longitude:	-108.06581497192383

	Degrees	Minutes	Seconds
Latitude:	32	50	21.1632
Longitude:	-108	3	56.934

Show Point from Latitude and Longitude

Use this if you know the latitude and longitude coordinates of a point and want to see where on the map the point is.

Use: **+** for *N* Lat or *E* Long **-** for *S* Lat or *W* Long.
Example: +40.689060 -74.044636
Note: Your entry should not have any embedded spaces.

Decimal Deg. Latitude:

Decimal Deg. Longitude:

Show Point

Example: **+34 40 50.12** for *34N 40' 50.12"*

	Degrees	Minutes	Seconds
Latitude:			
Longitude:			

Show Point

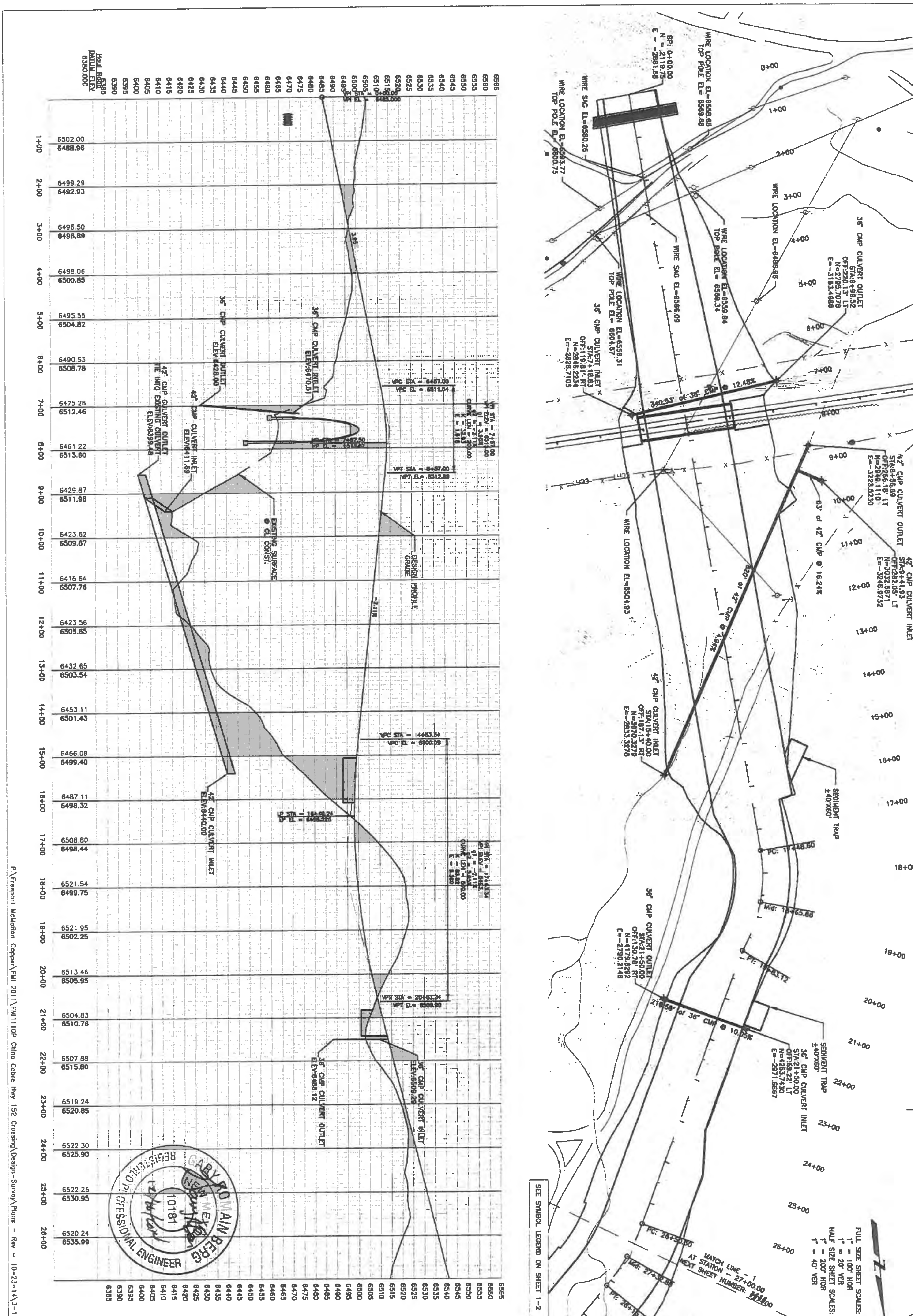
Precipitation Frequency Data Output

NOAA Atlas 2
New Mexico 32.8392131999°N 108.065814971923°W
Site-specific Estimates

Map	Precipitation (inches)	Precipitation Intensity (in/hr)
2-year 6-hour	1.31	0.22
2-year 24-hour	1.66	0.07
100-year 6-hour	3.09	0.52
100-year 24-hour	3.82	0.16

Hydrometeorological Design Studies Center - NOAA/National Weather Service
1325 East-West Highway - Silver Spring, MD 20910 - (301) 713-1669
Sun Aug 28 14:41:59 2011

ATTACHMENT 1



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DATE 8/30/11
JOB # FMI110P
DWG. BY TMILLER

REVISIONS
3/05/2012
9/06/2012
9/18/2012
12/19/2012
05/22/13 EJN
03/20/14 TM

PROJECT

CHINO/COBRE HWY 152 AND THE USFS ROAD CROSSING

GRANT COUNTY, NEW MEXICO

ENGINEERS INC

301 W. COLLEGE AVE. SUITE 1 SILVER CITY, NEW MEXICO 88061

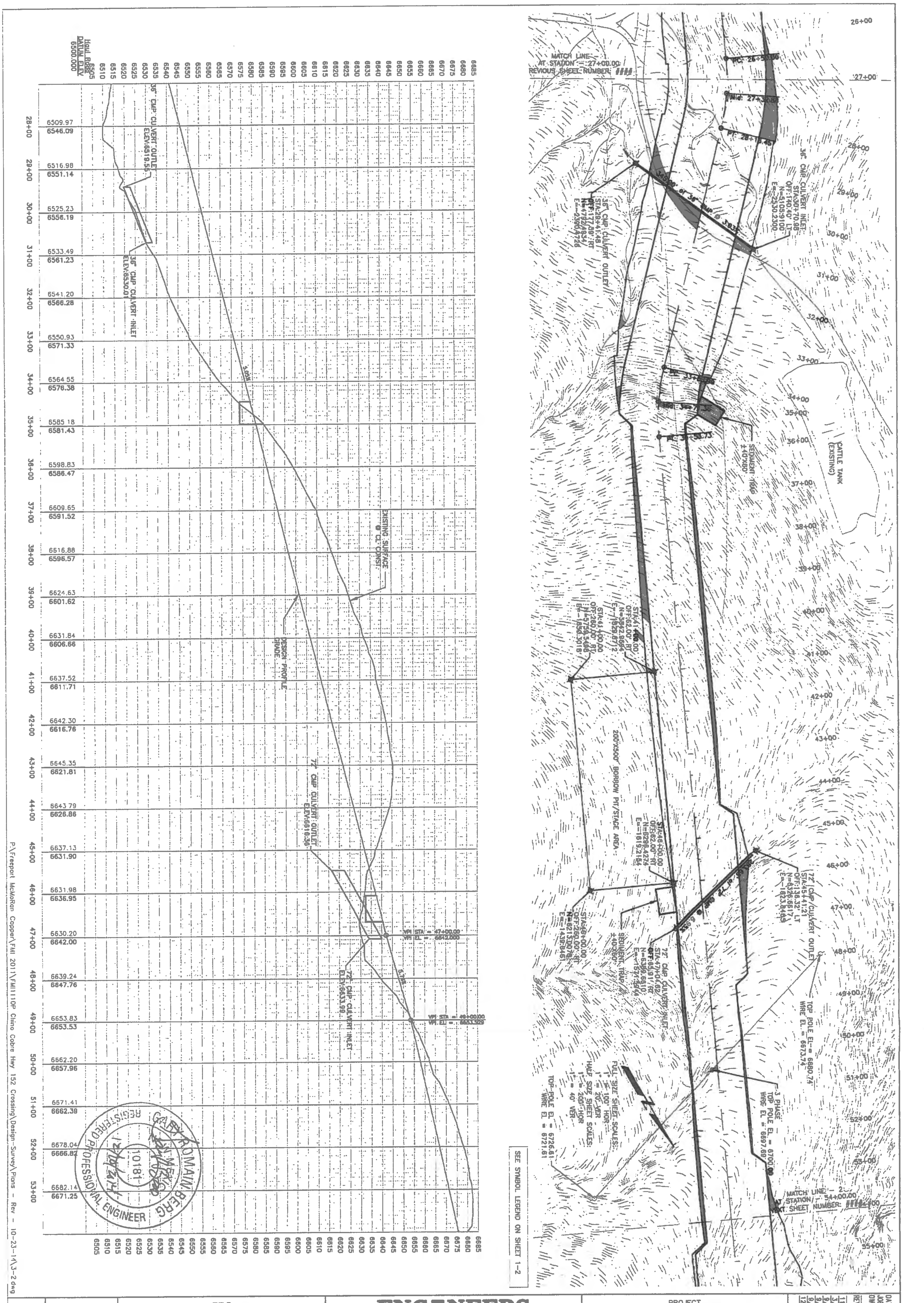
(575) 538-5395 (OFFICE) (575) 538-5410 (FAX)

TITLE

PLAN AND PROFILE SHEET
STA 0+00.00 TO 27+00.00

(SEAL)

SHEET
3-1



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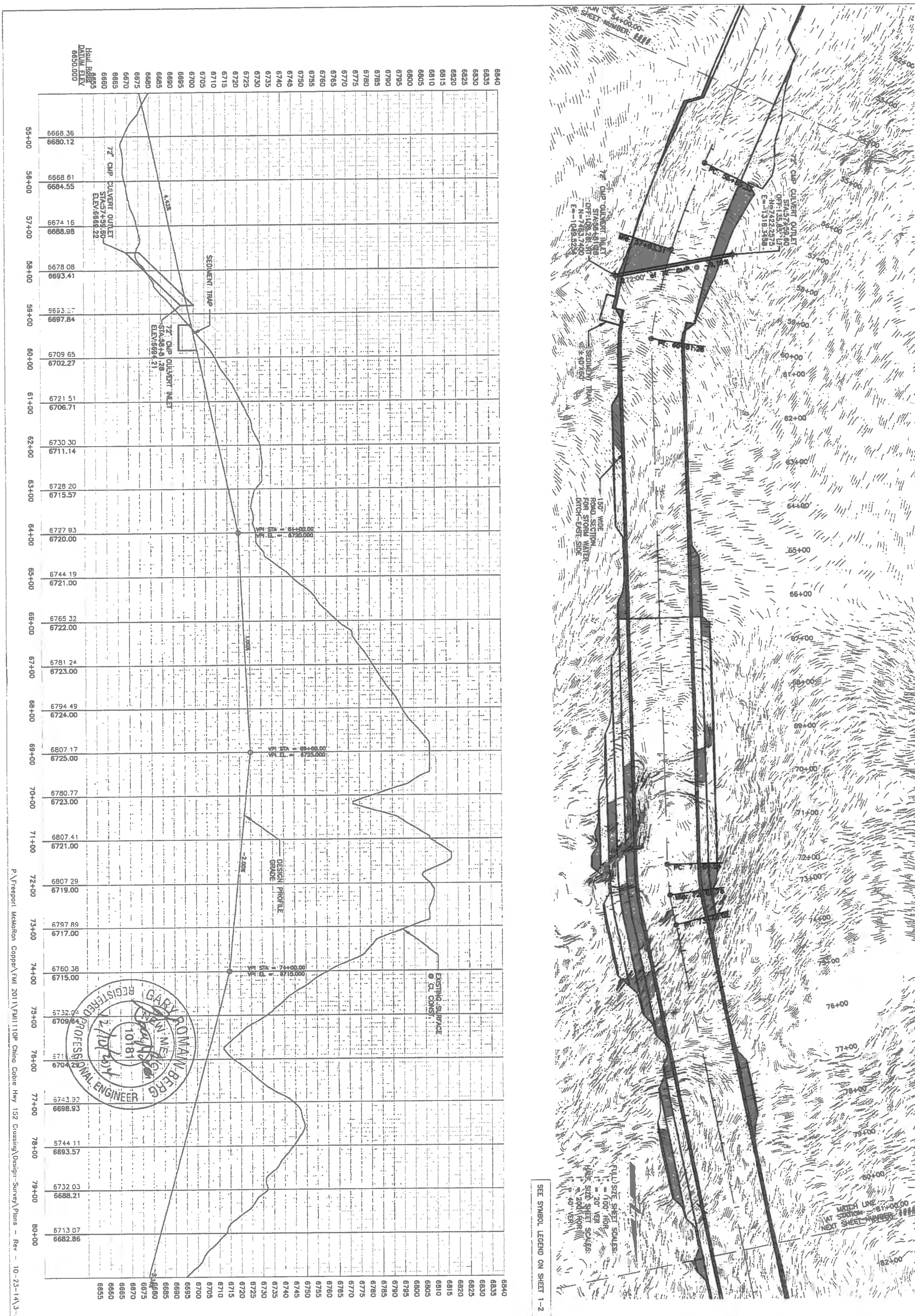

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DATE 8/30/11
JOB # FM1110P
DWG. BY: TMILLER

REVISIONS
3/05/2012
9/06/2012
9/18/2012
12/28/2012
11/20/2014 DMT

PROJECT

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TITLE

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STA 81+00.00 TO 108+00.00

(SEAL)

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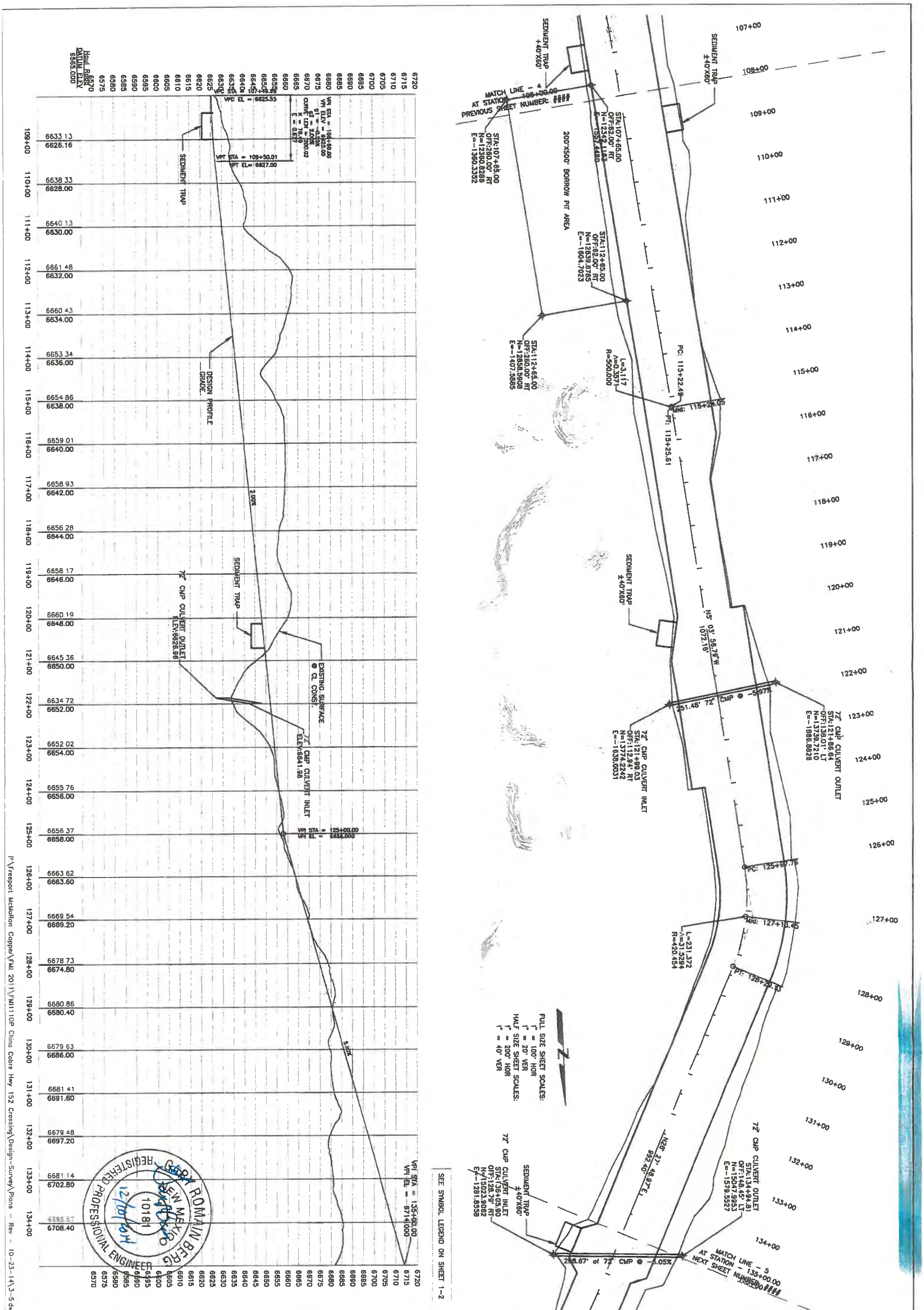

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(SEAL)

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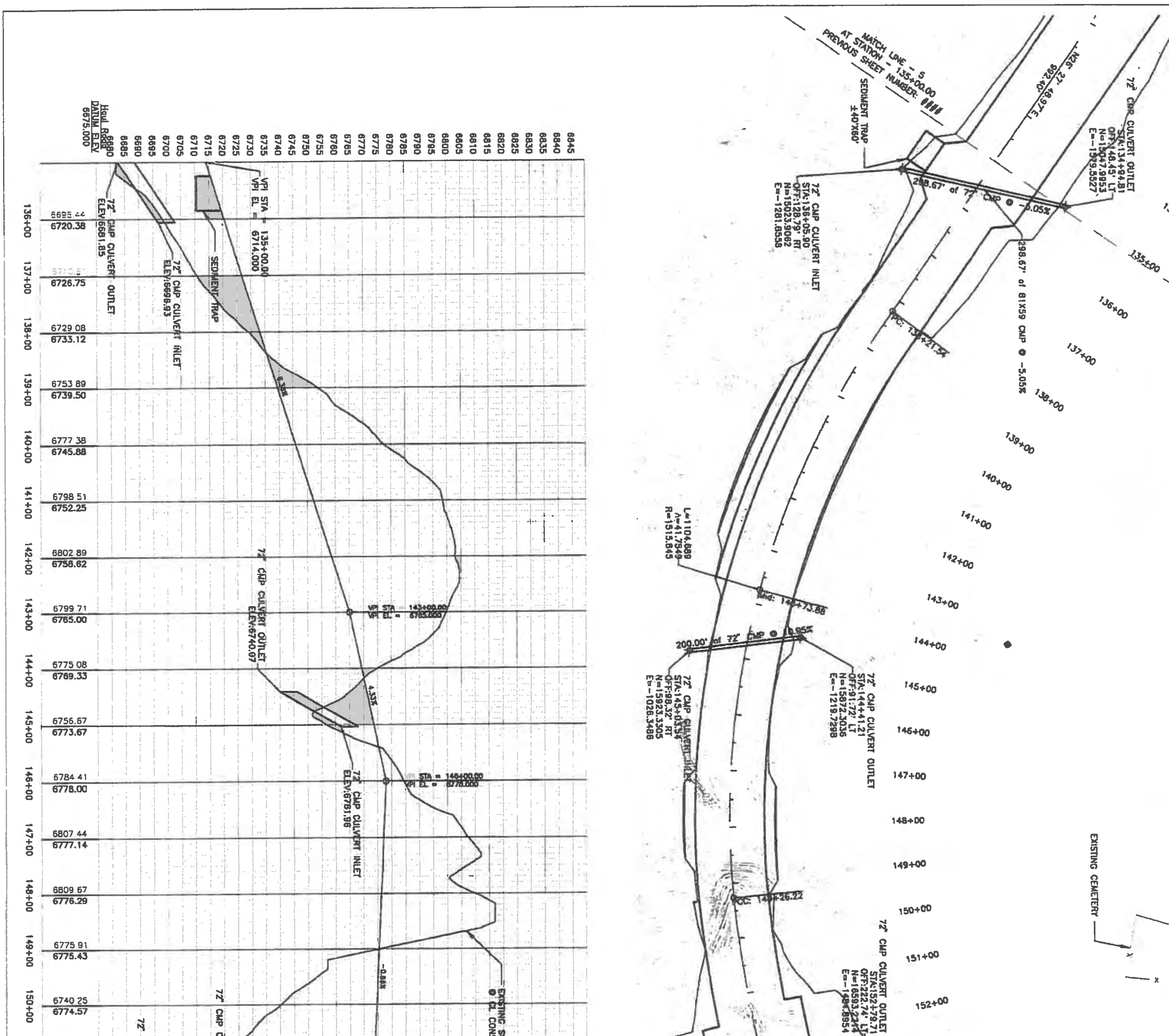

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	9/20/2012
	9/25/2012
	12/20/2012
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PROJECT

CHINO/COBRE HWY 152 AND THE USFS ROAD CROSSING

GRANT COUNTY, NEW MEXICO

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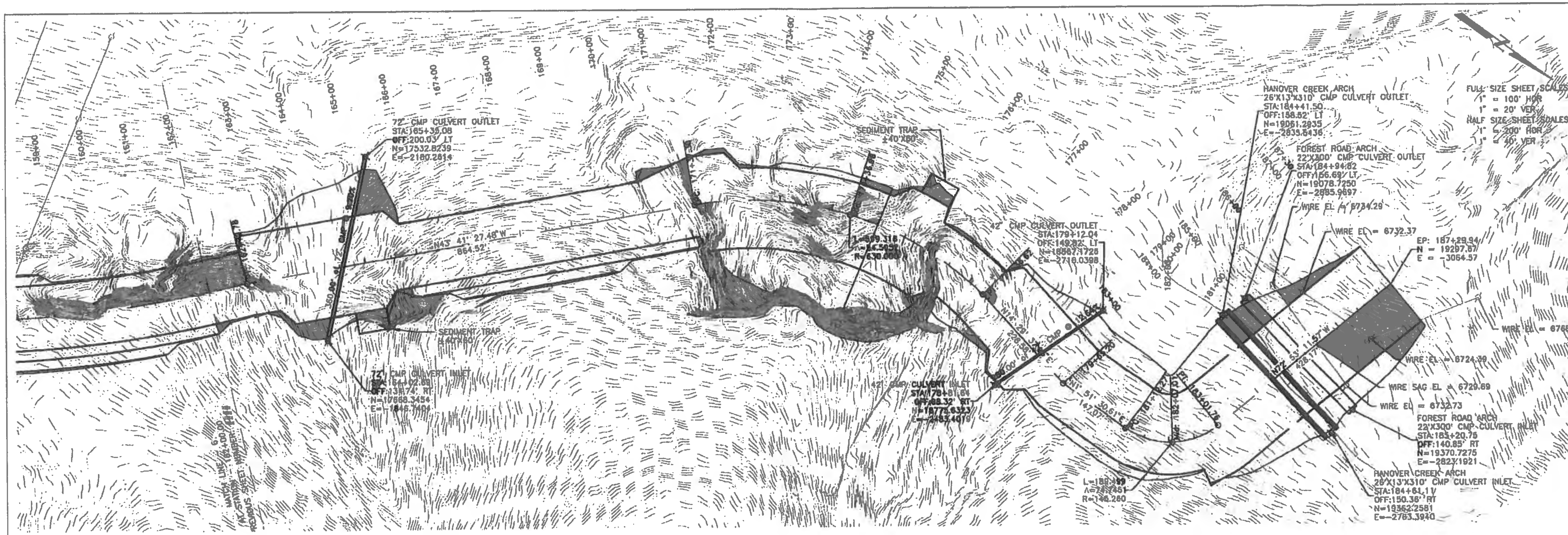
TITLE

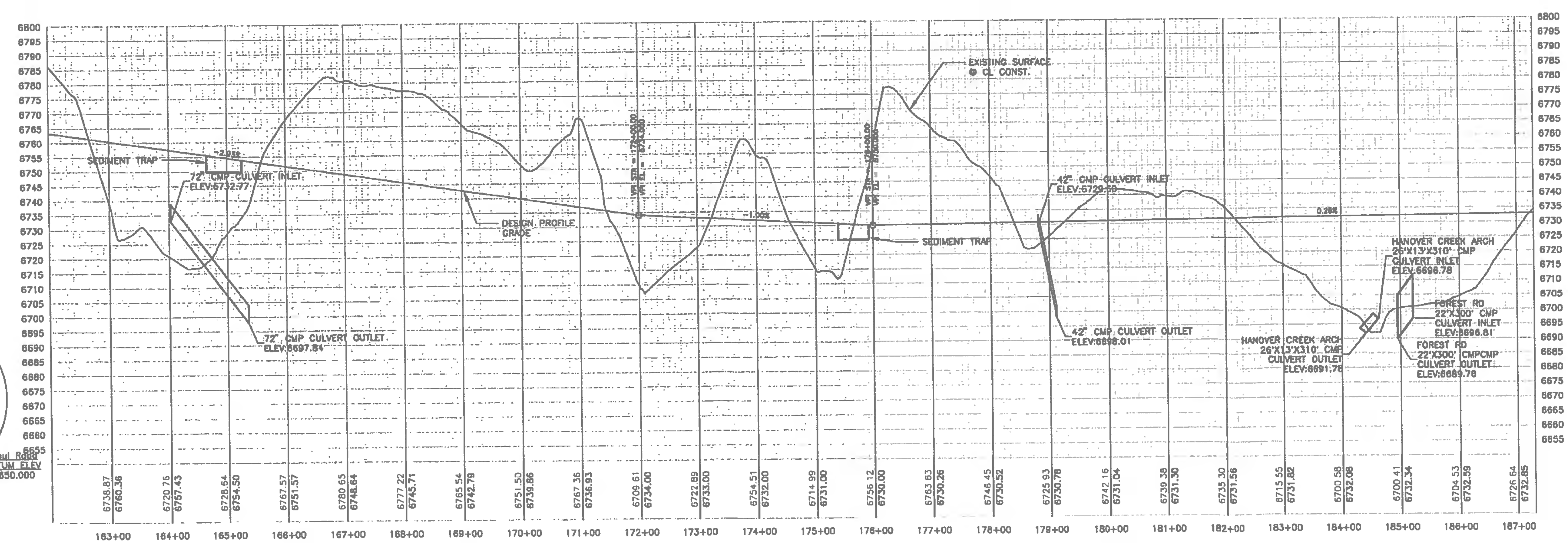
PLAN AND PROFILE SHEET
STA 135+00.00 TO 162+00.00

(SEAL)

SHEET 3-6



SEE SYMBOL LEGEND ON SHEET 1-2



GARY ROMAIN BERG
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10181
12/10/2014
REGISTERED PROFESSIONAL ENGINEER

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DATE	8/30/11
JOB #	FMI1110P
DWG. BY	TMILLER

REVISIONS
3/05/2012
9/06/2012
9/20/2012
9/25/2012
12/20/2012
11/14/2014 ONT

PROJECT
CHINO/COBRE HWY 152 AND THE USFS ROAD CROSSING
GRANT COUNTY, NEW MEXICO

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TITLE
PLAN AND PROFILE SHEET
STA 162+00.00 TO 187+29.94

(SEAL)

SHEET
3-7

ATTACHMENT 2

November 20, 2015

CHINO COBRE HIGHWAY 152 AND THE USFS (FIERRO) ROAD CROSSING FINAL DRAINAGE REPORT
EI Project #FMI1110P

ENGINEERS INC

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Telephone: 575-538-5395
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11/20/2015

Revised NOVEMBER 2015

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Tables

Figures

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I. PROJECT DESCRIPTION

A mining haul road is proposed to be constructed from the Chino Mine to the Cobre Mine, north and east of Fierro, New Mexico. The haul road will cross over NM Highway 152 and the Forest Road. Engineers Inc. (E.I.) has been retained to provide preliminary alignment and design of the haul road including the necessary culverts at the drainage crossing. See Figure 1, *Site Description Map*.

A pre-fabricated BEBO Arch Bridge System by Contech or an approved equivalent is going to be constructed at the NM 152 crossing. At the Forest Road, along the east edge of Hanover Mountain, a 22'-0" diameter multi-plate culvert will be used for the haul road to cross over the Forest Road. These structures will be designed to carry traffic on the haul road while leaving access beneath along the existing roadways.

The haul road will cross over Hanover Creek at the northern end of the corridor. A 26'-0" x 13'-0" multi-plate arch will be used for the haul road to cross over Hanover Creek. The other drainage basins will be conveyed underneath the haul road using CMP culvert pipes.

II. RESOURCES

Resources used to prepare the storm water analysis were: USGS and FMI topographic maps, aerial photos, haul road improvement plans, precipitation data, soils information and an assessment of impervious areas to determine runoff coefficients. See Appendix B for key data sources used.

III. HYDROLOGIC PARAMETERS

Terrain – The proposed haul road is primarily located within private property near the Gila National Forest. The general topography of the project area is steep. High points in the area consist of Hanover Mountain, Fierro Hill, and Topknot Hill. The Snowflake Canyon is located near the middle of the length of the haul road.

Terrain slopes range from 5-10%. The general drainage pattern across the proposed haul road corridor is from the east to west. The Hanover Creek is the natural low point across the drainage. All drainage areas impacting the haul road are tributary to the Hanover Creek, though some intersect downstream of the project area.

The USGS topography was used for the basin hydrologic calculations with a contour interval of 40 feet. Also, two foot contours were provided by FMI for the Hanover Creek crossing area.

Method - The HEC-HMS program, using the SCS method, was selected to be used for the hydrologic analysis for the haul road crossings. CulvertMaster software, which relies upon well-accepted Federal Highway Administration algorithms, was used to analyze the proposed culverts under the haul road at drainage crossings. Proposed culvert sizing was verified according to "Hydraulic Charts for the Selection of Highway Culverts" U.S. Department of Commerce, Bureau of Public Roads. Appendix C provides the updated computations for the culvert diameters relative to the 100-year 24-hour rainfall event.

Tc (Time of Concentration) – Kirpich was used to develop Time of Concentration for each basin, based on data developed for each area.

FEMA Flood Zone – According to the U.S. Department of Housing and Urban Development, Federal Insurance Administration, the portion of the Hanover Creek that is crossed by the haul road is located within a designated flood zone. See the Flood Hazard Boundary Map, Figure 2, in the Appendix A.

IV. SUB-BASIN DESCRIPTIONS

The drainage basin sub-areas are shown on Figure 4. Basin HC drains south and west and is the headwaters of the Hanover Creek. The proposed haul road will cross Hanover Creek via an arch crossing. Basins 2-6 drain west to Culverts 2-6. Basin SC is within Snowflake Canyon and drains to Culvert SC. Basins 8-11 drain west to Culverts 8-11. Basin TH drains south and west from Topknot Hill to the existing culvert under Highway 152. This culvert has been extended northward to extend past the fill area required for the bridge crossing over Highway 152.

The sub-basin parameters and 2-, 25-, and 100-year, 24 hour peak flow rates results are shown below.

TABLE 1
DRAINAGE SUBBASINS AND COMPUTED STORM FLOWS

SUBBASIN	Area (acre)	CN Value	Tc (min)	24-hr 2-yr (cfs)	24-hr 25-yr (cfs)	24-hr 100-yr (cfs)
HC	872.5	79	22.7	158	704	1056
2	38.5	78	10.0*	11	53	80
3	45.3	77	10.0*	13	64	97
4	145.8	79	10.0*	37	174	262
5	42.7	80	10.0*	16	63	93
6	50.2	79	10.0*	18	75	111
SC	200.1	73	13.8	18	144	235
SC-1	17.9	73	10.0*	2	13	22
8	208.0	79	12.1	52	220	327
9	38.7	80	10.0*	17	64	94
10	46.7	80	10.0*	19	75	110
11	85.8	80	10.0*	30	123	182
TH	274.2	78	17.1	50	250	381
TH-1	8.0	78	10.0*	2	7	11
TH-2	7.0	78	10.0*	1	6	10
TH-3	11.7	78	10.0*	21	106	163

* Ten minutes is the minimum time of concentration for undeveloped conditions.

The flow to the haul road at each crossing was determined using HEC-HMS. The area that drains to each location is shown on Table 1. The rainfall depth for the 2-, 25-, and 100-year storm event is 1.66, 3.06, and 3.82 inches as shown below. The rainfall depths for the various storms were taken from the National Oceanic and Atmospheric Administration's NOAA Atlas 14 for the area between the Chino and Cobre Mines. The CN value for each sub-basin was calculated from the soil types and the cover type. See Appendix B.

TABLE 2
RAINFALL DEPTHS

Storm Event - Year	2	25	100
Rainfall	1.66	3.06	3.82

V. HYDRAULIC ANALYSIS

The results of the hydraulic calculations of the culverts are shown below in Table 3.

The location of Culvert #10 from the draft drainage report ended up being in a cut section where roadside ditches were widened to carry storm water flow away from the drainage.

During the course of the design of the 2011 project, three field reviews of the corridor were performed. In the course of those field reviews, ground conditions, including depths of canyons, other observed erosion conditions and constructability, were considered in adjusting both culvert diameters and lengths to those observed field conditions. As the result of the field reviews, both culvert diameter and length were generally increased relative to their originally calculated values. Assemblies of small diameter culverts were eliminated from the design due to considerations of high installation labor costs, difficulty of installation in deep arroyos and susceptibility to plugging by floating debris.

TABLE 3
CULVERT SUMMARY

CULVERT ID	Total Flow 100 Year Event (cfs)	Culvert Capacity (cfs) at Headwater Depth (ft.)		Culvert Locations & Dimensions
		Culvert Capacity (CFS)	Culvert Headwater Depth (ft)	
HC	1056	1056	1.3	Sta 184+51 – 26' x 13' x 310"
2	80	88	1.5	Stat 178+65 – 42" x 250'
3	97	396	1.9	Sta 164+02 – 72" x 300'
4	262	386	1.8	Sta 152+35 – 72" x 400'
5	93	283	1.3	Sta 144+85 – 72" x 205'
6	111	387	1.8	Sta 135+54 – 72" x 245'
SC	235	386	1.8	Sta 121+93 – 72" x 255'
SC-1	22	541	1.7	Sta 105+72 – 84" x 240'
8	327	407	2.0	Sta 98+66 – 72" x 350'
9	94	618	2.0	Sta 89+03 – 84" x 340'
10	110		N/A	Sta 76+00 – Cut Section. Roadside ditch drainage.
11	182	409	2.0	Sta 58+33 - 72" x 265'
TH-3	163	412	2.0	Sta 46+51 – 72" x 290'
TH-2	10	81	4.0	Sta 30+13 – 36" x 325'
TH-1	11	71	1.9	Sta 21+50 – 36" x 211'
TH	381	217	22.5	Sta 12+58 - 42" x 883'
Arch detour (Chino)				Sta 9+00 – Storm water drainage from detour area – 24" x 60', 24" x 72'
Hwy 152 arch (Chino)				Sta 7+11 - South ditch under Hwy 152 arch - 36" x 330'

VI. Hanover Creek

Hanover Creek is an ephemeral stream that the northern end of the haul road will cross over. The Forest Road runs approximately parallel to Hanover Creek. A 26' x 13' multi-plate arch culvert will be constructed over the existing streambed.

VII. Highway 152 Culvert

The existing 42" CMP culvert under Highway 152 is undersized to carry the 100-year peak flow rate of 381 cfs. Flow will back up to a depth of approximately 22.5 feet above the invert of the culvert. This culvert will be extended approximately 820 feet north to be outside of the fill area needed for the temporary traffic diversion of the highway. A tee to the west would also be constructed to capture storm water from an isolated area.

VIII. CONCLUSIONS\RECOMMENDATIONS

In order to provide proper drainage along the Chino Cobre Haul Road, the following drainage structures will need to be constructed with the roadway improvements:

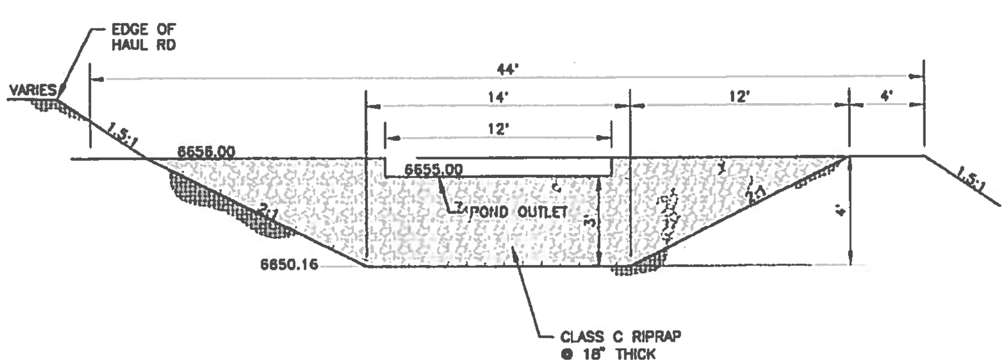
- Construct 36-inch, 42-inch, 72-inch and 84-inch corrugated metal pipe (CMP) culverts at fourteen (14) locations across the haul road. Entrance end sections will be constructed at every culvert crossing.
- Construct a 26' x 13' multi-plate arch culvert at the Hanover Creek crossing.
- Construct a 36-inch culvert in the Hwy 152 south ditch to carry storm water under the haul road fill.
- Construct 2 each 24-inch culverts in the Hwy 152 detour fill to carry storm water away from the highway traffic and construction areas.
- Storm water flow draining off of the haul road will be captured and passed through sediment basins prior to being released downstream.

ATTACHMENT 3

SEDIMENT POND – (TYPICAL)

FULL SCALE: 1" = 10'

NOTE: ALL SEDIMENT PONDS VARIES IN ELEVATIONS. CONTRACTOR TO VERIFY WITH PROJECT ENGINEERS.



SEDIMENT POND – SECTION (TYPICAL)

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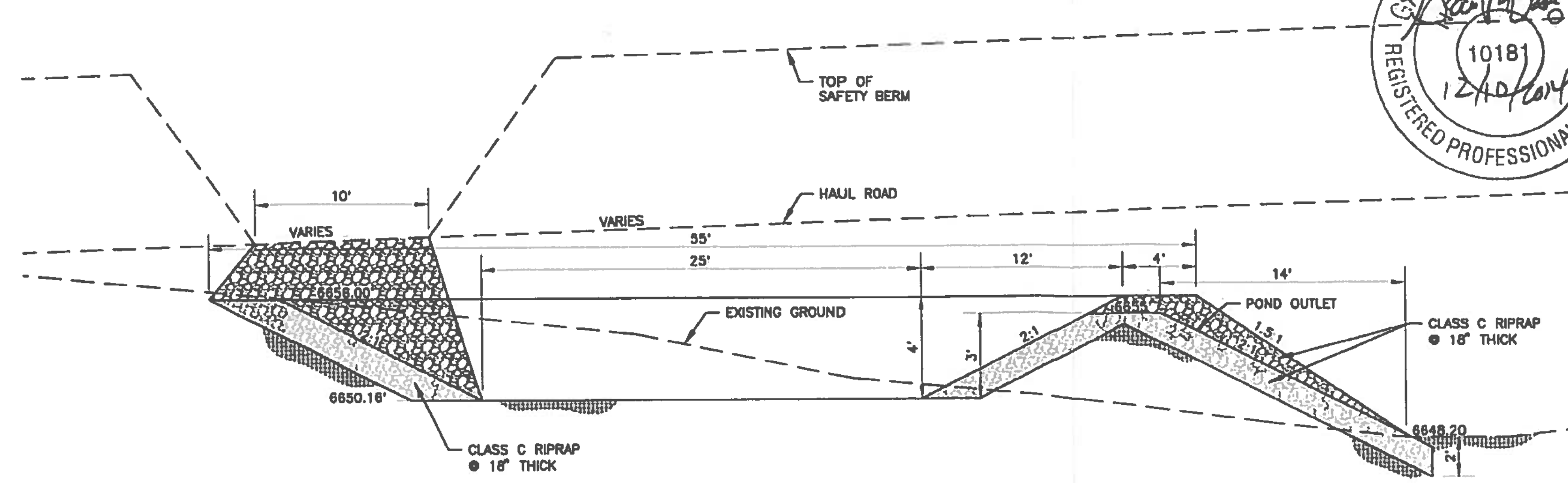

SEDIMENT POND – PROFILE (TYPICAL)

FULL SCALE: 1" = 5'

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GRANT COUNTY, NEW MEXICO

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TITLE
SEDIMENT POND &
SEDIMENT POND DETAILS

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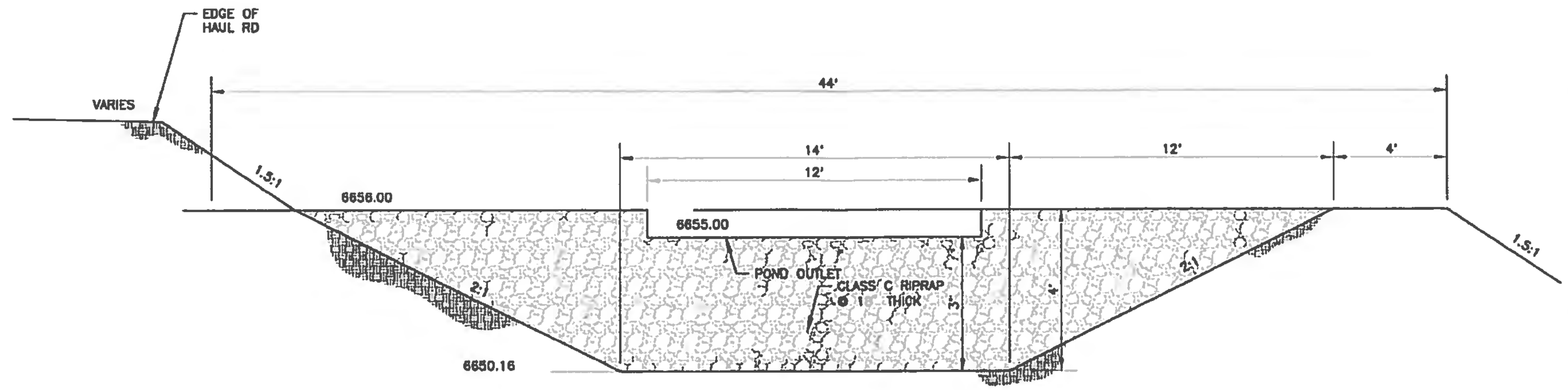
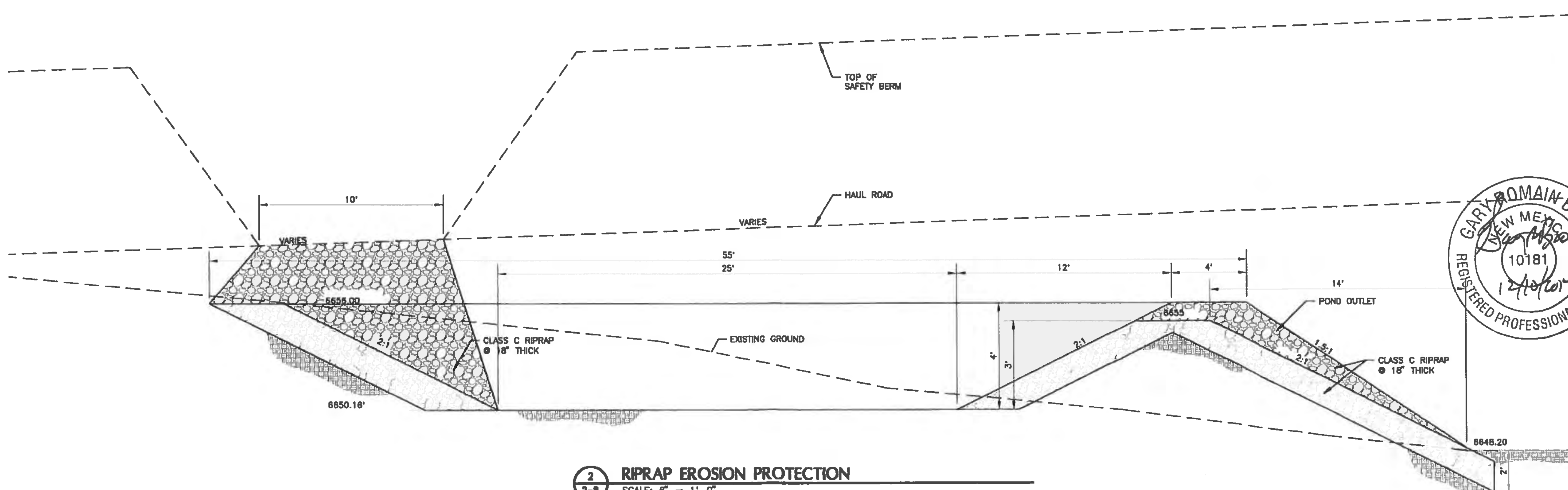


(1/2-8) RIPRAP EROSION PROTECTION
SCALE: 1" = 3'-0"



(2/2-8) RIPRAP EROSION PROTECTION
SCALE: 6" = 1'-0"

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SEDIMENT POND DETAILS

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