Appendix 1: Performance Bond Calculations

Table 1: Remaining bond after TCP, A9&10, and A11& 12 (Escalated to 2015 dollars, and Funds Reallocated)

Item #	Cost Category		Quantity	Rate		TOTAL
1	Grading - Worst Case Pits					$0
2	Grading - Spoils					$0
3	Acid & Toxic Material Management					$0
4	Topsoil Replacement	South Facilities (Ac)	234.1	$1,135	$265,704	$265,700
5	Revegetation	Total Disturbance (Ac)	4982.3	$822	$4,095,451	$4,095,451
6	Road Removal	Sourth Facilities (Ac)	7	$4,335	$30,345	$30,345
7	Sedimentation Pond Removal	Sourth Faciliites Ponds	2	$7,000	$14,000	$14,000
8	Earthmoving Support (For South Facilities)		$418,800	100%	$418,800	$418,800
9	Facility Removal		$1,053,000	100%	$1,053,000	$1,053,000
10	Hydrologic Structures					$0
	SUBTOTAL - Direct Costs					$5,877,296
11	Contractor Mobilization/Demobilization (1% of Subtotal)					$59,000
12	Supplemental Contingencies (3% of Subtotal)					$176,000
13	Engineering Design Fees (2.5% of Subtotal)					$147,000
14	Contractor's Profit and Overhead (15% of Subtotal)					$882,000
15	Project Management Fee (2.5% of Subtotal)					$147,000
	TOTAL Without Gross Receipts Tax					$7,288,296
	Gross Receipts Tax (2022 rate: 6.75%)				6.75%	$492,000
	TOTAL With Gross Receipts Tax (In 2000 Dollars)					$7,780,296
	Inflation rate Qtr-1 2000 to Qtr-4 2015	1.62046			Total Escalated to 2015 Dollars	$12,607,692
	Inflation Factors: Qtr-1 2000 & Qtr-4 2015	500.48	811.01			
	Supplemental Fund For Permit Modifications/Revisions/Misc					$10,887,226
	Total bond (After A11/12 PI Approval and Reduction)					**$23,494,918**

Table 2: Bond Escalated to 2022 Dollars

Item #	Cost Category		Quantity	Rate		TOTAL
1	Grading - Worst Case Pits					$0
2	Grading - Spoils					$0
3	Acid & Toxic Material Management					$0
4	Topsoil Replacement	South Facilities (Ac)	234.1	$1,135	$265,703.50	$265,700
5	Revegetation	Total Disturbance (Ac)	4982.3	$822	$4,095,451	$4,095,451
6	Road Removal	Sourth Facilities (Ac)	7	$4,335	$30,345	$30,345
7	Sedimentation Pond Removal	Sourth Faciliites Ponds	2	$7,000	$14,000	$14,000
8	Earthmoving Support (For South Facilities)		$418,800	100%	$418,800	$418,800
9	Facility Removal		$1,053,000	100%	$1,053,000	$1,053,000
10	Hydrologic Structures					$0
	SUBTOTAL - Direct Costs					$5,877,296
11	Contractor Mobilization/Demobilization (1% of Subtotal)					$59,000
12	Supplemental Contingencies (3% of Subtotal)					$176,000
13	Engineering Design Fees (2.5% of Subtotal)					$147,000
14	Contractor's Profit and Overhead (15% of Subtotal)					$882,000
15	Project Management Fee (2.5% of Subtotal)					$147,000
	TOTAL Without Gross Receipts Tax					$7,288,296
	Gross Receipts Tax (2022 rate: 6.75%)				6.75%	$492,000
	TOTAL With Gross Receipts Tax (In 2000 Dollars)					$7,780,296
	Inflation rate Qtr 4 2000 to Qtr-2 2022	2.02689		Total Escalated to 2022 Dollars		$15,769,804
	Inflation Factors: Qtr-4 2000 & Qtr-2 2022:	500.48	1014.42			
	Supplemental Fund For Permit Modifications/Revisions/Misc					$7,725,114
	Total bond (After A11/12 PI Approval and Reduction)					**$23,494,918**

Table 3: Bond After 9S PII and PIII in 2022 dollars

k	Cost Category		Quanity	Rate		TOTAL
		Area 9S Revegetation Reduction	1193	822	$980,646	
1	Grading - Worst Case Pits					$0
2	Grading - Spoils					$0
3	Acid & Toxic Material Management					$0
4	Topsoil Replacement	South Facilities (Ac)	234.1	$1,135	$265,703.50	$265,700
5	Revegetation	Total Disturbance (Ac)	4982.3	$822	$4,095,451	$3,114,805
6	Road Removal	Sourth Facilities (Ac)	7	$4,335	$30,345	$30,345
7	Sedimentation Pond Removal	Sourth Facilites Ponds	2	$7,000	$14,000	$14,000
8	Earthmoving Support (For South facilities)		$418,800	100%	$418,800	$418,800
9	Facility Removal		$1,053,000	100%	$1,053,000	$1,053,000
10	Hydrologic Structures		$266,600	0%	$0	$0
	SUBTOTAL - Direct Costs					$4,896,650
11	Contractor Mobilization/Demobilization (1% of Subtotal)					$49,000
12	Supplemental Contingencies (3% of Subtotal)					$147,000
13	Engineering Design Fees (2.5% of Subtotal)					$122,000
14	Contractor's Profit and Overhead (15% of Subtotal)					$734,000
15	Project Management Fee (2.5% of Subtotal)					$122,000
	TOTAL Without Gross Receipts Tax					$6,070,650
	Gross Receipts Tax (2022 rate: 6.75%)				6.75%	$410,000
	TOTAL With Gross Receipts Tax (In 2000 Dollars)					$6,480,650
		Inflation rate Qtr 4 2000 to Qtr-2 2022	2.02689		Total inflated to 2022 Dollars	$13,135,565
		Inflation Factors: Qtr-4 2000 & Qtr-2 2022	500.48	1014.42		
	Supplemental Fund For Permit Modifications/Revisions/Misc					$7,725,114
	Total bond					**$20,860,679**

Appendix 2: Surface and Mineral Rights Owners of Lands

Chevron Mining Inc - McKinley Mine
Permit 2016-02
Area 9S Bond Release Application
Surface and Mineral Rights Owners of Lands

Area	Township and Range	Section	Phase I Acres	Phase II Acres	Phase III Acres	Surface Ownership	Allotment Numbers	Right of Entry	Mineral Rights Ownership	Right to Mine
9S	T16N, R20W	15	0.0	23.9	23.9	Westbrook		Lease	PNRC	Lease
		15	0.0	23.7	23.7	Chevron USA, Inc.		Fee Land	PNRC	Lease
		16	1.2	60.0	60.0	BIA	1592	Lease	BLM	Lease
		16	1.8	1.8	1.8	BIA	1593	Lease	BLM	Lease
		16	24.5	25.0	25.0	BIA	1594	Lease	BLM	Lease
		16	2.5	8.0	8.0	BIA	1595	Lease	BLM	Lease
		21	1.1	235.8	235.8	Chevron USA, Inc.		Fee Land	PNRC	Lease
		22	0.0	161.2	161.2	BIA	1581	Lease	BLM	Lease
		22	0.0	155.5	155.5	BIA	1582	Lease	BLM	Lease
		22	0.0	147.7	147.7	BIA	1583	Lease	BLM	Lease
		22	0.0	85.3	85.3	BLM		Lease	BLM	Lease
		23	0.0	104.4	104.4	Chevron USA, Inc.		Fee Land	PNRC	Lease
		26	5.9	41.6	41.6	BIA	1566	Lease	BLM	Lease
		27	3.3	77.8	77.8	Chevron USA, Inc.		Fee Land	PNRC	Lease
		28	1.7	41.3	41.3	BIA	1591	Lease	BLM	Lease
		Total	42.0	1193.0	1193.0					

Note: BIA is the Bureau of Indian Affairs, BLM is the Burearu of Land Management, and PNRC is the Peabody Natural Resources Company

Land Owner	Address
BIA	USDI, Bureau of Indian Affairs, P.O. Box 1060, Gallup, NM 87305
BLM	USDI, Bureau of Land Management, Farmington Field Office, 6251 College Blvd., Suite A, Farmington, NM 87402
Westbrook	Paula Westbrook Heirs, c/o Bruce Williams, 25 Roaad 5787, NBU 2010, Farmington, NM 87401
PNRC	Peabody Natural Resources Company, 701 Market St., Suite 718, St. Louis, MO 63101-1830
Chevron USA, Inc.	Chevron Mining Inc. 6101 Bollinger Canyon Road, San Ramon, CA 94583-2324

Appendix 3: Draft Notification Letter

Draft Notification Letter (Area 9S)

Date: August 12, 2022
Mr. John Doe
1000 John Doe Lane
City, NM Zip Code

Re: McKinley Mine Area 9S Bond Release Application
Permit No. 2016-02

Dear Mr. Doe:

Chevron Mining Inc. (formerly The Pittsburg & Midway Coal Mining Co.) has filed an application for bond release of the permanent-program performance bond for Area 9 South (Area 9S) which includes 1,193 acres of Phase II and Phase III bond release and 42 acres of Phase I bond release which lies within the Phase II and III area. Phase II bond release is being sought since vegetation has been established and the contribution of suspended solids to streamflow or runoff outside the permit is not in excess of the 19.8 NMAC requirements. Phase III bond release is being sought since the area has met vegetation standards in accordance with the permit and the regulations and all remaining reclamation obligations have been completed. The Phase I bond release consists of a road corridor and reclaimed pond areas that were excluded from the prior 2015 Phase I bond release in the area and now qualify for Phase I release.

The application was filed with the New Mexico Mining and Minerals Division (MMD) of the Energy, Minerals & Resources Department in Santa Fe, New Mexico. This application concerns property that may be under your control or ownership or that may be of interest to you.

Chevron Mining Inc.'s headquarters is located at 6001 Bollinger Canyon Road, San Ramon, CA 94583. The current permit number for the McKinley Mine regulated by the State of New Mexico Mining and Minerals Division is 2016-02, which expires on March 7, 2021 and has been administratively extended.

The McKinley Mine is located approximately 23 miles northwest of Gallup, NM and 3 miles east of Window Rock, AZ on NM State Highway 264. The Area 9S bond release application is located within the Samson Lake USGS quadrangle map.

The lands for which bond release is sought are shown on the accompanying map Figure 1: McKinley Mine Area 9S - Bond Release Area, and are located within the following areas:
T16N, R20W New Mexico Principal Meridian, McKinley County, New Mexico:
Section Numbers: 15, 16, 21, 22, 23, 26, 27 and 28

Area 9S Surface Ownership

Township and Range	Section	Phase I Acres	Phase II Acres	Phase III Acres	Surface Ownership	Allotment Numbers
T16N, R20W	15	0.0	23.9	23.9	Westbrook	
	15	0.0	23.7	23.7	Chevron USA, Inc.	
	16	30.0	94.8	94.8	BIA	1592, 1593, 1594, 1595
	21	1.1	235.8	235.8	Chevron USA, Inc.	
	22	0.0	464.4	464.4	BIA	1581, 1582, 1583
	22	0.0	85.3	85.3	BLM	
	23	0.0	104.4	104.4	Chevron USA, Inc.	
	26	5.9	41.6	41.6	BIA	1566
	27	3.3	77.8	77.8	Chevron USA, Inc.	
	28	1.7	41.3	41.3	BIA	1591
	Total	42.0	1193.0	1193.0		

Additional details are provided below concerning this application:
Bonding Information:
The following summarizes the current and remaining bond fund, proposed bond release and remaining bond:

Current Bond Type: Surety Bond

- Current Bond Fund: $ 24,645,642
- Less Previous A11/12 PI Bond Release: $ 1,150,724
- Remaining Bond Fund: $ 23,494,918
- Area 9S direct & indirect costs to be released: $ 2,634,239
- New Bond Fund Amount: $ 20,860,679 (in 2022 dollars)

Disturbed Acreage to be released:

- Total acreage to be released: 1,193.0 ac.
- Acres permitted: 12,958.2 ac.
- Percentage of acres permitted being released: 9.2 %

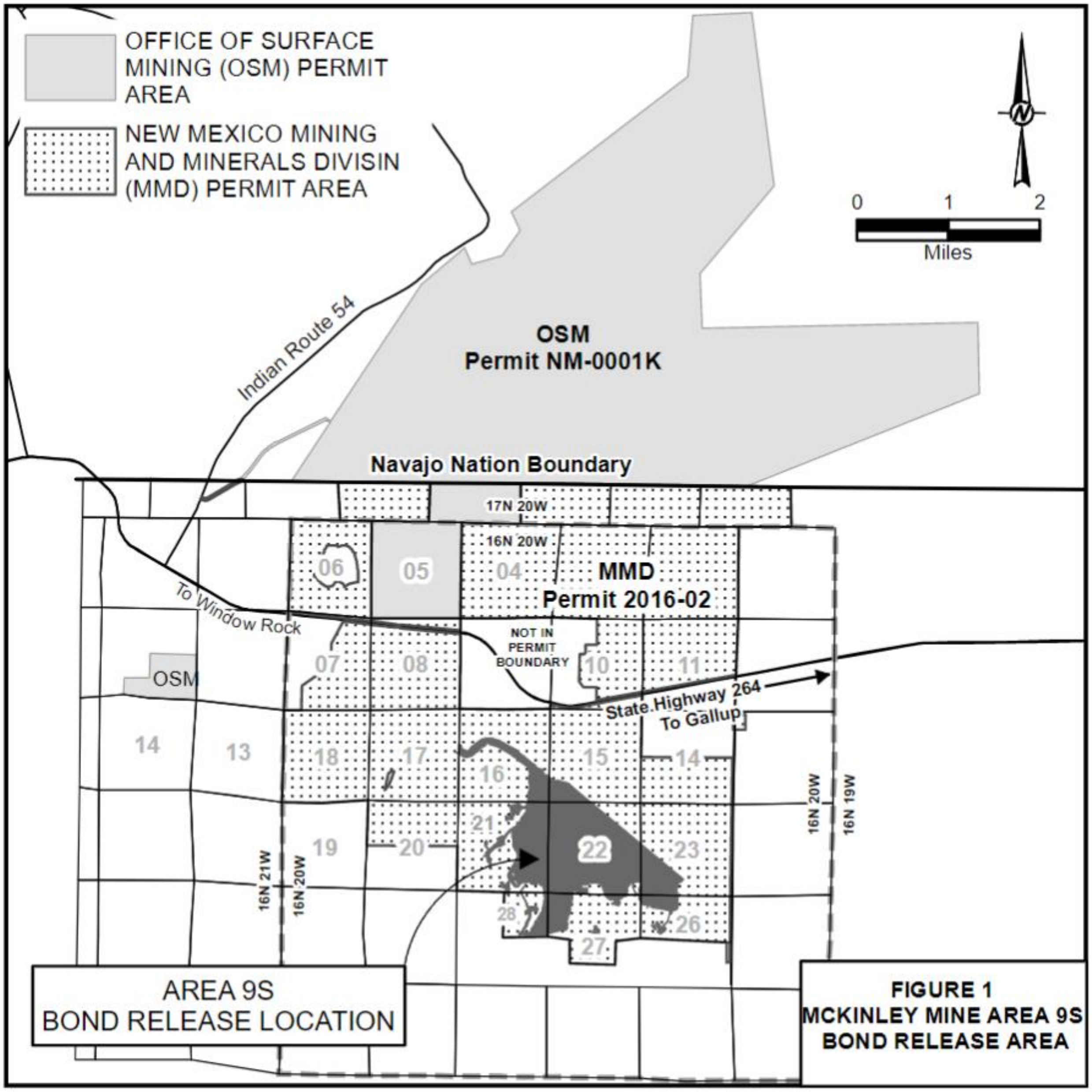
Phase I bond for much of the area was released in 2015, which covered backfilling and grading, graded spoil suitability, topsoil replacement and construction of hydrologic structures and drainage control. Phase I bond release for 42 acres of road corridor and sedimentation pond areas that were excluded from the 2015 Phase I bond release are included with this bond release application. Reclamation of the road corridor and the sedimentation ponds were completed after the initial application date for the 2015 bond release and these 42 acres now qualify for Phase I bond release. Phase II and Phase III bond release is being sought for the portion of bond associated with completion of reclamation requirements that results in the reduction of settleable solids and the development of vegetation to meet the requirement as established in the regulations and the applicable permit. Disturbance and mining in Area 9S occurred between 1986 and 2006. Seeding of the reclaimed lands occurred between 1995 and 2014 with 94.6% of the area having been seeded for a minimum of 10 years. Assessment of Area 9S for vegetation performance was conducted in 2019, 2020, and 2021.

A copy of the bond-release application is available for public inspection at the following locations:

- County Clerk, McKinley County Courthouse, 201 W Hill Ave, Gallup, New Mexico, 87301.
- New Mexico Mining and Minerals Division, 1220 South St. Francis Drive, Santa Fe, NM 87505 (Contact Name: James R. Smith by phone at 505-690-8071 or by email at JamesR.Smith@state.nm.us to make arrangements to review the bond release application).
- Within 30 days of the final publication of a notice for this bond-release application in the Gallup Independent or Navajo Times newspaper, written comments, objections, or requests for a public hearing and informal conference on this bond-release application shall be submitted to:
  - Director, Mining and Minerals Division, 1220 South St. Francis Drive, Santa Fe, NM 87505.

An inspection of the lands to be released will be conducted at the McKinley Mine at 9 AM on September 21, 2022 (Wednesday). Parties interested in participating in the inspection may contact Mr. James R. Smith of the Mining and Minerals Division at 505-690-8071.

Figure 1: McKinley Mine Area 9S Bond Release Area



Appendix 4: BIA Allottee Names and Addresses

791 1566

DAVID JOHN
5073 HCR 33 BOX 310
GALLUP, NM 87301

IRENE NOTAH
PO BOX 83
WINDOW ROCK, AZ 86515-0083

NELLIE DOUGLAS
PO BOX 1193
GALLUP, NM 87305-1193

JANET C ETCITTY
7112 TREE LINE AVE NW
ALBUQUERQUE, NM 87114-5920

ELLA M JOHN
PO BOX 414
GAMERCO, NM 87317-0414

LEO JOHN
PO BOX 3930
YATAHEY, NM 87375-3930

AKEE DOUGLAS
PO BOX 2526
GALLUP, NM 87305-2526

WILFRED NEZ
PO BOX 642
ST MICHAELS, AZ 86511-0642

ROSE BITAH
PO BOX 4184
WINDOW ROCK, AZ 86515-4184

LUCY N SLINKEY
PO BOX 4344
YATAHEY, NM 87375-4344

LORETTA JAMES
PO BOX 127
ST MICHAELS, AZ 86511-0127

FRANCES T BEGAY
PO BOX 2065
GALLUP, NM 87305-2065

LARRY TOM ESTATE
C/O SUPERINTENDENT
EASTERN NAVAJO AGENCY
PO BOX 328
CROWNPOINT, NM 87313

NAN TOM
PO BOX 455
MENTMORE, NM 87319-0455

IRENE TOM
PO BOX 455
MENTMORE, NM 87319-0455

IRENE BITAH
403 SE 4TH ST APT 1
PERKINS, OK 74059-3410

VIRGINIA R TOM
PO BOX 2876
GALLUP, NM 87305-2876

ERNEST JOHN
PO BOX 4541
YATAHEY, NM 87375-4541

PETER B YAZZIE
PO BOX 2724
GALLUP, NM 87305-2724

ALFRED B TOM
PO BOX 6033
GALLUP, NM 87305-6033

MARIETTA BITAH
3405 W DANBURY DR APT D115
PHOENIX, AZ 85053-1884

ISABELLE E BENALLY
PO BOX 183
MENTMORE, NM 87319-0183

BERTHA SLINKEY
PO BOX 3581
YATAHEY, NM 87375-3581

EDDIE DOUGLAS
PO BOX 1917
GALLUP, NM 87305-1917

ELLA DOUGLAS
PO BOX 581
GALLUP, NM 87305-0581

HERMAN B TOM
PO BOX 4206
GALLUP, NM 87305-4206

DONALD L DOUGLAS
PO BOX 4495
GALLUP, NM 87305-4495

CLAYTON B TOM
PO BOX 4493
YATAHEY, NM 87375-4493

ROSELYN BITAH
PO BOX 666
GALLUP, NM 87305-0666

JOAN L DOUGLAS
PO BOX 309
MENTMORE, NM 87319-0309

791 1566

FREDDIE L DOUGLAS
PO BOX 309
MENTMORE, NM 87319-0309

DELORES SOMBRERO
PO BOX 2858
TUBA CITY, AZ 86045-2858

JURISTA BITAH
625 W 24TH ST
FARMINGTON, NM 87401-3995

LEE DOUGLAS JR
PO BOX 581
GALLUP, NM 87305-0581

EGBERT L DOUGLAS
PO BOX 309
MENTMORE, NM 87319-0309

NATHANIEL NOTAH
PO BOX 83
WINDOW ROCK, AZ 86515-0083

ANTOINETTE CHRISTENSEN
PO BOX 2725
WINDOW ROCK, AZ 86515-2725

PHYLLIS BEGAY
PO BOX 2414
WINDOW ROCK, AZ 86515-2414

LAVIDA COLLINS
PO BOX 2341
GALLUP, NM 87305-2341

ALVERA L CANYON
NAVAJO REGIONAL OFFICE
PO BOX 1060
WINDOW ROCK, AZ 86515

MARITA J NEZ
PO BOX 1023
ST MICHAELS, AZ 86511-1023

NOLAN DUSTIN NOTAH
PO BOX 83
WINDOW ROCK, AZ 86515-0083

GWENDOLYN W SILVER
PO BOX 1483
WINDOW ROCK, AZ 86515-1483

791 1581

EMILY HEAD
2267 PIERCE ST
BEAUMONT, TX 77703-2246

KATERI HEAD
1310 CLAIRMONTE LN
FRANKLIN, TN 37064-2496

WILLIAM HEAD
2700 MEADOW VIEW ROAD
C/O EMILY HEAD
SACARMENTO, CA 95832

RENEE CLARK
PO BOX 521
ZUNI, NM 87327-0521

SANDEE A CLARK
3721 E POLK ST APT 4-B
PHOENIX, AZ 85008-6321

THOMAS NOTAH
PO BOX 437
GAMERCO, NM 87317-0437

LUCILLE STILWELL
P O BOX 564
CORRALES, NM 87048

NANCY YAZZIE
PO BOX 36
LUPTON, AZ 86508-1036

CHARLOTTE DAILEY
4009 E HOLLADAY ST
TUCSON, AZ 85706-2935

SHARON A SORRELL ESTATE
PO BOX 3945
GALLUP, NM 87305

MARY NEZ
301 EL PUEBLO RD NW APT 1211
LOS RANCHOS, NM 87114-3597

CHRIS NEZ JR
1326 KANE CT
SAN JOSE, CA 95121-2228

ALBERT E NOTAH ESTATE
2100 EAST BLANCO BLVD #34
BLOOMFIELD, NM 87413

LEO NOTAH
PO BOX 3153
FARMINGTON, NM 87499-3153

ELIZABETH NOTAH ESTATE
PO BOX 2595
GALLUP, NM 87305

LEO G WILLIE ESTATE
1710 S. 2ND ST.
GALLUP, NM 87301

ANN BEGAY
3421 BLUE HILL AVE
GALLUP, NM 87301-6902

JEANETTE CLARK
4009 E HOLLADAY ST
TUCSON, AZ 85706-2935

CARMELITA ETSITTY
PO BOX 306
GAMERCO, NM 87317-0306

ROBERT SPENCER JR
PO BOX 602
MENTMORE, NM 87319-0602

DANIEL SPENCER
102 W PALOMINO WAY DR APT 237-
2
CHANDLER, AZ 85225-7719

NIA F BECENTI
2205 AMBASSADOR RD NE APT 33
ALBUQUERQUE, NM 87112-2724

CHENOA B S JENSEN
P O BOX 564
CORRALES, NM 87048

ROBERT BECENTI
601 DANI DRIVE APT#Q19
GALLUP, NM 87301

MARVIN TOM
PO BOX 518
MENTMORE, NM 87319-0518

MICHAEL K SPENCER
P.O. BOX 1292
CROWNPOINT, NM 87313

SYDNEY HOLDERNESS
3313 241ST AVE SE
SAMMAMISH, WA 98029-6315

KEE N GRINDE
1076 GOLDEN PHEASANT DR
REDMOND, OR 97756-9260

EMIL J HEAD ESTATE
PO BOX 162
REHOBOTH, NM 87322

SHANTE D JENSEN
P.O. BOX 564
CORRALES, NM 87048

791 1581

IRA MICHAEL NEZ ESTATE
1027 CARL AVE RAPID VALLEY
PENNINGTON, SD 57703

791 1582

JOHN NOTAH 28021 NOTAH RD PARKER, AZ 85344-7726	GRACE BUTLER 43607 YUKON CT HEMET, CA 92544-2786	LORETTA MAE DEYSIE PO BOX 355 PARKER, AZ 85344-0355
BEYAJA AH NOTAH PO BOX 1355 SAN JACINTO, CA 92581-1355	NATANI G NOTAH 1002 W MARSHALL BLVD SAN BERNARDINO, CA 92405-2950	MYEEKAY C J NOTAH PARENT OF MYEEKAY C J NOTAH 1002 W MARSHALL BLVD SAN BERNARDINO, CA 92405-2950
SHELLEY NOTAH 1002 W MARSHALL BLVD SAN BERNARDINO, CA 92405-2950	CALLIE S NOTAH 3100 S MADOLE BV OKLAHOMA CITY, OK 73159	TERESA S NOTAH 5356 S MONTE DR OKLAHOMA CITY, OK 73119-5448

791 1583

ALICE NEZ
PO BOX 631
HOLBROOK, AZ 86025-0631

MARY ALICE JAMES
HC 58 BOX 70 UNIT 131
GANADO, AZ 86505-9708

EDITH NEZ
HC 58 BOX 70 UNIT 131
GANADO, AZ 86505-9708

KENNETH E NEZ
PO BOX 3455
WINDOW ROCK, AZ 86515-3455

MARY L LENHART
624 46TH AVENUE CT
GREELEY, CO 80634-2010

VALENTINO DOMINQUEZ
PO BOX 1553
CHINLE, AZ 86503-1553

VIRGIL M LONG
PO BOX 41
GANADO, AZ 86505-0041

ANCITA TSOSIE
PO BOX 1207
GANADO, AZ 86505-1207

HOLMES M LONG
HC 58 BOX 70 UNIT 227
GANADO, AZ 86505-9708

CLIFFORD M LONG
PO BOX 219
LUPTON, AZ 86508-1219

FREELAND M LONG
HC 58 BOX 70 UNIT 227
GANADO, AZ 86505-9708

ALBERT NEZ
PO BOX 975
BLOOMFIELD, NM 87413-0975

MELISSA ANN LEWIS
HC 58 BOX 70 UNIT 227
GANADO, AZ 86505-9708

LAURA A NEZ
PO BOX 975
BLOOMFIELD, NM 87413-0975

MELINDA LONG
HC 58 BOX 70
GANADO, AZ 86505-9708

TOMIE LONG JR
PO BOX 1362
ST MICHAELS, AZ 86511-1362

KIMBERLY LOPEZ
401 N DEER MOUNTAIN RD
BEAR RIVER, WY 82930-9008

ELVIN L NEZ
786 E 800 N
PLEASANT GROVE, UT 84062-1956

791 1591

IRENE NOTAH
PO BOX 83
WINDOW ROCK, AZ 86515-0083

ESTHER DAWES
PO BOX 1434
WINDOW ROCK, AZ 86515-1434

ANNA R SANDERSON
PO BOX 1149
WINDOW ROCK, AZ 86515-1149

KENNETH NOTAH ESTATE
2442 LILAC AVE NW
ALBUQUERQUE, NM 87104

JOSEPH R NOTAH
PO BOX 14
WINDOW ROCK, AZ 86515-0014

RONALD W NOTAH
7936 RED BEAN DR
PENSACOLA, FL 32526-2925

ANTHONY C NOTAH
PO BOX 201
FORT WINGATE, NM 87316-0201

DELORES VIGIL
PO BOX 1488
ST MICHAELS, AZ 86511-1488

PHILLIP NOTAH
1537 W CAMELBACK RD APT 119
PHOENIX, AZ 85015-3747

JEANETTE L BYINGTON
1419 BRIGHTON CIR
LAWRENCE, KS 66049-3726

LAWRENCE NOTAH
6096 RIVERSIDE AVE APT 15
RIVERSIDE, CA 92506-2109

REYNALDA J DIXON
PO BOX 1852
FORT DEFIANCE, AZ 86504-1852

GERALD NOTAH
3735 W NEVIL CT
TUCSON, AZ 85746-2563

NATHANIEL NOTAH
PO BOX 83
WINDOW ROCK, AZ 86515-0083

ANTOINETTE CHRISTENSEN
PO BOX 2725
WINDOW ROCK, AZ 86515-2725

NOLAN DUSTIN NOTAH
PO BOX 83
WINDOW ROCK, AZ 86515-0083

JULIA HAILEY
255 SENIOR DR
PAWHUSKA, OK 74056-2227

MELISSA K STANDRIDGE
805 E 11TH ST
BARTLESVILLE, OK 74003-5118

SAMANTHA NOTAH
PO BOX 11
C/O STEPHANIE L NOTAH
DEWEY, OK 74029

SAVHANNA NOTAH
PO BOX 11
C/O STEPHANIE L NOTAH
DEWEY, OK 74029

SARAH M NOTAH
12905 E GEORGIA BLVD
PALMER, AK 99645-7318

LEWIS W NOTAH
2411 DOVE GLEN LN NW
POULSBO, WA 98370-8286

791 1592

THOMAS NOTAH
PO BOX 437
GAMERCO, NM 87317-0437

MAY F JOHN
PO BOX 1831
FRUITLAND, NM 87416-1831

LUCILLE STILWELL
P O BOX 564
CORRALES, NM 87048

RAYMOND JONES
8201 MARQUETTE AVE NE APT 30
ALBUQUERQUE, NM 87108-2478

NAVAJO NATION MINERA
PO BOX 1910
WINDOW ROCK, AZ 86515

NAVAJO NATION
PO BOX 1910
WINDOW ROCK, AZ 86515

TOM K BEGAY
PO BOX 14
LUPTON, AZ 86508-1014

SARAH L DICKENS
PO BOX 333
ST MICHAELS, AZ 86511-0333

DELLA MCCREA
PO BOX 183
GAMERCO, NM 87317-0183

MARY A DOOLINE
PO BOX 206
ST MICHAELS, AZ 86511-0206

ESTHER DAWES
PO BOX 1434
WINDOW ROCK, AZ 86515-1434

CATHERINE B PLUMMER
PO BOX 40
BLUFF, UT 84512-0040

ANNA R SANDERSON
PO BOX 1149
WINDOW ROCK, AZ 86515-1149

LAURA A LOWE
PO BOX 617
TOHATCHI, NM 87325-0617

JIM M COAN ESTATE
BOX 627
MENTMORE, NM 87319

JENNIE C WATSON ESTATE
PO BOX 183
GAMERCO, NM 87317

IRENE SINGER
356 SW HAMILTON ST UPPR
PORTLAND, OR 97239-4036

ROSE ANN D SANDOVAL
PO BOX 1974
SHIPROCK, NM 87420-1974

JOHN K BILLY ESTATE
HCR 57, BOX 9035
GALLUP, NM 87301

ETHEL M REDSTROM
509 GEORGIA ST SE
ALBUQUERQUE, NM 87108-3803

JAMES UPSHAW ESTATE
PO BOX 26
ST. MICHAELS, AZ 86511

ANTHONY MCCRAY SR
PO BOX 742
GALLUP, NM 87305-0742

ELLA MAE WHITE
HC 57 BOX 9008
GALLUP, NM 87301-9601

MARY LEE
PO BOX 1557
GALLUP, NM 87305-1557

ALICE EMERSON
PO BOX 825
ST MICHAELS, AZ 86511-0825

LORRAINE HASWOOD
PO BOX 484
WINDOW ROCK, AZ 86515-0484

PAUL E BITLOY
PO BOX 787
WINDOW ROCK, AZ 86515-0787

VERNA B HENRY
PO BOX 73
GAMERCO, NM 87317-0073

MARIE A SCOTT
PO BOX 14
ST MICHAELS, AZ 86511-0014

MARY UPSHAW ESTATE
PO BOX 615
ST MICHAELS, AZ 86511-0615

MARJORIE UPSHAW ESTATE
PO BOX 2244
WINDOW ROCK, AZ 86515

SAMMY PESHLAKAI
7322 CLOVERGLEN DR
DALLAS, TX 75249-1437

ELOUISE M BLACKGOAT
PO BOX 452
GALLUP, NM 87305-0452

RENA MAE CONNELL
PO BOX 112
ST MICHAELS, AZ 86511-0112

NOREEN M HARDY
PO BOX 1334
WINDOW ROCK, AZ 86515-1334

ROGER G PLUMMER ESTATE
P.O. BOX 804
GALLUP, NM 87305

TIMMIE MITCHELL
PO BOX 356
GAMERCO, NM 87317-0356

JUANITA B NEZ
HCR-57 PO BOX 9090
GALLUP, NM 87301

VIRGINIA A TSOSIE
PO BOX 325
MENTMORE, NM 87319-0325

ROSCOE SCOTT
PO BOX 1166
GALLUP, NM 87305-1166

HELEN C SINGER
HC 63 BOX 6156
WINSLOW, AZ 86047-9449

JAKE MCCRAY JR
PO BOX 221
MENTMORE, NM 87319-0221

ALBERT E NOTAH ESTATE
2100 EAST BLANCO BLVD #34
BLOOMFIELD, NM 87413

LEO NOTAH
PO BOX 3153
FARMINGTON, NM 87499-3153

JUANITA Y SAM
PO BOX 291
WINDOW ROCK, AZ 86515-0291

PETER BROWN ESTATE
PO BOX 24
ST MICHAELS, AZ 86511-0024

LOLA Y SHURLEY
PO BOX 107
ST MICHAELS, AZ 86511-0107

JOHNNIE M YAZZIE
PO BOX 855
ST MICHAELS, AZ 86511-0855

MARIE SAM
PO BOX 353
CHURCH ROCK, NM 87311-0353

EDWARD YAZZIE ESTATE
P.O. BOX 532
RAMAH, NM 87321

ISABELLE KEE
PO BOX 301
ST MICHAELS, AZ 86511-0301

BETTY EMERSON
PO BOX 218
ST MICHAELS, AZ 86511-0218

MARY JOE
400 ARNOLD ST APT A
GALLUP, NM 87301-6622

LOUISE W MCCRAY
PO BOX 337
MENTMORE, NM 87319-0337

ESTHER W KINSEL ESTATE
PO BOX 320
MENTMORE, NM 87319

MAE B JACKSON
PO BOX 4532
GALLUP, NM 87305-4532

ELLA PEREZ
PO BOX 1869
SEDONA, AZ 86339-1869

NELLIE COAN
PO BOX 978
WINDOW ROCK, AZ 86515-0978

BILLY YAZZIE ESTATE
P.O. BOX 323
ST. MICHAELS, AZ 86511

ELIZABETH NOTAH ESTATE
PO BOX 2595
GALLUP, NM 87305

KENNETH NOTAH ESTATE
2442 LILAC AVE NW
ALBUQUERQUE, NM 87104

JOSEPH R NOTAH
PO BOX 14
WINDOW ROCK, AZ 86515-0014

RAYMOND BLACKGOAT
PO BOX 2173
SHIPROCK, NM 87420-2173

ANNIE NEZ
PO BOX 266
ST MICHAELS, AZ 86511-0266

HELEN HASWOOD ESTATE
PO BOX 484
WINDOW ROCK, AZ 86515

JERRY YAZZIE
PO BOX 1086
ST MICHAELS, AZ 86511-1086

LARRY UPSHAW ESTATE
11 W GUTIERREZ UNIT 3733
SANTA FE, NM 87506-0225

ANDERSON SPEAN
PO BOX 35
LUPTON, AZ 86508-1035

DOROTHY A FORD
PO BOX 2902
KIRTLAND, NM 87417-2902

HARRISON BEGAY
PO BOX 564
CHURCH ROCK, NM 87311-0564

DIANA SLINKEY
PO BOX 621
ST MICHAELS, AZ 86511-0621

ALICE M DAMON
PO BOX 1172
GALLUP, NM 87305-1172

DENNISON MITCHELL
2522 ACERO AVE
PUEBLO, CO 81004-4108

GRACE B FORD
437 S 50 W TRLR 19
BURLEY, ID 83318-5735

FRANCIS MITCHELL
PO BOX 1614
FARMINGTON, NM 87499-1614

ALICE R BLACKGOAT
HC 33 BOX 310-5112
GALLUP, NM 87301-9701

EVELYN B DIXON
1320 N HICKS AVE
WINSLOW, AZ 86047-2530

KENNETH BAHE
PO BOX 3
ST MICHAELS, AZ 86511-0003

ANN BEGAY
3421 BLUE HILL AVE
GALLUP, NM 87301-6902

BOBBIE PESHLAKAI
PO BOX 1005
WINDOW ROCK, AZ 86515-1005

RAYMOND BAHE ESTATE
PO BOX 1193
WINDOW ROCK, AZ 86515

CLARA KIRK
PO BOX 1423
WINDOW ROCK, AZ 86515-1423

VICTOR MCCRAY
PO BOX 16
WINDOW ROCK, AZ 86515-0016

MARTINA S MCCRAY
2145 S YARROW ST
LAKEWOOD, CO 80227-2447

THOMAS MCCRAY JR
PO BOX 337
MENTMORE, NM 87319-0337

ALFRED COAN
PO BOX 978
WINDOW ROCK, AZ 86515-0978

BERNICE CLAYTON
PO BOX 280
CHEROKEE, NC 28719-0280

MARY L PESHLAKAI
PO BOX 282
ST MICHAELS, AZ 86511-0282

ESTHER CHEE
PO BOX 3764
GALLUP, NM 87305-3764

MILTON YAZZIE
PO BOX 655
CHURCH ROCK, NM 87311-0655

791 1592

LEROY MCCRAY 1000 E 66 GALLUP, NM 87301	PHILLIP WHITE PO BOX 9041 MENTMORE, NM 87319	EVELYN COAN PO BOX 471 MENTMORE, NM 87319-0471
ANDERSON BAHE PO BOX 858 SACATON, AZ 85147-0026	BENNIE T JAY PO BOX 1021 CHURCH ROCK, NM 87311-1021	MELINDA M LARSEN 201 S IVY ST CORNELIUS, OR 97113-7132
RAY MCCRAY 1011 YALE AVE BURLEY, ID 83318-1139	ROBERT SPENCER JR PO BOX 602 MENTMORE, NM 87319-0602	DAVID MCCRAY PO BOX 782 CROWNPOINT, NM 87313-0782
LARRY M BEGAY PO BOX 61 MENTMORE, NM 87319-0061	RONALD W NOTAH 7936 RED BEAN DR PENSACOLA, FL 32526-2925	ANTHONY C NOTAH PO BOX 201 FORT WINGATE, NM 87316-0201
ALFRED S BILLIE PO BOX 514 MENTMORE, NM 87319-0514	RAMONA M MONG PO BOX 253 PAUL, ID 83347-0253	ANNA M MYERS 2001 Y ST HEYBURN, ID 83336-8712
GLENIO S BILLIE PO BOX 3061 GALLUP, NM 87305-3061	LOUISE J GLEASON PO BOX 1170 WINDOW ROCK, AZ 86515-1170	TILLY GOLDEN P. O. BOX 368 ST MICHAELS, AZ 86511
LEON YAZZIE PO BOX 168 ST MICHAELS, AZ 86511-0168	BEVERLY ANN A BAHE PO BOX 1144 WINDOW ROCK, AZ 86515-1144	MARY J SMITH PO BOX 1252 ST MICHAELS, AZ 86511-1252
MARGARET PESHLAKAI PO BOX 36 ST MICHAELS, AZ 86511-0036	SHERRY A BLACKGOAT PO BOX 228 LUPTON, AZ 86508-1228	ROY MCCRAY PO BOX 793 GALLUP, NM 87305-0793
EDDIE DOUGLAS PO BOX 1917 GALLUP, NM 87305-1917	BENNY BAHE PO BOX 3318 INDIAN WELLS, AZ 86031-3318	BARBARA J SILVERSMITH PO BOX 1383 SAINT JOHNS, AZ 85936-1383
PATTY NEZ PO BOX 741 SHIPROCK, NM 87420-0741	PATRICK L MCCRAY 10064 W 68TH WAY ARVADA, CO 80004-1511	CHARLIE COAN PO BOX 2785 KIRTLAND, NM 87417-2785

791 1592

GRACE COAN
PO BOX 4533
WINDOW ROCK, AZ 86515-4533

DEBORAH A RODRIGUEZ
705 10TH AVE NW
RIO RANCHO, NM 87144-4008

LAURA M PLUMMER
PO BOX 691
MENTMORE, NM 87319-0691

PHILLIP COAN
PO BOX 475
MENTMORE, NM 87319-0475

JAYSON SAM
PO BOX 1081
MANY FARMS, AZ 86538-1081

DANIEL SPENCER
102 W PALOMINO WAY DR APT 237
2
CHANDLER, AZ 85225-7719

DELLA M WHITE
PO BOX 93
MENTMORE, NM 87319-0093

KEITH BALDWIN
3501 W MISSOURI AVE APT 203
PHOENIX, AZ 85019-4537

WRISTON T BILLY
PO BOX 1306
KIRTLAND, NM 87417-1306

RITA WHITE
PO BOX 350
MENTMORE, NM 87319-0350

BERNICE W COAN
PO BOX 3694
WINDOW ROCK, AZ 86515-3694

JAMES S BILLIE
PO BOX 128
CHURCH ROCK, NM 87311-0128

JERRY MCCRAY
2250 CONANT DR
BURLEY, ID 83318-2911

JERRY MCCRAY
PO BOX 211
GALLUP, NM 87305-0211

DEE ANN SANDOVAL
PO BOX 4453
YATAHEY, NM 87375-4453

EDDY K MCCRAY
PO BOX 42
MENTMORE, NM 87319-0042

JANICE SPENCER
PO BOX 464
MENTMORE, NM 87319-0464

STEVEN M MCCRAY
1006 E LOGAN AVE APT 10
GALLUP, NM 87301-5485

RONALD B SAM
PO BOX 6183
GALLUP, NM 87305-6183

WANDA M BENALLY
PO BOX 337
MENTMORE, NM 87319-0337

DONALD L DOUGLAS
PO BOX 4495
GALLUP, NM 87305-4495

SANDRA J PARKER
PO BOX 502
MENTMORE, NM 87319-0502

ERVIN J BEGAY
PO BOX 1020
CHURCH ROCK, NM 87311-1020

CHEE T SMITH
PO BOX 155
MENTMORE, NM 87319-0155

CHRISTINE T BROWN
HC 57 BOX 9114
GALLUP, NM 87301-9602

FRANCIS WHITE
PO BOX 464
MENTMORE, NM 87319-0464

CORNELIA A YAZHE
PO BOX 1231
CHURCH ROCK, NM 87311-1231

ELSIE W NELSON
PO BOX 520
MENTMORE, NM 87319-0520

JO ANN YOUNG
310 STAGECOACH DRIVE
GALLUP, NM 87301-6735

ESTHER M WHITE
PO BOX 515
MENTMORE, NM 87319-0515

791 1592

JUAN BEGAY JR
PO BOX 1331
CHURCH ROCK, NM 87311-1331

JOSEPHINE WILSON
PO BOX 1730
LUKACHUKAI, AZ 86507-1730

JOSEPH WILSON
3432 E COTTON LN
GILBERT, AZ 85234-4200

LAVONNE COAN
PO BOX 21
KEAMS CANYON, AZ 86034-0021

IVIS E BEGAY
PO BOX 1020
CHURCH ROCK, NM 87311

LLOYD MCCRAY
611 NORMAL AVE
BURLEY, ID 83318-1440

JULIAN BEGAY
PO BOX 1396
CHURCH ROCK, NM 87311-1396

CHENOA B S JENSEN
P O BOX 564
CORRALES, NM 87048

VIRGIL J WILSON
PO BOX 825
GAMERCO, NM 87317-0825

BERLENE SAMUELS
3420 SANOSTEE DR APT N98
GALLUP, NM 87301-7300

DARLENE R BIGGINS
613 E 18TH LN
BURLEY, ID 83318-2625

JOHN BEGAY
PO BOX 1333
SHEEP SPRINGS, NM 87364-1333

JASON BEGAYE
2915 ESTRELLA BRILLANTE ST NW
ALBUQUERQUE, NM 87120-1385

FREDA BILLIE
PO BOX 87
FORT WINGATE, NM 87316-0087

GABRIEL BILLIE
C O PRISCILLA SPENCER
PO BOX 4495
GALLUP, NM 87305-4495

TERRY BEGAY
PO BOX 411
GALLUP, NM 87305

ROSALINDA BILLIE
PO BOX 783
CHURCH ROCK, NM 87311-0783

HAROLD BEGAY
803 GIOVANETTI CIR
GALLUP, NM 87301-5058

ISAAC SPENCER
6700 CANTATA ST NW UNIT 1801
ALBUQUERQUE, NM 87114-5777

ERVIN BILLIE
PO BOX 4144
GALLUP, NM 87305-4144

ERWIN BILLIE
PO BOX 4411
YATAHEY, NM 87375-4411

LISA A BEGAY
PO BOX 411
GALLUP, NM 87305

ASHLEIGH D MCCRAY
3324 S FIELD ST APT 188
LAKEWOOD, CO 80227-4601

MARVIN TOM
PO BOX 518
MENTMORE, NM 87319-0518

DIANE GARCIA
PO BOX 233
HEYBURN, ID 83336-0233

SCOTT MCCRAY
2154 OREGON ST UNIT 69
SAINT HELENS, OR 97051-1388

MICHAEL K SPENCER
P.O. BOX 1292
CROWNPOINT, NM 87313

ALYSIA S BEGAY
PO BOX 134
ST MICHAELS, AZ 86511-0134

MELVIN BEGAY
PO BOX 554
MENTMORE, NM 87319-0554

MARVIN L BEGAY JR
PO BOX 554
MENTMORE, NM 87319-0554

JUSTIN JP PARKER ANDERSON
PO BOX 1608
GALLUP, NM 87305-1608

TASHAFAYE JOHNSON ESTATE
1730 W OLYMPIC BV ST. 300
ATTN: LUIS ROMERO
LOS ANGELES, CA 90015

ELEANOR J BILLIE
PO BOX 3203
CHINLE, AZ 86503-3203

TERRYSON K BEGAY ESTATE
PO BOX 484
SANDERS, AZ 86512

EARL T BEGAY
PO BOX 457
NAVAJO, NM 87328-0457

MELISSA N BEGAY
PO BOX 14
LUPTON, AZ 86508-1014

ERIC M BLACKGOAT
3330 N CHILDRESS ST
FLAGSTAFF, AZ 86004-2016

JERRY L BITLOY
PO BOX 4371
WINDOW ROCK, AZ 86515-4371

BENJAMIN PESHLAKAI
PO BOX 375
ST MICHAELS, AZ 86511-0375

JOAN L DOUGLAS
PO BOX 309
MENTMORE, NM 87319-0309

DARLENE MIKE
PO BOX 702
ST MICHAELS, AZ 86511-0702

JOHNNY BEGAY
PO BOX 1581
ST MICHAELS, AZ 86511-1581

JEANETTE L BYINGTON
1419 BRIGHTON CIR
LAWRENCE, KS 66049-3726

DEBRA A DICK
PO BOX 938
FORT DEFIANCE, AZ 86504-0938

FREDDIE L DOUGLAS
PO BOX 309
MENTMORE, NM 87319-0309

VERONICA FOWLER
PO BOX 1241
ST MICHAELS, AZ 86511-1241

LOLITA M PURDY
PO BOX 1363
WINDOW ROCK, AZ 86515-1363

RONALD RAY YAZZIE ESTATE
1/2 MI. S.E. OF HUNTERS POINT
SCHOOL
ST. MICHAELS, AZ 86511

JONAH BEGAY
PO BOX 723
ST MICHAELS, AZ 86511-0723

HARRISON L BITLOY
PO BOX 3051
KIRTLAND, NM 87417-3051

GERALD R YAZZIE ESTATE
PO BOX 368
ST MICHAELS, AZ 86511

LEE DOUGLAS JR
PO BOX 581
GALLUP, NM 87305-0581

MATILDA A KEMPTON
PO BOX 132
ST MICHAELS, AZ 86511-0132

KATIE A SHORTY
PO BOX 2037
WINDOW ROCK, AZ 86515-2037

ARLENE BEGAY
PO BOX 1504
ST MICHAELS, AZ 86511-1504

SHIRLENE B LEUPPE
PO BOX 991
ST MICHAELS, AZ 86511-0991

NANCY J JOE
PO BOX 2437
SHIPROCK, NM 87420-2437

MARY L BAHE
2921 N 38TH ST APT 1
PHOENIX, AZ 85018-7023

JOHNSON B TULLY
PO BOX 413
ST MICHAELS, AZ 86511-0413

GERALD NOTAH
3735 W NEVIL CT
TUCSON, AZ 85746-2563

791 1592

LAURA A BROWN
PO BOX 34
SAINT MICHAELS, AZ 86511-0034

DEBORAH M REYES
1940 LAKESHORE AVE APT 44
OAKLAND, CA 94606-1185

STEPHEN J BEGAY
PO BOX 2651
ALAMEDA, CA 94501-0651

VICTOR YAZZIE
PO BOX 1586
KIRTLAND, NM 87417-1586

EGBERT L DOUGLAS
PO BOX 309
MENTMORE, NM 87319-0309

GLORIA A. BROWN
PO BOX 495
ST MICHAELS, AZ 86511-0495

DANIEL BITLOY
PO BOX 4715
WINDOW ROCK, AZ 86515-4715

PATRICIA J BEGAYE
PO BOX 1345
KIRTLAND, NM 87417-1345

ELIZABETH R SHAMA
2045 ELWIN WAY
MODESTO, CA 95350-0374

NATHANIEL NOTAH
PO BOX 83
WINDOW ROCK, AZ 86515-0083

JAMES PESHLAKAI
PO BOX 217
ST MICHAELS, AZ 86511-0217

MELISSA UPSHAW
9440 N 32ND AVE APT 1113
PHOENIX, AZ 85051-2653

LENMORE KEVIN BAHE
PO BOX 1144
WINDOW ROCK, AZ 86515-1144

VALERIE ONEY
400 W ROUND VALLEY RD
PAYSON, AZ 85541-3397

SARAH CASTILLO
PO BOX 756
ST MICHAELS, AZ 86511-0756

ESTHER A GARCIA
1138 83RD AVE
OAKLAND, CA 94621-1808

DWAYNE MITCHELL
1113 7TH ST NW
ALBUQUERQUE, NM 87102-2050

DELBERT MITCHELL M11401
ESTATE
901 1/2 FRANCISCAN DR
ALBUQUERQUE, NM 87102

DEBI TSOSIE
1113 7TH ST NW
ALBUQUERQUE, NM 87102-2050

SHERWIN TSO
PO BOX 1279
WINSLOW, AZ 86047-1279

GENEVIEVE A BITLOY
32021 E 689 DR
WAGONER, OK 74467

TAINA TSO
41649 W SUNLAND DR
MARICOPA, AZ 85138-2240

TYESHA M BAHE
11674 E CLARENDON AVE
SCOTTSDALE, AZ 85256-6612

STEVEN T PLUMMER JR
PO BOX 40
BLUFF, UT 84512-0040

VICTORIA YAZZIE
PO BOX 1363
WINDOW ROCK, AZ 86515-1363

JEFFERSON WHITE
PO BOX 4105
SHIPROCK, NM 87420-4105

BRIAN K BEGAY
2219 39TH AVE
OAKLAND, CA 94601-4363

CATHLENA A PLUMMER
PO BOX 40
BLUFF, UT 84512-0040

TIFFANY BERRY
PO BOX 5483
WINDOW ROCK, AZ 86515-5483

FELISHA TSO
6445 S MAPLE AVE APT 1137
TEMPE, AZ 85283-3679

RACHEL M YAZZIE
PO BOX 1232
SAINT MICHAELS, AZ 86511-1232

SAMANTHA J BITLOY
PO BOX 447
ST MICHAELS, AZ 86511-0447

CHRISTOPHER T BAHE
PO BOX 1144
WINDOW ROCK, AZ 86515-1144

RORY V JONES ESTATE
PO BOX 4525
YAHTAHEY, NM 87325

BRANDON R PURDY
PO BOX 176
SMITH LAKE, NM 87365-0176

PHILLIP DOUGLAS
13398 SYCAMORE AVE
CHINO, CA 91710-5325

GILBERT DOUGLAS ESTATE
523 SW MORELAND AVE
APT 406
LOS ANGELES, CA 90020

MELINDA PEDROZA
2550 E RIVERSIDE DR APT 27
ONTARIO, CA 91761-7365

LINDA M DOUGLAS
13398 SYCAMORE AVE
CHINO, CA 91710

ROCKY C P JONES
8201 MARQUETTE AVE NE APT 26
ALBUQUERQUE, NM 87108-2468

SHANTE D JENSEN
P.O. BOX 564
CORRALES, NM 87048

JULIA HAILEY
255 SENIOR DR
PAWHUSKA, OK 74056-2227

NAVAJO NATION MINERA
PO BOX 1910
WINDOW ROCK, AZ 86515

SARAH L DICKENS
PO BOX 333
ST MICHAELS, AZ 86511-0333

DELLA MCCREA
PO BOX 183
GAMERCO, NM 87317-0183

MARY A DOOLINE
PO BOX 206
ST MICHAELS, AZ 86511-0206

ESTHER DAWES
PO BOX 1434
WINDOW ROCK, AZ 86515-1434

ANNA R SANDERSON
PO BOX 1149
WINDOW ROCK, AZ 86515-1149

JIM M COAN ESTATE
BOX 627
MENTMORE, NM 87319

JENNIE C WATSON ESTATE
PO BOX 183
GAMERCO, NM 87317

IRENE SINGER
356 SW HAMILTON ST UPPR
PORTLAND, OR 97239-4036

JOHN K BILLY ESTATE
HCR 57, BOX 9035
GALLUP, NM 87301

JAMES UPSHAW ESTATE
PO BOX 26
ST. MICHAELS, AZ 86511

ELLA MAE WHITE
HC 57 BOX 9008
GALLUP, NM 87301-9601

MARY LEE
PO BOX 1557
GALLUP, NM 87305-1557

ALICE EMERSON
PO BOX 825
ST MICHAELS, AZ 86511-0825

LORRAINE HASWOOD
PO BOX 484
WINDOW ROCK, AZ 86515-0484

VERNA B HENRY
PO BOX 73
GAMERCO, NM 87317-0073

MARIE A SCOTT
PO BOX 14
ST MICHAELS, AZ 86511-0014

MARY UPSHAW ESTATE
PO BOX 615
ST MICHAELS, AZ 86511-0615

MARJORIE UPSHAW ESTATE
PO BOX 2244
WINDOW ROCK, AZ 86515

SAMMY PESHLAKAI
7322 CLOVERGLEN DR
DALLAS, TX 75249-1437

ELOUISE M BLACKGOAT
PO BOX 452
GALLUP, NM 87305-0452

RENA MAE CONNELL
PO BOX 112
ST MICHAELS, AZ 86511-0112

JUANITA B NEZ
HCR-57 PO BOX 9090
GALLUP, NM 87301

VIRGINIA A TSOSIE
PO BOX 325
MENTMORE, NM 87319-0325

ROSCOE SCOTT
PO BOX 1166
GALLUP, NM 87305-1166

HELEN C SINGER
HC 63 BOX 6156
WINSLOW, AZ 86047-9449

JUANITA Y SAM
PO BOX 291
WINDOW ROCK, AZ 86515-0291

LOLA Y SHURLEY
PO BOX 107
ST MICHAELS, AZ 86511-0107

JOHNNIE M YAZZIE
PO BOX 855
ST MICHAELS, AZ 86511-0855

EDWARD YAZZIE ESTATE
P.O. BOX 532
RAMAH, NM 87321

791 1593

ISABELLE KEE
PO BOX 301
ST MICHAELS, AZ 86511-0301

BETTY EMERSON
PO BOX 218
ST MICHAELS, AZ 86511-0218

MARY JOE
400 ARNOLD ST APT A
GALLUP, NM 87301-6622

ESTHER W KINSEL ESTATE
PO BOX 320
MENTMORE, NM 87319

MAE B JACKSON
PO BOX 4532
GALLUP, NM 87305-4532

ELLA PEREZ
PO BOX 1869
SEDONA, AZ 86339-1869

NELLIE COAN
PO BOX 978
WINDOW ROCK, AZ 86515-0978

BILLY YAZZIE ESTATE
P.O. BOX 323
ST. MICHAELS, AZ 86511

KENNETH NOTAH ESTATE
2442 LILAC AVE NW
ALBUQUERQUE, NM 87104

JOSEPH R NOTAH
PO BOX 14
WINDOW ROCK, AZ 86515-0014

RAYMOND BLACKGOAT
PO BOX 2173
SHIPROCK, NM 87420-2173

JERRY YAZZIE
PO BOX 1086
ST MICHAELS, AZ 86511-1086

LARRY UPSHAW ESTATE
11 W GUTIERREZ UNIT 3733
SANTA FE, NM 87506-0225

ANDERSON SPEAN
PO BOX 35
LUPTON, AZ 86508-1035

DOROTHY A FORD
PO BOX 2902
KIRTLAND, NM 87417-2902

HARRISON BEGAY
PO BOX 564
CHURCH ROCK, NM 87311-0564

DIANA SLINKEY
PO BOX 621
ST MICHAELS, AZ 86511-0621

GRACE B FORD
437 S 50 W TRLR 19
BURLEY, ID 83318-5735

ALICE R BLACKGOAT
HC 33 BOX 310-5112
GALLUP, NM 87301-9701

EVELYN B DIXON
1320 N HICKS AVE
WINSLOW, AZ 86047-2530

KENNETH BAHE
PO BOX 3
ST MICHAELS, AZ 86511-0003

BOBBIE PESHLAKAI
PO BOX 1005
WINDOW ROCK, AZ 86515-1005

RAYMOND BAHE ESTATE
PO BOX 1193
WINDOW ROCK, AZ 86515

CLARA KIRK
PO BOX 1423
WINDOW ROCK, AZ 86515-1423

ALFRED COAN
PO BOX 978
WINDOW ROCK, AZ 86515-0978

BERNICE CLAYTON
PO BOX 280
CHEROKEE, NC 28719-0280

MARY L PESHLAKAI
PO BOX 282
ST MICHAELS, AZ 86511-0282

ESTHER CHEE
PO BOX 3764
GALLUP, NM 87305-3764

MILTON YAZZIE
PO BOX 655
CHURCH ROCK, NM 87311-0655

PHILLIP WHITE
PO BOX 9041
MENTMORE, NM 87319

791 1593

EVELYN COAN
PO BOX 471
MENTMORE, NM 87319-0471

ANDERSON BAHE
PO BOX 858
SACATON, AZ 85147-0026

BENNIE T JAY
PO BOX 1021
CHURCH ROCK, NM 87311-1021

RONALD W NOTAH
7936 RED BEAN DR
PENSACOLA, FL 32526-2925

ANTHONY C NOTAH
PO BOX 201
FORT WINGATE, NM 87316-0201

ALFRED S BILLIE
PO BOX 514
MENTMORE, NM 87319-0514

ANNA M MYERS
2001 Y ST
HEYBURN, ID 83336-8712

GLENIO S BILLIE
PO BOX 3061
GALLUP, NM 87305-3061

TILLY GOLDEN
P. O. BOX 368
ST MICHAELS, AZ 86511

LEON YAZZIE
PO BOX 168
ST MICHAELS, AZ 86511-0168

BEVERLY ANN A BAHE
PO BOX 1144
WINDOW ROCK, AZ 86515-1144

MARY J SMITH
PO BOX 1252
ST MICHAELS, AZ 86511-1252

MARGARET PESHLAKAI
PO BOX 36
ST MICHAELS, AZ 86511-0036

SHERRY A BLACKGOAT
PO BOX 228
LUPTON, AZ 86508-1228

BENNY BAHE
PO BOX 3318
INDIAN WELLS, AZ 86031-3318

CHARLIE COAN
PO BOX 2785
KIRTLAND, NM 87417-2785

GRACE COAN
PO BOX 4533
WINDOW ROCK, AZ 86515-4533

DEBORAH A RODRIGUEZ
705 10TH AVE NW
RIO RANCHO, NM 87144-4008

PHILLIP COAN
PO BOX 475
MENTMORE, NM 87319-0475

DELLA M WHITE
PO BOX 93
MENTMORE, NM 87319-0093

WRISTON T BILLY
PO BOX 1306
KIRTLAND, NM 87417-1306

RITA WHITE
PO BOX 350
MENTMORE, NM 87319-0350

BERNICE W COAN
PO BOX 3694
WINDOW ROCK, AZ 86515-3694

JAMES S BILLIE
PO BOX 128
CHURCH ROCK, NM 87311-0128

DEE ANN SANDOVAL
PO BOX 4453
YATAHEY, NM 87375-4453

JANICE SPENCER
PO BOX 464
MENTMORE, NM 87319-0464

ERVIN J BEGAY
PO BOX 1020
CHURCH ROCK, NM 87311-1020

CHEE T SMITH
PO BOX 155
MENTMORE, NM 87319-0155

CHRISTINE T BROWN
HC 57 BOX 9114
GALLUP, NM 87301-9602

FRANCIS WHITE
PO BOX 464
MENTMORE, NM 87319-0464

791 1593

CORNELIA A YAZHE
PO BOX 1231
CHURCH ROCK, NM 87311-1231

ELSIE W NELSON
PO BOX 520
MENTMORE, NM 87319-0520

JO ANN YOUNG
310 STAGECOACH DRIVE
GALLUP, NM 87301-6735

ESTHER M WHITE
PO BOX 515
MENTMORE, NM 87319-0515

JUAN BEGAY JR
PO BOX 1331
CHURCH ROCK, NM 87311-1331

JOSEPHINE WILSON
PO BOX 1730
LUKACHUKAI, AZ 86507-1730

JOSEPH WILSON
3432 E COTTON LN
GILBERT, AZ 85234-4200

LAVONNE COAN
PO BOX 21
KEAMS CANYON, AZ 86034-0021

IVIS E BEGAY
PO BOX 1020
CHURCH ROCK, NM 87311

JULIAN BEGAY
PO BOX 1396
CHURCH ROCK, NM 87311-1396

VIRGIL J WILSON
PO BOX 825
GAMERCO, NM 87317-0825

BERLENE SAMUELS
3420 SANOSTEE DR APT N98
GALLUP, NM 87301-7300

JOHN BEGAY
PO BOX 1333
SHEEP SPRINGS, NM 87364-1333

FREDA BILLIE
PO BOX 87
FORT WINGATE, NM 87316-0087

GABRIEL BILLIE
C O PRISCILLA SPENCER
PO BOX 4495
GALLUP, NM 87305-4495

TERRY BEGAY
PO BOX 411
GALLUP, NM 87305

ROSALINDA BILLIE
PO BOX 783
CHURCH ROCK, NM 87311-0783

HAROLD BEGAY
803 GIOVANETTI CIR
GALLUP, NM 87301-5058

ERVIN BILLIE
PO BOX 4144
GALLUP, NM 87305-4144

ERWIN BILLIE
PO BOX 4411
YATAHEY, NM 87375-4411

LISA A BEGAY
PO BOX 411
GALLUP, NM 87305

ALFONZO R PURDY
PO BOX 176
SMITH LAKE, NM 87365-0176

MELVIN BEGAY
PO BOX 554
MENTMORE, NM 87319-0554

MARVIN L BEGAY JR
PO BOX 554
MENTMORE, NM 87319-0554

CODY D AUSTIN
P O BOX 889
GAMERCO, NM 87317

KYLE P AUSTIN
P O BOX 889
GAMERCO, NM 87317

TASHAFAYE JOHNSON ESTATE
1730 W OLYMPIC BV ST. 300
ATTN: LUIS ROMERO
LOS ANGELES, CA 90015

ELEANOR J BILLIE
PO BOX 3203
CHINLE, AZ 86503-3203

ERIC M BLACKGOAT
3330 N CHILDRESS ST
FLAGSTAFF, AZ 86004-2016

PHILLIP NOTAH
1537 W CAMELBACK RD APT 119
PHOENIX, AZ 85015-3747

BENJAMIN PESHLAKAI
PO BOX 375
ST MICHAELS, AZ 86511-0375

JEANETTE L BYINGTON
1419 BRIGHTON CIR
LAWRENCE, KS 66049-3726

VERONICA FOWLER
PO BOX 1241
ST MICHAELS, AZ 86511-1241

LOLITA M PURDY
PO BOX 1363
WINDOW ROCK, AZ 86515-1363

RONALD RAY YAZZIE ESTATE
1/2 MI. S.E. OF HUNTERS POINT SCHOOL
ST. MICHAELS, AZ 86511

GERALD R YAZZIE ESTATE
PO BOX 368
ST MICHAELS, AZ 86511

MATILDA A KEMPTON
PO BOX 132
ST MICHAELS, AZ 86511-0132

KATIE A SHORTY
PO BOX 2037
WINDOW ROCK, AZ 86515-2037

ARLENE BEGAY
PO BOX 1504
ST MICHAELS, AZ 86511-1504

MARY L BAHE
2921 N 38TH ST APT 1
PHOENIX, AZ 85018-7023

DEBORAH M REYES
1940 LAKESHORE AVE APT 44
OAKLAND, CA 94606-1185

STEPHEN J BEGAY
PO BOX 2651
ALAMEDA, CA 94501-0651

VICTOR YAZZIE
PO BOX 1586
KIRTLAND, NM 87417-1586

ELIZABETH R SHAMA
2045 ELWIN WAY
MODESTO, CA 95350-0374

NATHANIEL NOTAH
PO BOX 83
WINDOW ROCK, AZ 86515-0083

JAMES PESHLAKAI
PO BOX 217
ST MICHAELS, AZ 86511-0217

MELISSA UPSHAW
9440 N 32ND AVE APT 1113
PHOENIX, AZ 85051-2653

LENMORE KEVIN BAHE
PO BOX 1144
WINDOW ROCK, AZ 86515-1144

VALERIE ONEY
400 W ROUND VALLEY RD
PAYSON, AZ 85541-3397

BARBARA AUSTIN
PO BOX 356
GAMERCO, NM 87317-0356

ESTHER A GARCIA
1138 83RD AVE
OAKLAND, CA 94621-1808

SHERWIN TSO
PO BOX 1279
WINSLOW, AZ 86047-1279

TAINA TSO
41649 W SUNLAND DR
MARICOPA, AZ 85138-2240

TYESHA M BAHE
11674 E CLARENDON AVE
SCOTTSDALE, AZ 85256-6612

VICTORIA YAZZIE
PO BOX 1363
WINDOW ROCK, AZ 86515-1363

BRIAN K BEGAY
2219 39TH AVE
OAKLAND, CA 94601-4363

TIFFANY BERRY
PO BOX 5483
WINDOW ROCK, AZ 86515-5483

FELISHA TSO
6445 S MAPLE AVE APT 1137
TEMPE, AZ 85283-3679

RACHEL M YAZZIE
PO BOX 1232
SAINT MICHAELS, AZ 86511-1232

CHRISTOPHER T BAHE
PO BOX 1144
WINDOW ROCK, AZ 86515-1144

791 1593

JULIA HAILEY
255 SENIOR DR
PAWHUSKA, OK 74056-2227

791 1594

ANGELINA DALE
PO BOX 38494
PHOENIX, AZ 85069-8494

TOMMY NELSON JR
PO BOX 3624
GALLUP, NM 87305-3624

LINDA MARTINEZ
PO BOX 3892
YATAHEY, NM 87375-3892

LENA NELSON
PO BOX 4364
YATAHEY, NM 87375-4364

ANGELA GOODWIN
PO BOX 4364
YATAHEY, NM 87375-4364

STEVEN NELSON
PO BOX 4364
YATAHEY, NM 87375-4364

MARY E CASTRO ESTATE
PO BOX 1095
FRUITLAND, NM 87416

ETHEL M REDSTROM
509 GEORGIA ST SE
ALBUQUERQUE, NM 87108-3803

MARY JANE LEE
PO BOX 803
WINDOW ROCK, AZ 86515-0803

JOANNE HALE
PO BOX 2515
ESPANOLA, NM 87532-4515

ROGER G PLUMMER ESTATE
P.O. BOX 804
GALLUP, NM 87305

TIMMIE MITCHELL
PO BOX 356
GAMERCO, NM 87317-0356

MARIE SAM
PO BOX 353
CHURCH ROCK, NM 87311-0353

ELSIE WILSON
PO BOX 738
WINDOW ROCK, AZ 86515-0738

LOUISE W MCCRAY
PO BOX 337
MENTMORE, NM 87319-0337

ALICE M DAMON
PO BOX 1172
GALLUP, NM 87305-1172

DENNISON MITCHELL
2522 ACERO AVE
PUEBLO, CO 81004-4108

FRANCIS MITCHELL
PO BOX 1614
FARMINGTON, NM 87499-1614

EDISON WILSON ESTATE
P.O. BOX 2011
CHINLE, AZ 86503

CLIFFORD CORNFIELD ESTATE
PO BOX 60
REHOBOTH, NM 87322

MILTON CORNFIELD
611 W LOGAN AVE
GALLUP, NM 87301-6537

JENNIE YAZZIE
PO BOX 4185
YATAHEY, NM 87375-4185

KEITH BALDWIN
3501 W MISSOURI AVE APT 203
PHOENIX, AZ 85019-4537

CARLA YAZZIE
11630 N MOON RANCH PL
MARANA, AZ 85658-4539

YVONNE J MCNIEL
PO BOX 2283
GALLUP, NM 87305-2283

JASON BEGAYE
2915 ESTRELLA BRILLANTE ST NW
ALBUQUERQUE, NM 87120-1385

ALYSIA S BEGAY
PO BOX 134
ST MICHAELS, AZ 86511-0134

JUSTIN JP PARKER ANDERSON
PO BOX 1608
GALLUP, NM 87305-1608

TERRYSON K BEGAY ESTATE
PO BOX 484
SANDERS, AZ 86512

DEBRA A DICK
PO BOX 938
FORT DEFIANCE, AZ 86504-0938

NATHAN E MARTIN
PO BOX 442
MONTICELLO, UT 84535-0442

DELBERT MITCHELL M11401
ESTATE
901 1/2 FRANCISCAN DR
ALBUQUERQUE, NM 87102

DEBI TSOSIE
1113 7TH ST NW
ALBUQUERQUE, NM 87102-2050

HAROLD LEE JOE
RT 5 BOX 29
GALLUP, NM 87301

GARY TSINNIJINNIE
PO BOX 1119
WINDOW ROCK, AZ 86515-1119

MICHELLE TSINNIJINNIE
PO BOX 1119
WINDOW ROCK, AZ 86515-1119

791 1595

RONALD L JOE ESTATE
BOX 4321
WINDOW ROCK, AZ 86515

ALEXANDER J BLACKGOAT
PO BOX 2503
WINDOW ROCK, AZ 86515-2503

MARCELLA TSINNIJINNIE
PO BOX 1119
WINDOW ROCK, AZ 86515-1119

JONAS S YAZZIE
PO BOX 903
ST MICHAELS, AZ 86511-0903

PHILLIP DOUGLAS
13398 SYCAMORE AVE
CHINO, CA 91710-5325

GILBERT DOUGLAS ESTATE
523 SW MORELAND AVE
APT 406
LOS ANGELES, CA 90020

MELINDA PEDROZA
2550 E RIVERSIDE DR APT 27
ONTARIO, CA 91761-7365

LINDA M DOUGLAS
13398 SYCAMORE AVE
CHINO, CA 91710

Appendix 5: Other Interests

Bureau of Indian Affairs
PO Box 1060
Gallup, NM 87301

Bureau of Land Management
6251 College Blvd. Suite A
Farmington, NM 87402

Continental Divide Electric
Corp.
PO Box 786
Gallup, NM 87301

El Paso Natural Gas Co.
Gallup District Office
PO Box 103
Rehoboth, NM 87322

Global Tower Partners
1801 Clint Moore Rd. Suite
215
Boca Raton, FL 33489

KHAC Radio
PO Box 9090
Window Rock, AZ 86515

McKinley County Manager
207 West Hill St
Gallup, NM 87301

Navajo Communications
Company Inc.
PO Drawer 6000
Window Rock, AZ 86515

Navajo Land Development
PO Box 2249
Window Rock, AZ 86515

Navajo Nation Minerals Dept.
PO Box 1910
Window Rock, AZ 86515

Navajo Partnership for
Housing, Inc.
PO Box 1370
St. Michaels, AZ 86511

Navajo Tribal Utility Authority
PO Box 170
Fort Defiance, AZ 86504

New Mexico State Land
Office
PO Box 1148
Santa Fe, NM 87504-1148

Peabody Natural Resource
Company
701 Market St.
St. Louis, MO 63101

Public Service Co. of NM
Alvandado Square
Albuquerque, NM 87158

Santa Fe Railroad
Trainmaster Office
811 Roundhouse Rd.
Gallup, NM 87301

District Technical Support
Engineer
NM State Highway Dept.
PO Box 2159
Milan, NM 87201

Tse Bonita Valley Water
Users Association
HCR-5, Box 34
Gallup, NM 87301

Paula Westbrook Heirs
c/o Bruce Williams
25 Road 5787
NBU 2010
Farmington, NM 87401

Appendix 6: Certification of Application

Certification of Application

I certify, to the best of my knowledge and belief, that all applicable reclamation activities have been accomplished on the lands contained in this Chevron Mining Inc – McKinley Mine, Permit 2016-02 Area 9 South Bond Release Application in accordance with the requirements of SMCRA, the Act, the regulatory program, and the approved permit and reclamation plan.

Jeff Schoenbacher – CEMREC (signature)   Date: 8.9.22
McKinley Mine – Operations Lead

State of New Mexico)
) SS
County of Taos)

Subscribed and sworn to before me, in my presence, this 9TH day of August, 2022.

(signature) a Notary Public in and for the State of New Mexico.

SONIA M. SUAZO
Notary Public - State of New Mexico
Commission # 1134781
My Comm. Expires Jun 24, 2025

(signature)
Notary Public

My Commission expires 6·24·25

Appendix 7: Public Notice

Public Notice

Chevron Mining Inc. (formerly The Pittsburg & Midway Coal Mining Co.) has filed an application for bond release of the permanent-program performance bond for Area 9 South (Area 9S) which includes 1,1193 acres of Phase II and Phase III bond release and 42 acres of Phase I bond release which lies within the Phase II and III area. Phase II bond release is being sought since vegetation has been established and the contribution of suspended solids to streamflow or runoff outside the permit is not in excess of the 19.8 NMAC requirements. Phase III bond release is being sought since the area has met vegetation standards in accordance with the permit and the regulations and all remaining reclamation obligations have been completed.

The application was filed with the New Mexico Mining and Minerals Division (MMD) of the Energy, Minerals & Resources Department in Santa Fe, New Mexico. The Phase I bond release consists of a road corridor and reclaimed pond areas that were excluded from the prior 2015 Phase I bond release in the area and now qualify for Phase I release.

Chevron Mining Inc.'s headquarters is located at 6001 Bollinger Canyon Road, San Ramon, CA 94583. The current permit number for the McKinley Mine regulated by the State of New Mexico Mining and Minerals Division is 2016-02, which expires on March 7, 2021 and has been administratively extended.

The McKinley Mine is located approximately 23 miles northwest of Gallup, NM and 3 miles east of Window Rock, AZ on NM State Highway 264. The areas in the bond release application are located within the Samson Lake USGS quadrangle map.

The land for which bond release is sought is shown on the accompanying map Figure 1 McKinley Mine Area 9S Bond Release Area, and is located within the following areas:
<u>T16N, R20W New Mexico Principal Meridian, McKinley County, New Mexico</u>
Section Numbers: 15, 16, 21, 22, 23, 26, 27 and 28.

Area 9S Surface Ownership

Township and Range	Section	Phase I Acres	Phase II Acres	Phase III Acres	Surface Ownership	Allotment Numbers
T16N, R20W	15	0.0	23.9	23.9	Westbrook	
	15	0.0	23.7	23.7	Chevron USA, Inc.	
	16	30.0	94.8	94.8	BIA	1592, 1593, 1594, 1595
	21	1.1	235.8	235.8	Chevron USA, Inc.	
	22	0.0	464.4	464.4	BIA	1581, 1582, 1583
	22	0.0	85.3	85.3	BLM	
	23	0.0	104.4	104.4	Chevron USA, Inc.	
	26	5.9	41.6	41.6	BIA	1566
	27	3.3	77.8	77.8	Chevron USA, Inc.	
	28	1.7	41.3	41.3	BIA	1591
	Total	42.0	1193.0	1193.0		

Additional details are provided below concerning this application:
Bonding Information:
The following summarizes the current and remaining bond fund, proposed bond release and remaining bond:

Current Bond Type:	Surety Bond
▪ Current Bond Fund:	$ 24,645,642
▪ Less Previous A11/12 PI Bond Release:	$ 1,150,724
▪ Remaining Bond Fund:	$ 23,494,918
▪ Area 9S direct & indirect costs to be released:	$ 2,634,239
▪ New Bond Fund Amount:	$ 20,860,679 (in 2022 dollars)

Disturbed Acreage to be released:

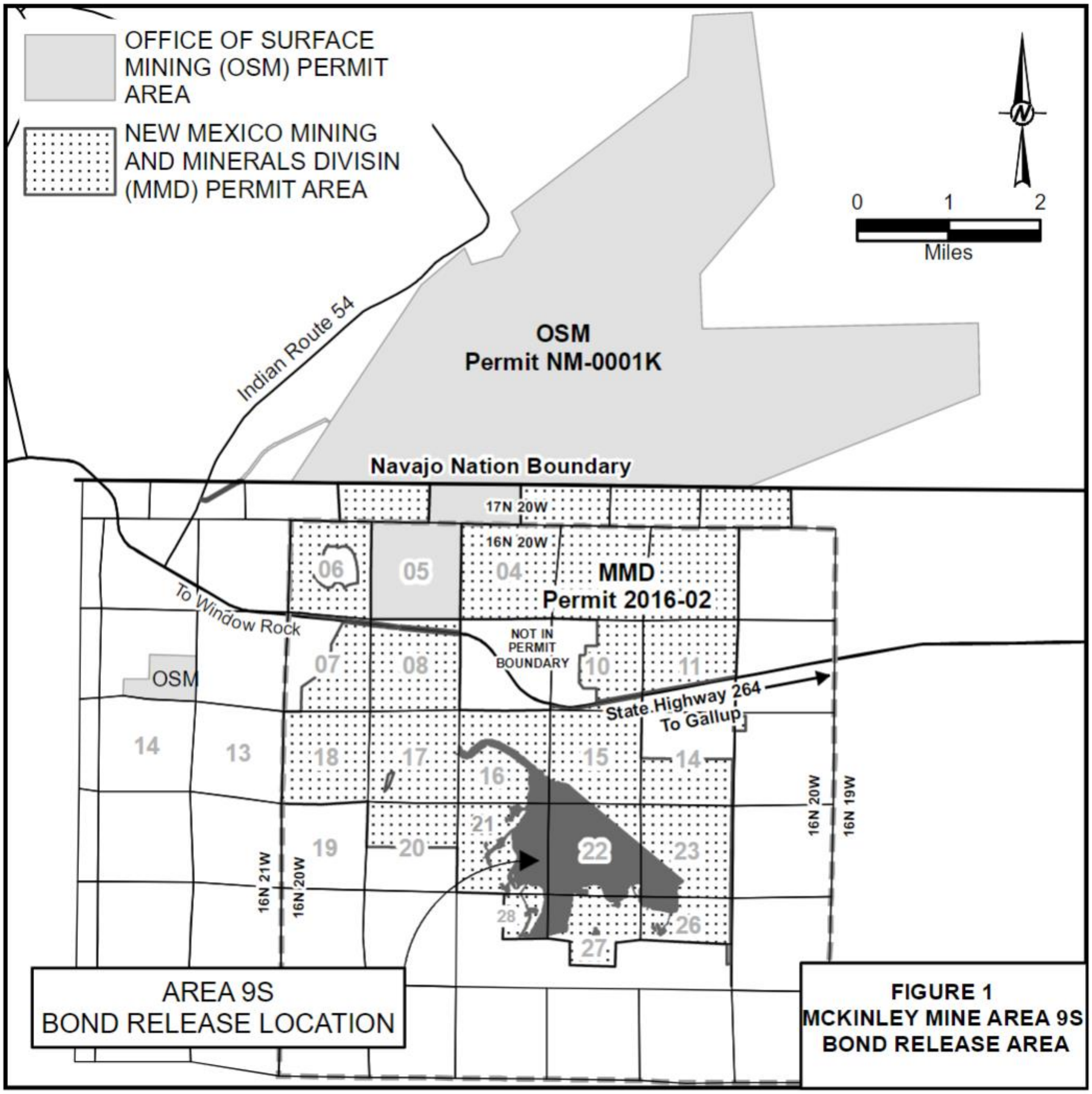
▪ Total acreage to be released:	1,193.0 ac.
▪ Acres permitted:	12,958.2 ac.
▪ Percentage of acres permitted being released:	9.2 %

Disturbance and mining in Area 9S occurred between 1986 and 2006. Phase I bond for much of the area was released in 2015, which covered backfilling and grading, graded spoil suitability, topsoil replacement and construction of hydrologic structures and drainage control. Reclamation of the remaining 42 acres of road corridor and the sedimentation ponds were completed after the initial application date for the 2015 bond release and these areas now qualify for Phase I bond release. Seeding of the reclaimed lands occurred between 1995 and 2014. Assessment of Area 9S for vegetation performance was conducted in 2019, 2020, and 2021.

A copy of the bond-release application is available for public inspection at the following locations:

- County Clerk, McKinley County Courthouse, 201 W Hill Ave, Gallup, New Mexico, 87301.
- New Mexico Mining and Minerals Division, 1220 South St. Francis Drive, Santa Fe, NM 87505 (Contact Name: James R. Smith by phone at 505-690-8071 or by email at JamesR.Smith@state.nm.us to make arrangements to review the bond release application).
- Within 30 days of the final publication of a notice for this bond-release application in the Gallup Independent or Navajo Times newspaper, written comments, objections, or requests for a public hearing and informal conference on this bond-release application shall be submitted to:
    - Director, Mining and Minerals Division, 1220 South St. Francis Drive, Santa Fe, NM 87505.

Figure 1: McKinley Mine Area 9S Bond Release Area



Appendix 8: Complete 2019, 2020, and 2021 Vegetation Monitoring Reports for VMU #4

REPORT

Vegetation Management Unit 4
Vegetation Success Monitoring, 2019

McKinley Mine, New Mexico Mining and Minerals Division Permit Area

Submitted to:

Chevron Environmental Management Company

Chevron Mining Inc. - McKinley Mine
24 Miles NW HWY 264
Mentmore, NM 87319

Submitted by:

Golder Associates Inc.

5200 Pasadena Avenue, N.E. Suite C
Albuquerque, New Mexico, USA 87113

+1 505 821-3043

133-8105207

February 21, 2020

Table of Contents

TABLES

FIGURES

APPENDICES

1.0 INTRODUCTION

Mining was completed in Mining and Minerals Division (MMD) jurisdictional lands at the McKinley Mine in 2007; most of the land is reclaimed, with only the facilities remaining. The lands mined and reclaimed included prelaw, initial-program, and permanent-program lands. Liability release has been completed on all prelaw and initial-program lands, and full bond release on a limited amount of permanent-program land.

Chevron Mining Inc. (CMI) is assessing the vegetation in the remaining permanent-program reclaimed areas in anticipation of future bond and liability releases. CMI understands the importance of returning the mined lands to productive traditional uses in a timely manner. In order to qualify for release, the lands must be in a condition that is as good as or better than the pre-mine conditions, stable, and capable of supporting the designated postmining land use of grazing and wildlife. The increment, or permit area as a whole, must meet vegetation establishment responsibility period criteria, which is a minimum of 10 years. Golder Associates Inc. (Golder) was retained to monitor and assess the vegetation relative to the established vegetation success standards in Permit # 2016-02.

1.1 Vegetation Management Unit 4

This report presents results from 2019 quantitative vegetation monitoring conducted in Vegetation Management Unit 4 (M-VMU-4), comprising about 1,240 acres of within Area 9 south and parts of Area 9 north (Figure 1). The elevation in this area ranges from about 6,700 to 7,000 feet above mean sea level. Permanent program reclamation in Area 9 started on lands disturbed after 1986, with the vast majority seeded by 2009. Thus, reclamation age in the majority of M-VMU-4 ranges from 8 to more than 30 years old. The configuration of the vegetation monitoring units within the MMD Permit Area, shown on Figure 1 were developed in consultation with MMD. This section provides a general description of the reclamation activities that were implemented. Additional details of the reclamation for specific areas can be obtained through review of McKinley's annual reports.

1.2 Reclamation and Revegetation Procedures

Reclamation methods applied in Area 9 included grading of the spoils to achieve positive drainage and approximate original contour. Graded spoil monitoring was then conducted to verify that the upper 42 inches of spoil was suitable for plant growth or if it required mitigation to establish a suitable root zone. A minimum of 6 inches of topsoil or topsoil substitute were then applied over suitable spoils.

After topsoil or topdressing placement, the surface was scarified in preparation for planting. Seeding was done using various implements that drilled and/or broadcast the seed. After the seeding, mulch consisting of either hay or straw was applied at a rate of about 2 tons/acre. The mulch was anchored 3 to 4 inches into the soil with a tractor-drawn straight coulter disc. The seeding was generally performed in the fall, which coincided with logical units for seeding that had been topdressed over the spring and summer. Seed mixes used at McKinley have varied over time but included both warm- and cool-season grasses, introduced and native forbs, and shrubs. The early seed mixes tended to emphasize the use of alfalfa and cool-season grasses. Over time the seed mixes shifted to include more warm-season grasses and a broader variety of native forbs.

1.3 Prevailing Climate Conditions

The amount and distribution of precipitation are important determinants for vegetation establishment and performance. Once vegetation is established, the precipitation dynamics affect the amount of vegetation cover and biomass on a year-to-year basis with grasses and forbs showing the most immediate response.

The South Mine Area has experienced several drought years recently. Total annual precipitation was above the regional average (about 11.8 inches at Window Rock) in 2015 and below average in 2016, 2017, and 2018 (Table 1). Annual precipitation for 2019 is comparable to long-term averages for the region, though monsoonal precipitation was well below average. Figure 1 shows the location of the precipitation gages used for the South Mine. Departure of growing season precipitation (April through September) from long-term seasonal mean at Window Rock (1937-1999) for McKinley is shown on Figure 2 based on the Rain 9 station. Between 2015 and 2019, growing season precipitation has been below average in all years but 2015, when growing season total precipitation was 0.85 inches above average. In 2016, 2018 and 2019, growing season precipitation was 2.4 to almost 2.8 inches below average. Growing season precipitation was 0.51 inches below average at the Rain 9 gage in 2017. From 2015 to 2019, peak growing season months have been relatively dry with a pronounced deficit in the early monsoon (July and August), with rare exceptions being July 2015 and July 2018.

1.4 Objectives

The intent of this report is to document the vegetation community attributes in M-VMU-4 and compare them to the Permit's vegetation success criteria. Section 2 describes the vegetation monitoring methods that were used in 2019. Section 3 presents the results of the investigation with respect to ground cover, annual production, shrub density, and composition and diversity. Section 4 is a summary of the results for M-VMU-4 with emphasis on vegetation success.

2.0 VEGETATION MONITORING METHODS

Vegetation attributes on M-VMU-4 in Area 9 were quantified using the methods described in Section 6.5 of the Permit. Fieldwork was conducted at the end of the growing season, but prior to the first killing frost. Vegetation monitoring in M-VMU-4 was conducted between October 16 and 17, 2019.

2.1 Sampling Design

A systematic random sampling procedure employing a transect/quadrat system was used to select sample sites within the reclaimed area. The transect locations were reviewed with MMD in advance of sampling. A 50-square foot grid was imposed over the VMU to delineate vegetation sample plots, and random points created in a geographic information system were used to select plots for vegetation sampling. The locations of randomly selected vegetation plots are shown on Figure 3 for M-VMU-4. In the field, the randomly selected transect locations were assessed in numerical order. If the transect location was determined to be unsuitable, the next alternative location was assessed for suitability. Unsuitable transects were those that fell on or would intersect roads, drainage ways, wildlife rock piles, or prairie dog colonies.

Transects originated from the southeastern corner of the vegetation plot. Each transect was 30 meters (m) long in a dog-leg pattern (Figure 4). Four 1-m^2 quadrats were located at pre-determined intervals along the transect for quantitative vegetation measurements. Each quadrat is considered an individual sample where measurements were made of production, total canopy, species canopy and basal cover, surface litter, surface rock fragments, and bare soil as discussed below.

2.2 Vegetation and Ground Cover

Relative and total canopy cover, basal cover, surface litter, rock fragments, and bare soil were estimated for each quadrat. Canopy cover estimates include the foliage and foliage interspaces of all individual plants rooted in the quadrat. Canopy cover is defined as the percentage of quadrat area included in the vertical projection of the canopy. The canopy cover estimates made on a species basis may exceed 100% in individual quadrats where the vegetation has multi-layered canopies. In contrast, the sum of the total canopy cover, surface litter, rock fragments, and bare soil does not exceed 100%.

Basal cover is defined as the proportion of the ground occupied by the crowns of grasses and rooting stems of forbs and shrubs. Basal cover estimates were also made for surface litter, rock fragments, and bare soil. Like the total cover estimates, the basal cover estimates do not exceed 100%. All cover estimates were made in 0.05% increments. Percent area cards were used to increase the accuracy and consistency of the cover estimates. Plant frequency was determined on a species-basis by counting the number of individual plants rooted in each quadrat.

2.3 Annual Forage and Biomass Production

Production was determined by clipping and weighing all annual (current year's growth) above-ground biomass within the vertical confines of a 1-m^2 quadrat. Grasses and forbs were clipped to within 5 centimeters (cm) of the soil surface, and the current year's growth was segregated from the previous year's growth (e.g., gray, weathered grass leaves and dried culms). For this sampling event, plants that were less than 5 cm tall or considered volumetrically insignificant were not collected. Production from shrubs was determined by clipping the current year's growth.

The plant tissue samples of every species collected were placed individually in labeled paper bags. The plant tissue samples were air-dried (> 90 days) until no weight changes were observed with repeated measurements on representative samples. The average tare weight of the empty paper bags was determined to correct the total sample weight to air-dry vegetation weights. The net weight of the air-dried vegetation was converted to a pounds per acre (lbs/ac) basis.

2.4 Shrub Density

Shrub density, or the number of plants per square meter, was determined using the frequency count data from the quadrats and the belt transect method (Bonham 1989). Shrub density was calculated from the quadrat data by dividing the total number of individual plants counted by the number of quadrats measured. The density per square meter was converted to density per acre.

Shrub density was also determined using a belt transect method (Bonham 1989). Shrub density was determined from a 1-meter wide; 30-meter long belt transect situated along the perimeter of the dog-legged transect (Figure 4). Shrubs rooted in the belt transect were counted on a species basis.

2.5 Statistical Analysis and Sample Adequacy

For the vegetation success demonstrations at McKinley, statistical adequacy is determined on the basis of the canopy cover, production and shrub density data. The number of samples required to characterize a particular vegetation attribute depends on the uniformity of the vegetation and the desired degree of certainty required for the analysis.

The number of samples necessary to meet sample adequacy (N_{min}) was calculated assuming the data were normally distributed using Snedecor and Cochran (1967).

$$N_{min} = \frac{t^2 s^2}{(\overline{x}D)^2}$$

Where N_{min} equals minimum number of samples required, t is the two-tailed t-distribution value based on a 90% level of confidence with n-1 degrees of freedom, s is the standard deviation of the sample data, $\overline{x}$ is the mean, and D is the desired level of accuracy, which is 10 percent of the mean.

In addition to N_{min}, the 90% confidence interval (CI) of the sample mean and the level of confidence that the sample mean is within 10 percent of the true mean are reported.

It is often impractical to achieve sample adequacy in vegetation monitoring studies based on Snedecor and Cochran's equation, and a minimum sample number approach is taken. MMD recognizes the practical limitations of achieving statistical adequacy and has provided minimum sample sizes for various quantitative methods (MMD 1999). With normally distributed data where sample adequacy cannot be met because of operational constraints or for other reasons, 40 samples are often considered adequate. The 40-sample recommendation is based on an estimate of the number of samples needed for a t-test under a normal distribution (Sokal and Rohlf 1981). Schulz et al. (1961) demonstrated that 30 to 40 samples provide a robust estimate for most cover and density measurements with increased numbers of samples only slightly improving the precision of the estimate.

CMI collected 40 samples at the outset of sampling based on the guidance discussed above. The 40 samples came from ten transects each having four quadrats as described in Section 2.1. Each quadrat is considered a unique sampling unit. Additional analysis around sample adequacy was done to see the number of samples that would have been required for adequacy by the Snedecor and Cochran equation. Further analysis for sample adequacy of cover, production and density attributes was also demonstrated using a graphical stabilization of the mean method (Clark 2001).

The emphasis on statistical adequacy assumes that parametric tests of normally distributed data will be conducted to demonstrate compliance with the vegetation success standards. It is important to note that normally distributed data and sample adequacy are not required for hypothesis testing. Nonparametric hypothesis tests are used to analyze data that are not normally distributed. When sample adequacy is not achieved, it is appropriate to use the reverse null approach for hypothesis testing. The reverse null is also generally recommended to evaluate reclamation success whether N_{min} is met or not (MMD 1999). This is because the reverse null is more defensible (compared to the classic approach) where the rejection of the null hypothesis definitively concludes that the reclamation mean is greater the technical standard (McDonald and Howlin 2013).

The procedures for financial assurance release as described in Coal Mine Reclamation Program Vegetation Standards (MMD 1999) guided the statistical analysis. Statistical tests were performed using both Microsoft® Excel and Analyse-it (version 5.40.3), a statistical add-in for Excel. The normality of each dataset was first assessed using the Shapiro-Wilk test to determine the appropriate hypothesis test method (i.e., parametric versus nonparametric). Data were considered normal when the test statistic was significant (p-value > 0.10) for alpha (α) = 0.10. Thus, the null hypothesis that the population is normally distributed was accepted if the p-value > 0.10. In cases where the data were not normally distributed, a log transformation was applied to see if it normalized the data.

All hypothesis testing used to demonstrate compliance with the vegetation success standards was conducted using a reverse null approach. Because vegetation performance at McKinley is compared to technical standards, the one-sample, one-sided t-test is used for normally distributed data to evaluate the mean and the one-sample, one-sided sign test to analyze the median of data that are not normal (MMD 1999; McDonald and Howlin 2013). The one-sided hypothesis tests using the reverse null approach were designed as follows:

Perennial/Biennial Canopy Cover

H_0 : Reclaim < 90% of the Technical Standard (15%)

H_a : Reclaim ≥ 90% of the Technical Standard (15%)

Annual Forage Production

H_0 : Reclaim < 90% of the Technical Standard (350 lbs/ac)

H_a : Reclaim ≥ 90% of the Technical Standard (350 lbs/ac)

Shrub Density

H_0 : Reclaim < 90% of the Technical Standard (150 stems/ac)

H_a : Reclaim ≥ 90% of the Technical Standard (150 stems/ac)

where H_0 is the null hypothesis and H_a is the alternative hypothesis. All hypothesis tests were performed with a 90% level of confidence.

Under the reverse null test, the revegetation success standard is met when H_0 is rejected and H_a is accepted. The decision criteria at 90% confidence under the reverse null hypothesis are as follows:

One-sample, one-sided t-test

If $t^* < t_{(1-\alpha;\ n-1)}$, conclude failure to meet the performance standard

If $t^* \geq t_{(1-\alpha;\ n-1)}$, conclude that the performance standard was met

One-sample, one-sided sign test

If P > 0.10, conclude failure to meet the performance standard.

If P ≤ 0.10, conclude that the performance standard was met.

Statistical hypothesis testing was performed on perennial/biennial cover, annual forage production and shrub density (woody stem stocking) using the one-sample, one-sided t-test and the one-sample, one-sided sign test. The hypotheses testing used the reverse null hypothesis bond release testing procedure as described in Coal Mine Reclamation Program Vegetation Standards (MMD 1999).

3.0 RESULTS

The vegetation community in M-VMU-4 is well established and dominated by perennial plants. A representative photograph of the vegetation and topography in M-VMU-4 is shown in Figure 5. The vegetation cover levels in 2019 suggest that the site is progressing to achieve vegetation success standards for the Permit Area. Vegetation success standards consist of four vegetative parameters: ground cover, productivity, diversity and woody stem stocking (Table 2). The ground cover requirement for live perennial/biennial cover on the reclamation is 15%. The productivity requirement is 350 air-dry lbs/ac perennial/biennial annual production. The woody stem stocking success standard is 150 live woody stems per acre.

Diversity is evaluated against numerical guidelines for different growth forms and photosynthetic pathways of the vegetation. In summary, the diversity guideline required by MMD would be met if at least two shrub or subshrub species with individual relative cover values of 1%; at least two perennial warm-season grass species have individual relative cover levels of at least 1%; at least one perennial cool-season grass species has an individual relative cover level of at least 1%; and three perennial or biennial forb species have a combined relative cover of at least 1%. MMD (1999) allows for the use of biennial forbs because they are technically monocarpic (single-flowering) perennials that annually produce a significant amount of seed and therefore as a species, they persist in the reclaimed plant community. Relative cover is the average percent cover of a perennial/biennial species divided by the total perennial/biennial cover of the sampling unit.

Diversity is also demonstrated by evidence of colonization or recruitment of native (not-seeded) plants from adjacent undisturbed native areas. Table 3 summarizes the attributes for plants recorded in the quadrats in addition to those encountered or observed but not recorded in the formal quantitative monitoring of M-VMU-4. Recruitment of these native plant species is indicative of ecological succession and the capacity of the site to support a self-sustaining ecosystem.

The field data for canopy and basal cover, density, production and shrub density by the belt transect are included in Appendix A, accompanied by Figure A-1 showing the 2019 transect locations within M-VMU-4. Figure A-1 also shows the seeded areas grouped by years. Photographs of the quadrats are included in Appendix B. Appendix C provides the statistical outputs for perennial/biennial canopy cover, annual forage production and shrub density by the belt transect method.

3.1 Ground Cover

Average total ground cover in M-VMU-4 is 52.0% comprised of 39.6% total vegetation cover, 3.8% rock, and 8.6% litter on a canopy cover basis (Table 3). On a basal area basis, average ground cover is 36.2% with 2.2% vegetation, 4.3% rock and 29.7% litter. Consistent with semi-arid rangelands the vegetation canopy cover in the individual quadrats varied, ranging from 0 to 78% (Table A-1).

Perennial/biennial canopy cover was calculated by summing the perennial/biennial species cover estimates after excluding the annual forbs and grasses. The mean perennial/biennial canopy cover was 40.9%, which exceeds the mean total vegetation canopy cover suggesting the occurrence of overlapping canopies. In M-VMU-4, both the mean total vegetation canopy cover (39.6% ± 6.1% [90% confidence interval, CI]) and mean perennial/biennial canopy cover (40.9% ± 7.5%) exceeded the vegetation success standard of 15% perennial/biennial cover (Table 4).

The perennial/biennial canopy cover data for M-VMU-4 were not normally distributed (Figure C-1). A log transformation of the canopy cover data did not result in a normal distribution. The calculated minimum sample size needed to meet N_{min} was 99 samples for total cover and 142 samples for perennial/biennial canopy cover (Table 4). Because N_{min} was not met and called for an unreasonable number of samples, the perennial/biennial canopy cover data were evaluated using a stabilization of the mean approach (Clark 2001) and with a one-sided, one sample sign test using the reverse null (MMD 1999). Figure 6 illustrates the stabilization of the estimated mean for perennial/biennial canopy cover based on grouping four sample increments associated with a single transect. The samples were analyzed in four sample increments to allow an estimation of variability. The corresponding variability around the mean is expressed by the 90% CIs for each successive analytical increment. These data suggest that the mean stabilized within 90% CI of the 40-sample mean after the collection of 12 to 16 samples. The variability of the estimate slightly decreased with the collection of additional data, but not to a meaningful degree. This analysis suggests that the collection of additional data beyond 40 samples would not improve the precision of the estimate of perennial/biennial cover.

Evaluation of the data using a one-sample, one-sided sign-test found only 10 quadrats with perennial/biennial cover not meeting 90% of the performance standard (13.5%), resulting in the probability (P) of 0.0013 of observing a z value less than -3.00. Therefore, under the reverse null hypothesis we conclude the performance standards is met forthe perennial/biennial canopy cover in 2019 (Table C-1).

3.2 Production

The 2019 annual forage production in M-VMU-4 was estimated to be 958 (± 191 [90% CI]) lbs/ac with an annual total production of 1000 ± 199 lbs/ac (Table 4). The relatively high ratio for forage to total biomass suggests the range conditions are favorable with few undesirable species. Colorado wildrye (*Leymus ambiguus*), western wheatgrass (*Pascopyrum smithii*) and galleta (*Pleuraphis jamesii*) accounted for about 47% of the forage, while four-wing saltbush (*Atriplex canescens*) accounted for an additional 37% (Table 3). Forage production for nine perennial grasses totaled 490 lbs/ac in M-VMU-4 exceeding the vegetation success standard of 350 lbs/ac by about 40%.

The annual forage production data for M-VMU-4 were not normally distributed (Figure C-2). A log transformation of the production data did not result in a normal distribution. The calculated minimum sample size needed to meet N_{min} at the 90% confidence level for annual forage production was estimated to be 167 samples (Table 4). Because N_{min} was not met and called for an unreasonable number of samples, the data were evaluated using a stabilization of the mean (Clark 2001) and with a one-sided, one sample sign test using the reverse null (MMD 1999). Figure 7 illustrates the stabilization of the estimated mean and 90% CI for annual forage production. These data indicate that the mean stabilizes near 916 lbs/ac after the collection of 28 samples with little change in the mean or 90% CI thereafter. This analysis suggests that the collection of additional data would not improve the precision of the estimate of forage production.

Evaluation of the data using the one-sample, one-sided sign test found only 7 production quadrats did not meet 90% of the performance standard (315 lbs/ac) resulting in the probability (P) of <0.0001 of observing a z value less than -3.95. Therefore, under the reverse null hypothesis we conclude the performance standard is met for annual forage production in 2019 (Table C-2).

3.3 Shrub Density

Shrub density ranged from an average of 3,723 ± 791 stems/ac based on the belt transect method to 6,778 ± 2,923 stems/ac for quadrat method (Table 4). In M-VMU-4, 9 shrub species were encountered in the belt transects (Table A-5) compared to 6 species in the quadrats (Table 3), reflecting the increased area of analysis associated with the belt transects. Four-wing saltbush and winterfat (*Krascheninnikovia lanata*) were the most common shrubs encountered under both measurement methods.

The shrub density data by the belt transect method were normally distributed (Figure C-3) and the calculated minimum sample size needed to meet N_{min} at the 90% confidence level was estimated to be 56 samples (Table 4). Because N_{min} was not met and called for an unreasonable number of samples, the shrub density belt transect data were evaluated using a stabilization of the mean (Clark 2001) and a one-sided, one sample t-test using the reverse null (MMD 1999). Figure 8 illustrates the stabilization of the mean for shrub density based on individual belt transect data. The corresponding variability around the mean is expressed by the 90% CIs for each successive analytical increment. These data suggest that the mean stabilized within the 90% CI of the 10-sample mean after the collection of 6 to 7 samples. The variability of the estimate slightly decreased with the collection of additional data, but not to a meaningful degree. This analysis suggests that the collection of additional data beyond 10 samples would not improve the precision of the estimate of shrub density.

The one-sided t-test calculated t*-statistic for M-VMU-4 shrub density is 7.72, where the sample mean is 3,723 stems/ac with a standard deviation of 1,520, the technical standard is 150 stems/ac and the sample size is 10. The one-tail $t_{(0.1, 9)}$ value is 1.383. Therefore, testing under the reverse null hypothesis ($t^* >= t_{(1-\alpha; n-1)}$), we conclude that the performance standard for shrub density (i.e., woody stem stocking) was met (Table C-3).

3.4 Composition and Diversity

Grasses dominated the canopy cover with Colorado wildrye, western wheatgrass and galleta being most prevalent (Table 3). Cool-season perennial grasses contribute 39% to perennial/biennial canopy cover in M-VMU-4 reflecting the past seed mixes and season of seeding. Four-wing saltbush, winterfat and yellow rabbitbrush (*Chrysothamnus viscidiflorus*) dominate the shrub component of the reclamation plant community in M-VMU-4. Forbs are minor contributors to the cover in M-VMU-4 even though numerous species occurred. The annual forb Russian thistle (*Salsola tragus*) and the annual/biennial forb flatspine stickseed (*Lappula occidentalis*) were the most prevalent forbs from a relative cover perspective.

Diversity is assessed through comparing the relative cover of various life-forms, based on their duration to the perennial/biennial cover of the vegetation management unit. In this context, relative cover is the average percent cover of a perennial/biennial species divided by the mean perennial/biennial cover of the sampling unit. Relative canopy cover of individual species contributing to perennial cover are listed in Table 3.

The diversity standard for cool-season grasses is achieved by several species that exceed 1% relative cover including Colorado wildrye (21.31%), western wheatgrass (13.94%) and thickspike wheatgrass (2.66%, *Elymus lanceolatus ssp. lanceolatus*).

The diversity standard for warm-season grasses requires a minimum of two species with 1% relative cover each. Only three warm-season perennial grasses were recorded including blue grama (*Bouteloua gracilis*), galleta, and alkali sacaton (*Sporobolus airoides*). The three warm-season perennial grasses encountered had relative covers of 21.09% for galleta, 0.48% for alkali sacaton and 0.19% for blue grama. Thus, the warm-season grass standard was not achieved in M-VMU-4. Multiple factors may contribute to the reduced cover of warm-season perennial grasses in this region and reclamation plant community including reclamation seed mixes emphasizing cool-season grasses, fall planting, growing-season drought in prior years and continued grazing pressure from trespass horses. With respect to 2019, we believe that the above-average winter precipitation followed by droughty conditions during the early monsoon rainfall period probably contributed to higher cover for cool-season grasses relative to the warm-season perennial grasses (Figure 2).

The diversity standard for forbs requires a minimum of three non-annual forb taxa combining to contribute at least 1% relative cover. The combined relative cover of 7 non-annual forbs is 11.34%, dominated by a native monocarpic forb, flatspine stickseed (8.73%). Additional forbs contributing to the diversity standard are flixweed (1.91%, *Descuurainia sophia*) and blazingstar species (0.55%, *Mentzelia spp.*). Other important forbs include upright prairie coneflower (0.06%, *Ratibida columnifera*), scarlet globemallow (0.06%, *Sphaeralcea coccinea*), rose heath (0.02%, *Chaetopappa ericoides*) and Palmer’s penstemon (0.01%, *Penstemon palmeri*). Based on 2019 sampling, 7 non-annual forbs have a combined relative cover greater than 1%, meeting the diversity standard for forbs on the M-VMU-4 reclamation.

The diversity standard for shrubs requires two species with a minimum relative cover of 1% for each species. The diversity standard for shrubs is achieved by four-wing saltbush (26.56%), yellow rabbitbrush (1.37%) and winterfat (3.05%).

Based on the 2019 vegetation monitoring, 82 different plant species were present within the reclamation areas of M-VMU-4 (Table 3). We encountered 39 forbs, 23 grasses and 20 shrubs, trees and cacti. Of the 39 forbs, 15 are considered annuals whereas the remaining 24 have variable durations or are purely perennial. Of the 23 grasses, 13 are cool-season perennials, seven are warm-season perennials and three are cool-season annuals. Cacti (one species) and trees (three species) were rare on the reclamation, while shrubs and subshrubs were more commonly observed (17 species).

During the 2019 monitoring program, we infrequently encountered four Class C noxious weeds (NMDA 2016) on M-VMU-4. Class C noxious weeds are generally widespread in the state and managed at the local level based on feasibility of control and level of infestation. The only noxious weed recorded in the quadrats was cheatgrass (*Bromus tectorum*) with a mean canopy cover of 1.15%. Cheatgrass was not used in the assessment of revegetation success. Other noxious weeds observed on M-VMU-4 were musk thistle (*Carduus nutans*), saltcedar (*Tamarix ramosissima*) and Siberian elm (*Ulmus pumila*). The contribution of these species to the vegetation community is insignificant with densities much lower than native rangeland beyond the permit boundary. CMI continues to monitor for noxious weeds and actively controls them through husbandry practices that include annual services for weed control. Further, competition from desirable seeded and native species is expected to inhibit any substantial increase of noxious weeds in the reclamation.

The recruitment of native plants and establishment of seeded species within M-VMU-4 is indicative of ecological succession and the capacity of the site to support a diverse and self-sustaining ecosystem.

4.0 SUMMARY

McKinley Mine’s vegetation success standards for the post-mining land uses of grazing and wildlife are based on canopy cover, production, shrub density, and plant diversity. Results of the 2019 vegetation monitoring indicate that the vegetation community in M-VMU-4 is progressing well and is nearly in full compliance with the vegetation success standards. Statistical hypothesis testing was performed on shrub density data using the one-sample, one-sided t-test, and the one-sample, one-sided sign test for perennial/biennial cover and the annual forage production. All hypotheses testing used the reverse null hypothesis as recommended in Coal Mine Reclamation Program Vegetation Standards (MMD 1999). Results of the statistical testing indicate that perennial/biennial canopy cover, annual forage production and shrub density levels in M-VMU-4 exceed their respective technical standards at the 90% level of confidence.

The diversity standards for cool-season grasses, forbs and shrubs were met in M-VMU-4. The diversity parameter for the warm-season grass standard was not met since only one species (a minimum of two needed) exceeded 1% relative cover. The lack of expression of the warm-season grasses may be due to drier summer monsoons over the past several years in combination with relatively wet springs that preferentially favor cool-season grass cover.

Overall, the performance of the vegetation is encouraging considering several growing seasons between 2016 and 2019 with below-average precipitation, a two-year drought in 2017 and 2018 and grazing pressure from feral horses. The performance of the vegetation under these conditions suggests that the plant communities developing on these areas are resilient and capable of sustaining themselves under adverse conditions that are characteristic of this region. While the reclamation in M-VMU-4 is now clearly capable of meeting and sustaining the postmining land use, CMI will evaluate the results of this sampling program to determine what is needed to achieve the revegetation success criteria for warm-season grasses.

5.0 REFERENCES

Bonham, C.D. 1989. Measurements for Terrestrial Vegetation. John Wiley & Sons. New York, NY.

Clark, D.L. 2001. Stabilization of the mean as a demonstration of sample adequacy. American Society for Surface Mining and Reclamation Annual Meeting. Albuquerque, NM. June 3-7, 2001. ASSMR, Lexington, KY.

Daubenmire, R. 1968. Plant communities: A textbook of plant synecology. Harper & Row, Publishers, New York.

Mining and Minerals Division (MMD). 1999. Coal Mine Reclamation Program Vegetation Standards. Santa Fe, NM. April 30.

McDonald, L., and S. Howlin. 2013. Evaluation and comparison of hypothesis testing techniques for bond release application. University of Wyoming, Laramie, WY.

New Mexico Department of Agriculture (NMDA). 2016. New Mexico Noxious Weed List Update. New Mexico State University, Las Cruces, NM.

Sokal, R.R. and F.J. Rohlf. 1981. Biometry (2nd edit.). W. H. Freeman and Co., San Francisco.

Schulz, A. M., R. P. Gibbens, and L. F. DeBano. 1961. Artificial populations for teaching and testing range techniques. J. Range Management. 14:236-242.

Snedecor, G.W. and W.G. Cochran. 1967. Statistical methods applied to experiments in agriculture and biology. 6th ed. Ames, Iowa: Iowa State University Press.

Golder and the G logo are trademarks of Golder Associates Corporation

\\albuquerque\projects\abq projects\mckinley\2019\2019_vegetationmonitoring\1_mmd_veg-phiii_2019\mmd-vmu4\text\1338105207-r-rev0-m_vmu4_2019veg-20200221.docx

Tables

Table 1: South Mine Seasonal and Annual Precipitation (2015-2019)

Year	Station	Area	Precipitation (inches)													
			January	February	March	April	May	June	July	August	September	October	November	December	Annual Total	Growing Season Total
2015	Tipple	South Shop	2.05	1.59	0.11	0.52	1.64	1.11	2.37	1.62	0.30	1.36	1.31	0.76	14.74	7.56
	Rain 9	9				0.50	1.38	1.22	2.88	1.25	0.22	1.13	0.99			7.45
	Rain 10	10				0.42	1.32	1.11	2.59	1.39	0.30	1.10	0.78			7.13
	Rain 11	11				0.48	1.88	1.02	2.80	1.69	0.26	0.97	1.08			8.13
2016	Tipple	South Shop	0.62	0.22	0.05	1.31	0.80	0.07	1.37	1.74	1.75	0.40	1.57	1.84	11.74	7.04
	Rain 9	9				0.22	0.62	0.45	1.24	0.50	1.05	1.05	0.00			4.08
	Rain 10	10				0.13	0.55	0.20	2.75	0.38	0.99	0.14	0.02			5.00
	Rain 11	11				0.28	0.77	0.64	1.61	0.42	1.09	0.09	0.04			4.81
2017	Tipple	South Shop	1.25	1.64	0.48	0.35	0.77	0.42	2.48	0.90	1.34	0.15	0.09	0.02	9.89	6.26
	Rain 9	9				1.20	1.02	0.01	0.82	1.40	1.64	0.37	0.91			6.09
	Rain 10	10				1.00	0.67	0.08	0.94	1.63	1.36	0.34	0.81			5.68
	Rain 11	11				1.23	1.16	0.05	0.86	2.00	1.85	0.34	0.49			7.15
2018	Tipple	South Shop	0.35	0.79	0.54	0.09	0.29	0.51	2.61	1.34	1.10	1.65	0.19	0.29	9.75	5.94
	Rain 9	9				0.07	0.27	0.25	2.16	0.74	0.67	1.31			5.47	4.16
	Rain 10	10				0.08	0.20	0.27	3.05	1.15	0.92	1.51			7.18	5.67
	Rain 11	11				0.09	0.29	0.26	1.92	1.00	0.89	1.45			5.90	4.45
2019	Tipple	South Shop	1.30	1.81	1.23	0.44	1.77	0.33	0.22	0.05					7.15	2.81
	Rain 9	9				0.16	1.36	0.24	0.46	0.37					2.59	2.59
	Rain 10	10				0.20	1.49	0.37	0.19	0.27					2.52	2.52
	Rain 11	11				0.20	1.50	0.19	0.44	0.20					2.53	2.53
Window Rock, Long-term (029410)			0.72	0.68	0.88	0.61	0.49	0.47	1.75	2.05	1.23	1.14	0.83	0.95	11.80	6.60

Notes:
Long-term averages are from Window Rock, Arizona Station (029410) for 1937 to 1999 (Western Regional Climate Center, 2019).
Growing season total precipitation is the sum of monthly totals between April and September

Table 2: Revegetation Success Standards for the Mining and Minerals Division Permit Area

Vegetative Parameter	Success Standard
Ground Cover	15% live perennial/biennial cover
Productivity	350 air-dry pounds per acre perennial/biennial annual production
Diversity	A minimum of 2 shrub or subshrub taxa contributing at least 1% relative cover each.
	A minimum of 2 perennial warm-season grass taxa contributing at least 1% relative cover each.
	A minimum of 1 perennial cool-season grass contributing at least 1% relative cover.
	A minimum of 3 perennial/biennial forb taxa combining to contribute at least 1% relative cover.
Woody Stem Stocking	150 live woody stems per acre

Notes:
Diversity criteria are assessed through evaluating individual perennial/biennial species relative cover, as agreed upon by MMD and CMI in June 2019. Further, relative cover is the average percent cover of a perennial/biennial species divided by the total perennial/biennial cover of the sampling unit.

Table 3: Vegetation Cover, Density and Production by Species, M-VMU-4, 2019

Scientific Name	Common Name	Code	Mean Vegetation Cover (%)			Mean Density (#/ac)	Mean Annual Production (lbs/ac)
			Canopy	Basal	Relative Canopy[a]		
Cool-Season Grasses							
Annuals							
Bromus arvensis	Field brome	BRAR5	<0.05	<0.05	--	304	<1
Bromus tectorum	Cheatgrass	BRTE	1.15	<0.05	--	36,826	18
Hordeum vulgare	Common barley	HOVU	obs	obs	obs	obs	obs
Perennials							
Achnatherum hymenoides	Indian ricegrass	ACHY	obs	obs	obs	obs	obs
Agropyron cristatum	Crested wheatgrass	AGCR	obs	obs	obs	obs	obs
Bromus inermis	Smooth brome	BRIN2	obs	obs	obs	obs	obs
Elymus elymoides	Bottlebrush squirreltail	ELEL	0.30	<0.05	0.73	6,171	4
Elymus lanceolatus ssp. lanceolatus	Thickspike wheatgrass	ELLAL	1.09	0.09	2.66	5,362	10
Elymus trachycaulus	Slender wheatgrass	ELTR7	<0.05	<0.05	0.02	101	<1
Hesperostipa comata	Needle and thread	HECO26	<0.05	<0.05	0.02	202	<1
Hordeum jubatum	Foxtail barley	HOJU	obs	obs	obs	obs	obs
Leymus ambiguus	Colorado wildrye	LEAM	8.72	0.46	21.31	28,733	237
Pascopyrum smithii	Western wheatgrass	PASM	5.71	0.27	13.94	30,857	108
Pseudoroegneria spicata	Bluebunch wheatgrass	PSSP6	obs	obs	obs	obs	obs
Thinopyrum intermedium	Intermediate wheatgrass	THIN6	obs	obs	obs	obs	obs
Thinopyrum ponticum	Tall wheatgrass	THPO7	obs	obs	obs	obs	obs
Warm-Season Grasses							
Perennials							
Aristida purpurea	Purple threeawn	ARPU	obs	obs	obs	obs	obs
Bouteloua curtipendula	Sideoats grama	BOCU	obs	obs	obs	obs	obs
Bouteloua gracilis	Blue grama	BOGR2	0.08	<0.05	0.19	1,720	<1
Bouteloua hirusta	Hairy grama	BOHI2	obs	obs	obs	obs	obs
Panicum virgatum	Switchgrass	PAVI2	obs	obs	obs	obs	obs
Pleuraphis jamesii	James' galleta	PLJA	8.63	0.85	21.09	54,936	102
Sporobolus airoides	Alkali sacaton	SPAI	0.20	<0.05	0.48	1,315	29
Forbs							
Annuals							
Alyssum desertorum	Desert madwort	ALDE	obs	obs	--	obs	obs
Alyssum simplex	Alyssum	ALSI8	obs	obs	--	obs	obs
Chenopodium album	Lambsquarters	CHAL7	<0.05	<0.05	--	101	<1
Chenopodium incanum	Mealy goosefoot	CHIN2	<0.05	<0.05	--	202	<1
Chenopodium leptophyllum	Narrowleaf goosefoot	CHLE4	0.17	<0.05	--	911	6
Cordylanthus wrightii	Wright's bird's beak	COWR2	obs	obs	--	obs	obs
Eriogonum cernuum	Nodding buckwheat	ERCE2	obs	obs	--	obs	obs
Eriogonum divaricatum	Divergent buckwheat	ERDI5	obs	obs	--	obs	obs
Helianthus annuus	Common sunflower	HEAN3	obs	obs	--	obs	obs
Kochia scoparia	Kochia	KOSC	<0.05	<0.05	--	101	<1
Malacothrix fendleri	Fendler's desertdandelion	MAFE	<0.05	<0.05	--	101	<1
Polygonum erectum	Erect knotweed	POER2	obs	obs	--	obs	obs
Salsola tragus	Russian thistle	SATR	1.39	<0.05	--	2,630	17
Unknown Annual Forb 1	Unk annual forb 1	UNKAF1	0.23	<0.05	--	27,822	<1
Xanthium strumarium	Rough cocklebur	XAST	obs	obs	--	obs	obs
Perennials/Biennials							
Achillea millefolium	Common yarrow	ACMI2	obs	obs	obs	obs	obs
Calochortus nuttallii	Sego lily	CANU3	obs	obs	obs	obs	obs
Carduus nutans	Musk thistle	CANU4	obs	obs	obs	obs	obs
Chaetopappa ericoides	Rose heath	CHER	<0.05	<0.05	0.02	101	<1
Conyza canadensis	Horseweed	COCA	obs	obs	obs	obs	obs
Descurainia sophia	Flixweed	DESO	0.78	<0.05	1.91	2,529	6
Ipomopsis longiflora	Flaxflowered ipomopsis	IPLO	obs	obs	obs	obs	obs
Lappula occidentalis	flatspine stickseed	LAOC3	3.57	<0.05	8.73	17,604	22
Machaeranthera canescens	Purple aster	MACA	obs	obs	obs	obs	obs
Machaeranthera tanacetifolia	Tanseyleaf tansyaster	MATA	obs	obs	obs	obs	obs
Mentzelia Spp.	Blazingstar species	MENTZ	0.23	<0.05	0.55	3,743	1
Melilotus officinalis	Yellow sweetclover	MEOF	obs	obs	obs	obs	obs
Medicago sativa	Alfalfa	MESA	obs	obs	obs	obs	obs
Mirabilis multiflora	Colorado four o'clock	MIMU	obs	obs	obs	obs	obs
Penstemon palmeri	Palmer's penstemon	PEPA8	<0.05	<0.05	0.01	202	<1
Polygonum aviculare	Prostrate knotweed	POAV	obs	obs	obs	obs	obs
Ratibida columnifera	Upright prairie coneflower	RACO3	<0.05	<0.05	0.06	101	<1
Rumex crispus	Curly dock	RUCR	obs	obs	obs	obs	obs
Sisymbrium altissimum	Tall tumblemustard	SIAL2	obs	obs	obs	obs	obs
Sphaeralcea coccinea	Scarlet globemallow	SPCO	<0.05	<0.05	0.06	1,012	<1
Sphaeralcea emoryi	Emory's globemallow	SPEM	obs	obs	obs	obs	obs
Sphaeralcea grossulariifolia	Gooseberryleaf globemallow	SPGR2	obs	obs	obs	obs	obs
Sphaeralcea incana	Gray globemallow	SPIN2	obs	obs	obs	obs	obs
Tragopogon dubius	Yellow salsify	TRDU	obs	obs	obs	obs	obs

Table 3: Vegetation Cover, Density and Production by Species, M-VMU-4, 2019

Scientific Name	Common Name	Code	Mean Vegetation Cover (%)			Mean Density (#/ac)	Mean Annual Production (lbs/ac)
			Canopy	Basal	Relative Canopy[a]		
Shrubs, Trees and Cacti							
Perennials							
Artemisia ludoviciana	White sagebrush	ARLU	obs	obs	obs	obs	obs
Artemisia tridentata	Big sagebrush	ARTR2	obs	obs	obs	obs	obs
Atriplex canescens	Four-wing saltbush	ATCA	9.71	0.29	23.73	4,452	355
Atriplex confertifolia	Shadscale saltbush	ATCO	0.19	<0.05	0.46	202	14
Atriplex corrugata	Mat saltbush	ATCO4	obs	obs	obs	obs	obs
Chrysothamnus viscidiflorus	Yellow rabbitbrush	CHVI	0.50	<0.05	1.22	101	38
Ephedra trifurca	Longleaf jointfir	EPTR	obs	obs	obs	obs	obs
Ephedra viridis	Mormon tea	EPVI	obs	obs	obs	obs	obs
Ericameria nauseosa	Rubber rabbitbrush	ERNA	<0.05	<0.05	<0.01	101	<1
Fallugia paradoxa	Apache plume	FAPA	obs	obs	obs	obs	obs
Gutierrezia sarothrae	Broom snakeweed	GUSA	obs	obs	obs	obs	obs
Heterotheca villosa	Hairy false goldenaster	HEVI	obs	obs	obs	obs	obs
Krascheninnikovia lanata	Winterfat	KRLA	1.12	<0.05	2.73	1,821	30
Opuntia polyacantha	Plains pricklypear	OPPO	obs	obs	obs	obs	obs
Pinus edulis	Piñon pine	PIED	obs	obs	obs	obs	obs
Purshia mexicana	Mexican cliffrose	PUME	obs	obs	obs	obs	obs
Purshia tridentata	Antelope bitterbrush	PUTR2	<0.05	<0.05	0.06	101	<1
Sarcobatus vermiculatus	Greasewood	SAVE4	obs	obs	obs	obs	obs
Tamarix ramosissima	Saltcedar	TARA	obs	obs	obs	obs	obs
Ulmus pumila	Siberian elm	ULPU	obs	obs	obs	obs	obs
Cover Components							
Perennial/Biennial Vegetation Cover			40.9	2.1			
Total Vegetation Cover			39.6	2.2			
Rock			3.8	4.3			
Litter			8.6	29.7			
Bare Soil			48.0	63.8			

Notes:
[a] = relative cover is the average percent cover of a perennial/biennial species divided by the total perennial/biennial cover of the sampling unit
-- = this parameter is not calculated for this attribute
#/ac = number of plants per acre
lbs/ac = air-dry forage pounds per acre
obs = observed on vegetation management unit during monitoring, but not recorded in the quadrats
Ps Pathway or growing season for the grasses is from Allred (2005)
Duration for plants is from the USDA Plants Database

Table 4: Summary Statistics for M-VMU-4, 2019

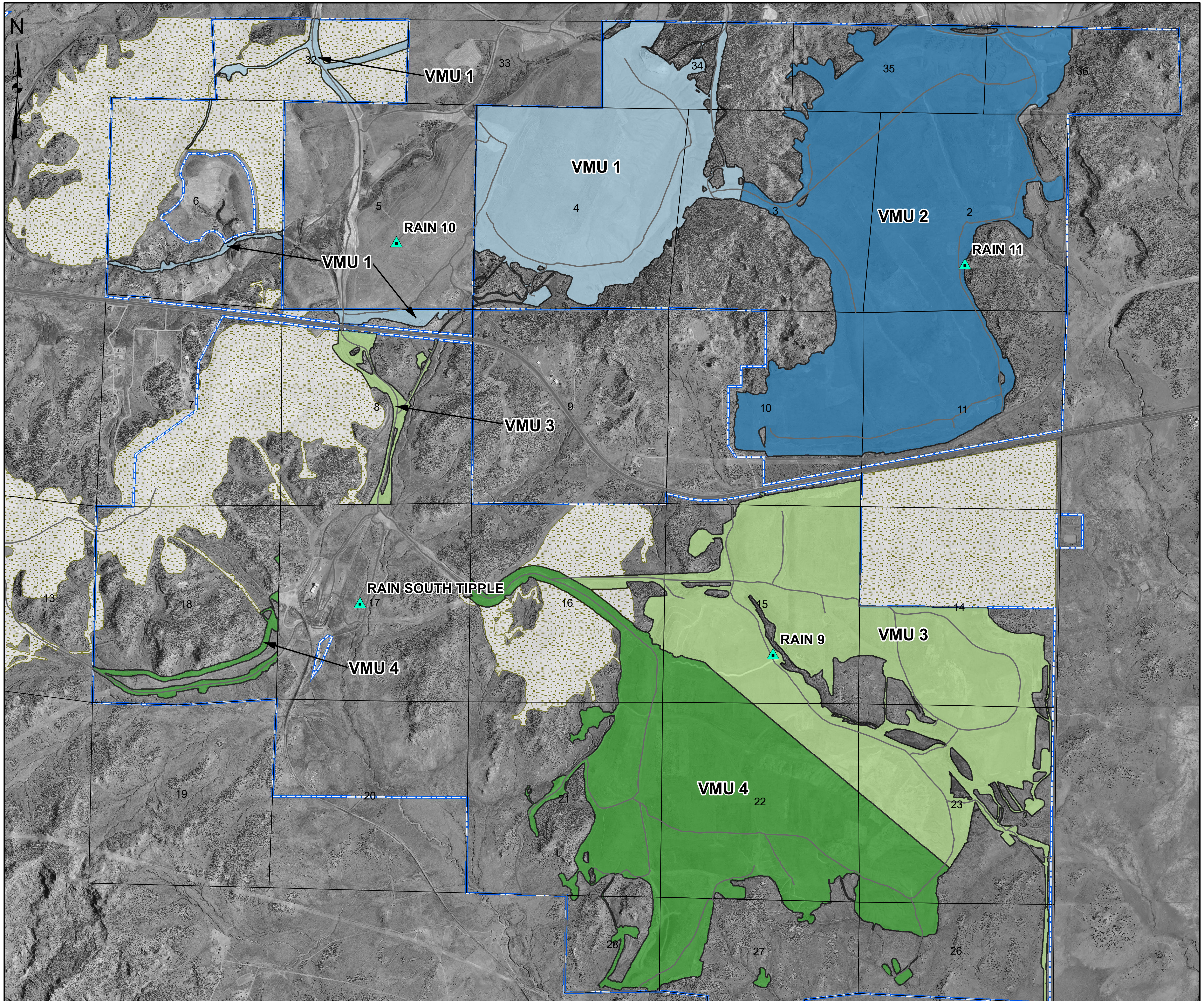
		Technical Standard
Total Vegetation Canopy Cover (%)		
Mean	39.6	None
Standard Deviation	23.4	
90% Confidence Interval	6.1	
Nmin[1]	99	
Probability within true mean[2]	0.64	
Perennial/Biennial Canopy Cover (%)		
Mean	40.9	15.0
Standard Deviation	29.0	
90% Confidence Interval	7.5	
Nmin[1]	142	
Probability within true mean[2]	0.67	
Basal Cover (%)		
Mean	2.2	None
Standard Deviation	1.9	
90% Confidence Interval	0.5	
Nmin[1]	198	
Probability within true mean[2]	0.70	
Annual Forage Production (lbs/ac)		
Mean	958	350
Standard Deviation	736	
90% Confidence Interval	191	
Nmin[1]	167	
Probability within true mean[2]	0.69	
Annual Total Production (lbs/ac)		
Mean	1,000	None
Standard Deviation	764	
90% Confidence Interval	199	
Nmin[1]	166	
Probability within true mean[2]	0.68	
Shrub Density (stems/acre) from Quadrats		
Mean	6,778	150
Standard Deviation	11,238	
90% Confidence Interval	2,923	
Nmin[1]	780	
Probability within true mean[2]	0.85	
Shrub Density (stems/acre) from Belt Transect		
Mean	3,723	150
Standard Deviation	1,520	
90% Confidence Interval	791	
Nmin[1]	56	
Probability within true mean[2]	0.55	

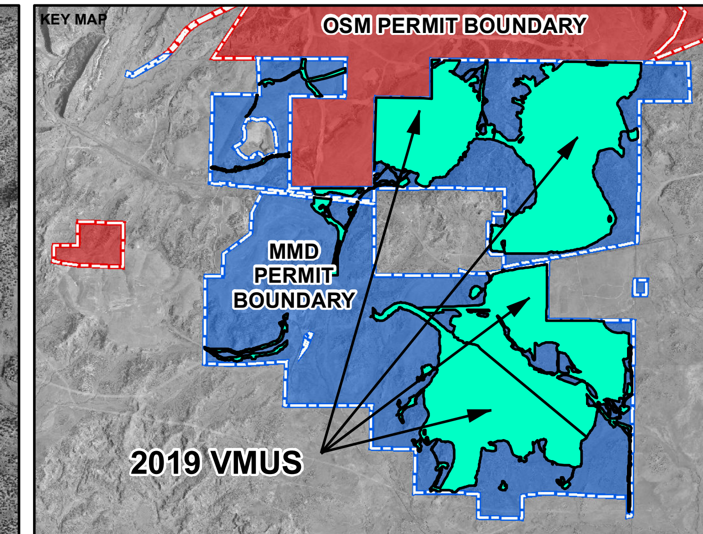
Notes:

1 Minimum number of samples required to obtain 90 percent probability that the sample mean is within 10 percent of the population mean

2 Probability the true value of the mean is within 10 percent of the mean for the sample size

Figures





LEGEND

- Rain Gauges
- Two-tracks, Roads and Highways
- PLSS - Sections
- MMD VMU 1 (~ 838 acres)
- MMD VMU 2 (~ 1,518 acres)
- MMD VMU 3 (~ 1,275 acres)
- MMD VMU 4 (~ 1,238 acres)
- Liability Release
- MMD Permit Boundary

0 3,000 6,000 Feet

1 inch = 2,667 feet

NOTE(S)

1. VMU = VEGETATION MANAGEMENT UNIT FOR VEGETATION SAMPLING PLAN

REFERENCE(S)

1. COORDINATE SYSTEM: NAD 1927, STATE PLANE - NEW MEXICO, WEST, FIPS 3003 (FEET)

CLIENT
CHEVRON MINING, INC. - MCKINLEY MINE
24 MILES, NW HWY 264
MENTMORE, NM 87319

PROJECT
MCKINLEY MINE - MMD PERMIT PHASE III BOND RELEASE
2019 VEGETATION SAMPLING PROGRAM

TITLE
GENERAL OVERVIEW OF MCKINLEY SOUTH MINE AREA VEGETATION MANAGEMENT UNITS (VMU), 2019

CONSULTANT

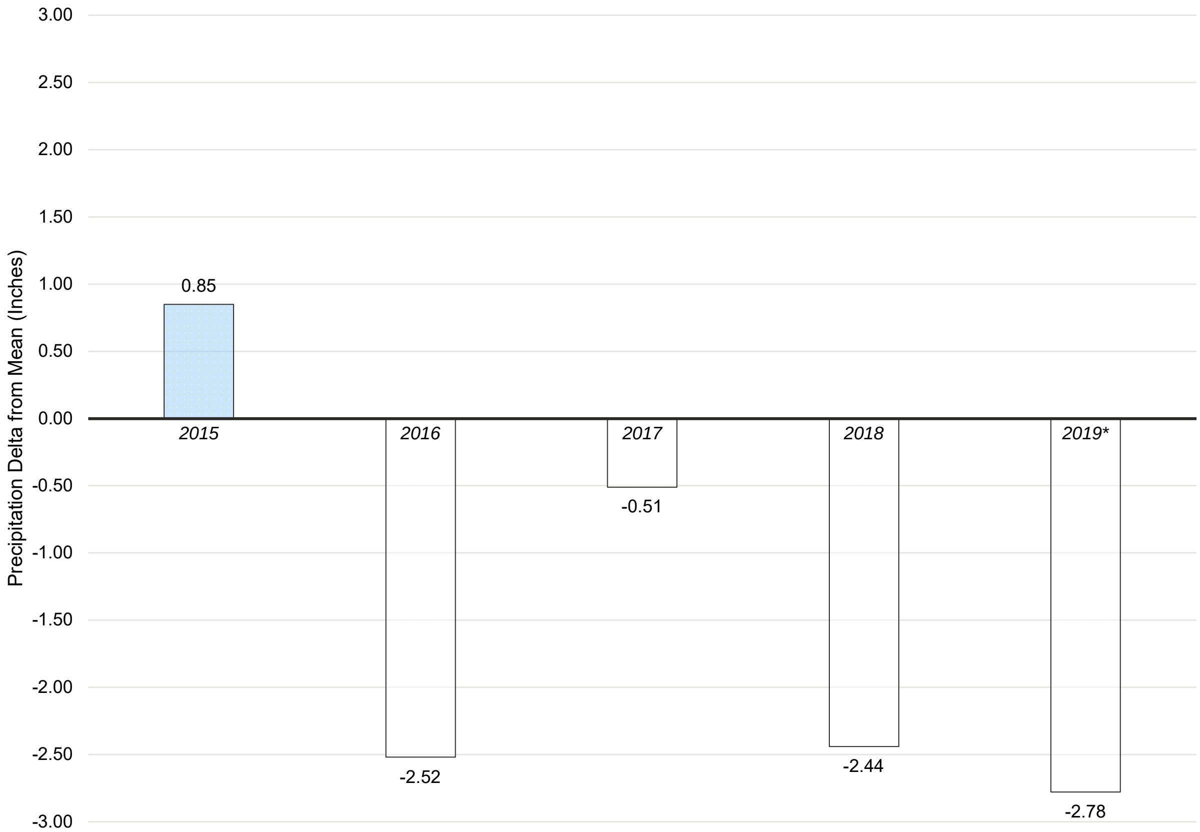
GOLDER

YYYY-MM-DD	2020-01-22
DESIGNED	DSW
PREPARED	DSW
REVIEWED	DR
APPROVED	FR

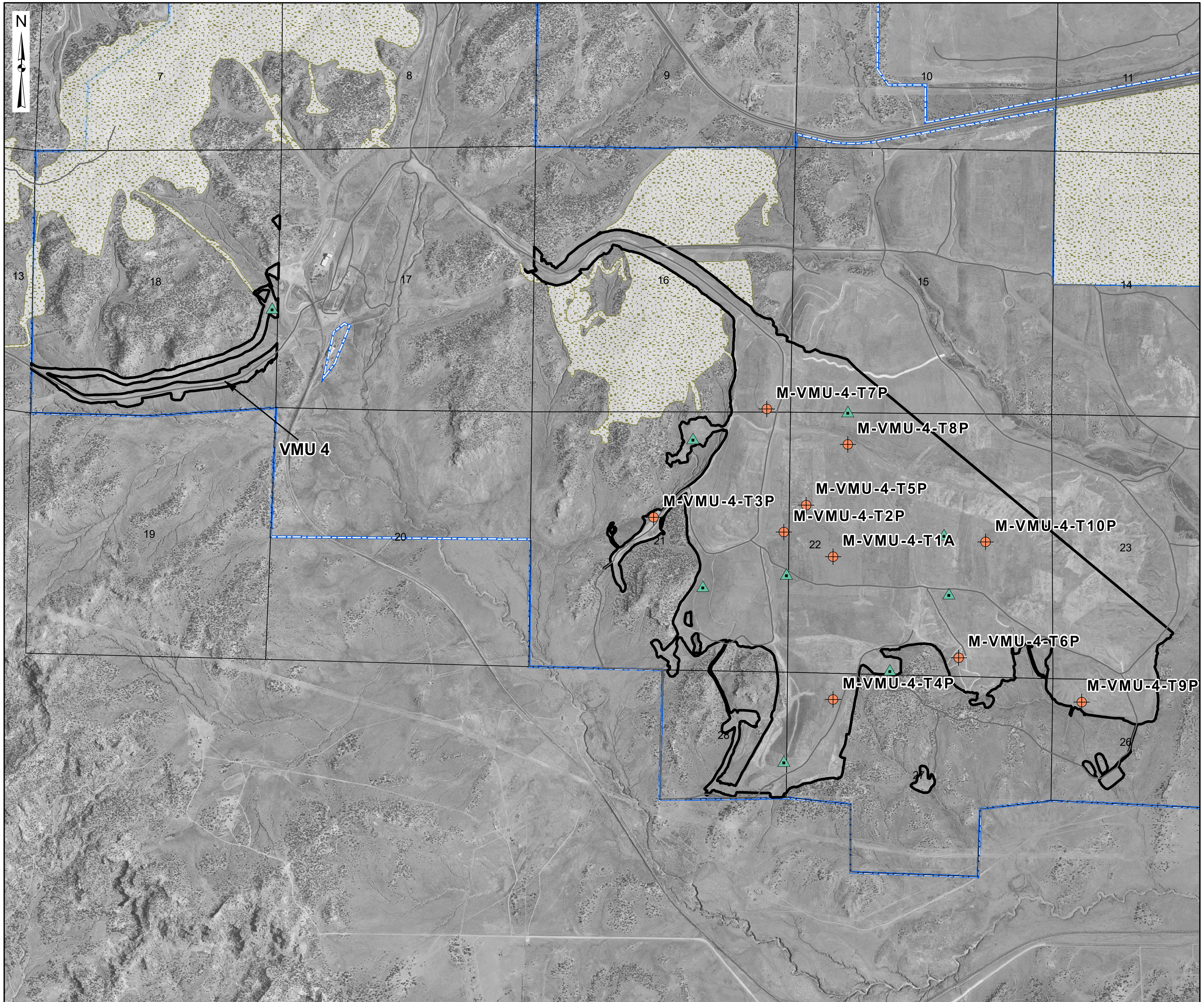
PROJECT NO.	CONTROL	REV.	FIGURE
133-8105207	000610	--	1

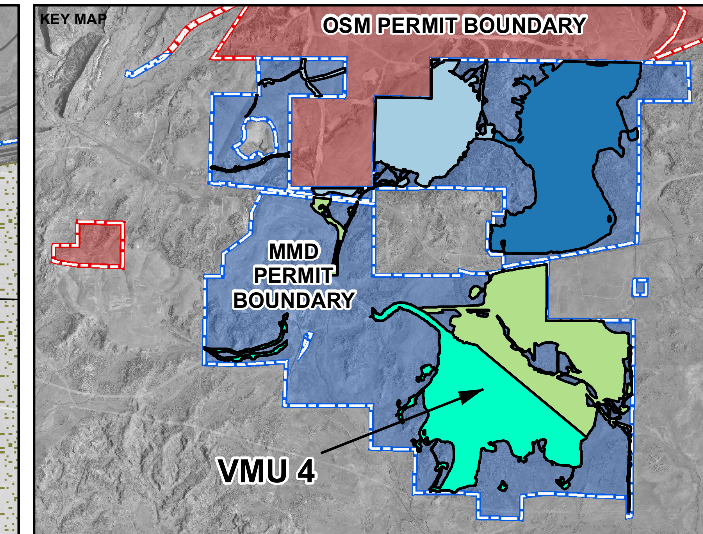
IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

Figure 2: Departure of Growing Season Precipitation from Long-Term Seasonal Mean at Window Rock; Rain 9 Gage



Notes:
Long-term averages are from Window Rock, Arizona Station (029410) for 1937 to 1999 (Western Regional Climate Center, 2019).
Growing season total precipitation is the sum of monthly totals between April and September
* The Seasonal mean for 2019 is from April through August





LEGEND

- Vegetation Transect - Sampled
- Vegetation Transect - Additional Alternate
- Two-tracks, Roads and Highways
- PLSS - Sections
- MMD VMU 4 (~ 1,238 acres)
- Liability Release
- MMD Permit Boundary

TRANSECT LABEL EXPLANATION:

M-VMU-1-T1P

MMD Permit Area | Vegetation Management Unit (VMU-#) | Transect Number | Primary (P) or Alternate (A)

0 2,000 4,000 Feet

1 inch = 2,000 feet

NOTE(S)

1. KEY MAP SCALE IS DIFFERENT FROM OVERVIEW OF VMUS
2. M-VMU-4-T1A REPLACED M-VMU-4-T1P DUE TO LANDING OUTSIDE THE DISTURBANCE BOUNDARY

REFERENCE(S)

1. COORDINATE SYSTEM: NAD 1927, STATE PLANE - NEW MEXICO, WEST, FIPS 3003 (FEET)
2. ORTHO SOURCE: CHEVRON, 2013

CLIENT

CHEVRON MINING, INC. - MCKINLEY MINE
24 MILES, NW HWY 264
MENTMORE, NM 87319

PROJECT

MCKINLEY MINE - MMD PERMIT PHASE III BOND RELEASE
2019 VEGETATION SAMPLING PROGRAM

TITLE

VEGETATION MONITORING TRANSECTS, 2019
VEGETATION MANAGEMENT UNIT 4

CONSULTANT

GOLDER

YYYY-MM-DD	2020-01-22
DESIGNED	DSW
PREPARED	DSW
REVIEWED	DR
APPROVED	FR

PROJECT NO.	CONTROL	REV.	FIGURE
133-8105207	000614	--	3

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

Figure 4: Vegetation Plot, Transect and Quadrat Layout

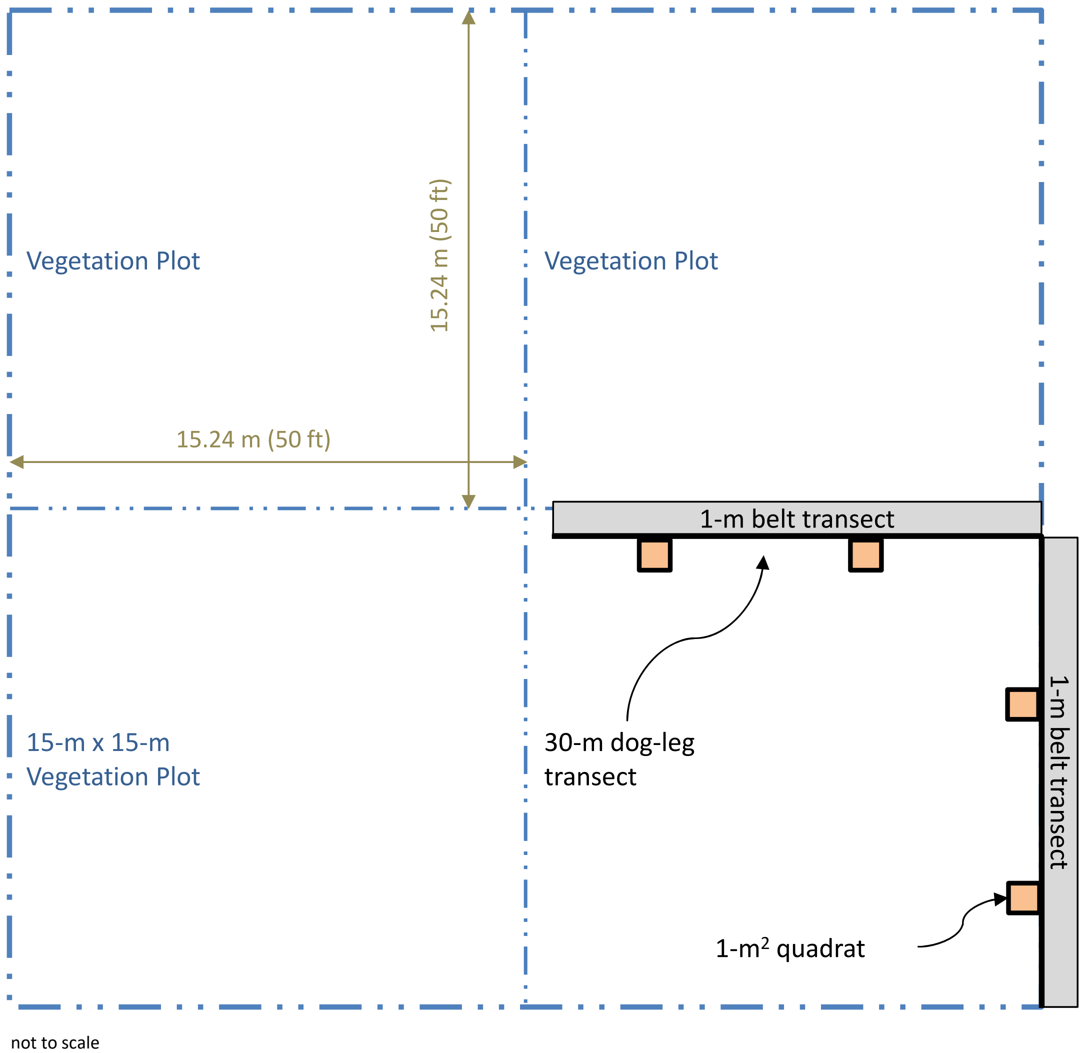


Figure 5: Typical Grass-Shrubland Vegetation in M-VMU-4, October 2019

Figure 6: Stabilization of the Mean for Perennial/Biennial Cover - M-VMU-4

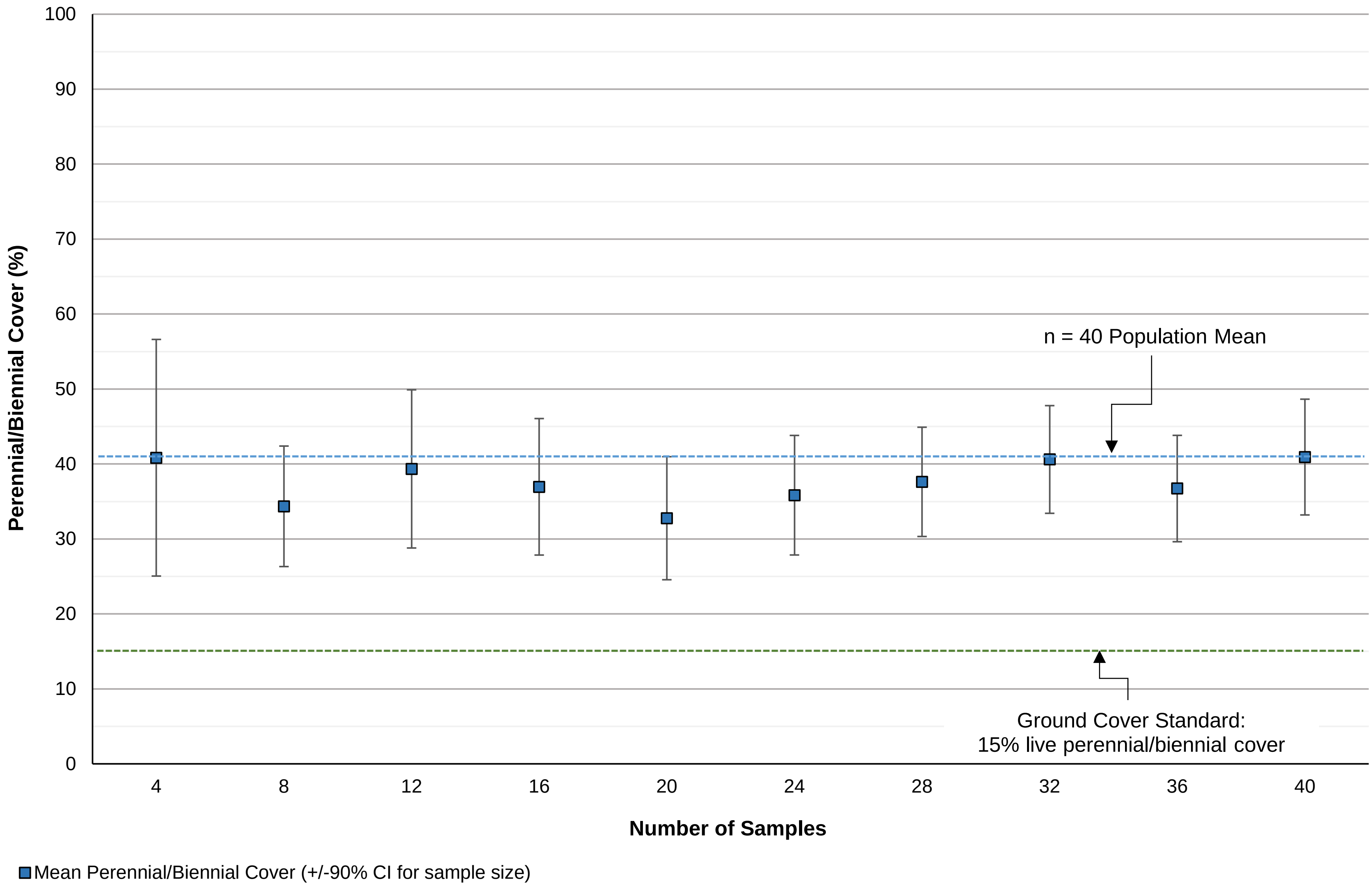


Figure 7: Stabilization of the Mean for Annual Forage Production - M-VMU-4

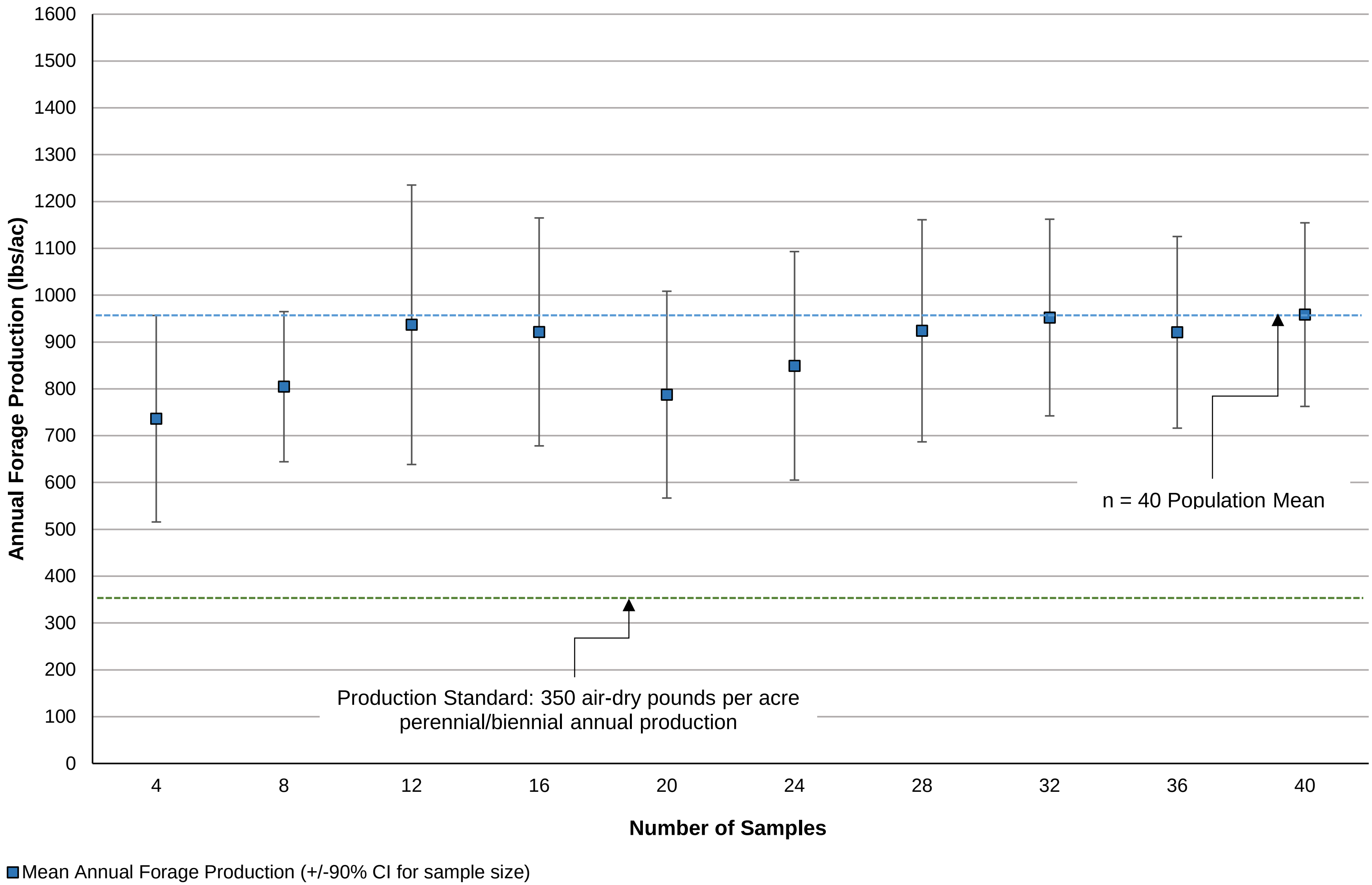
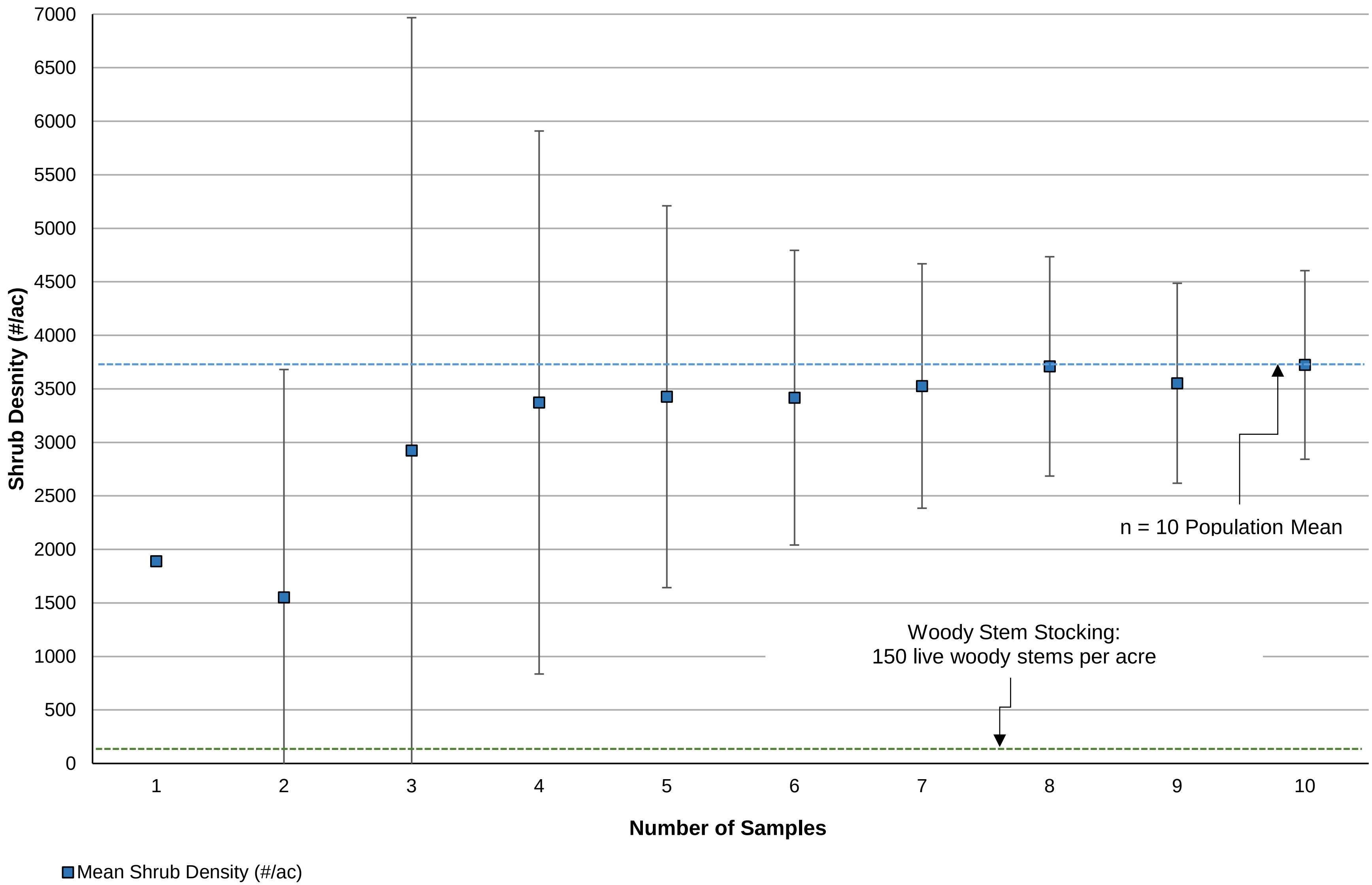
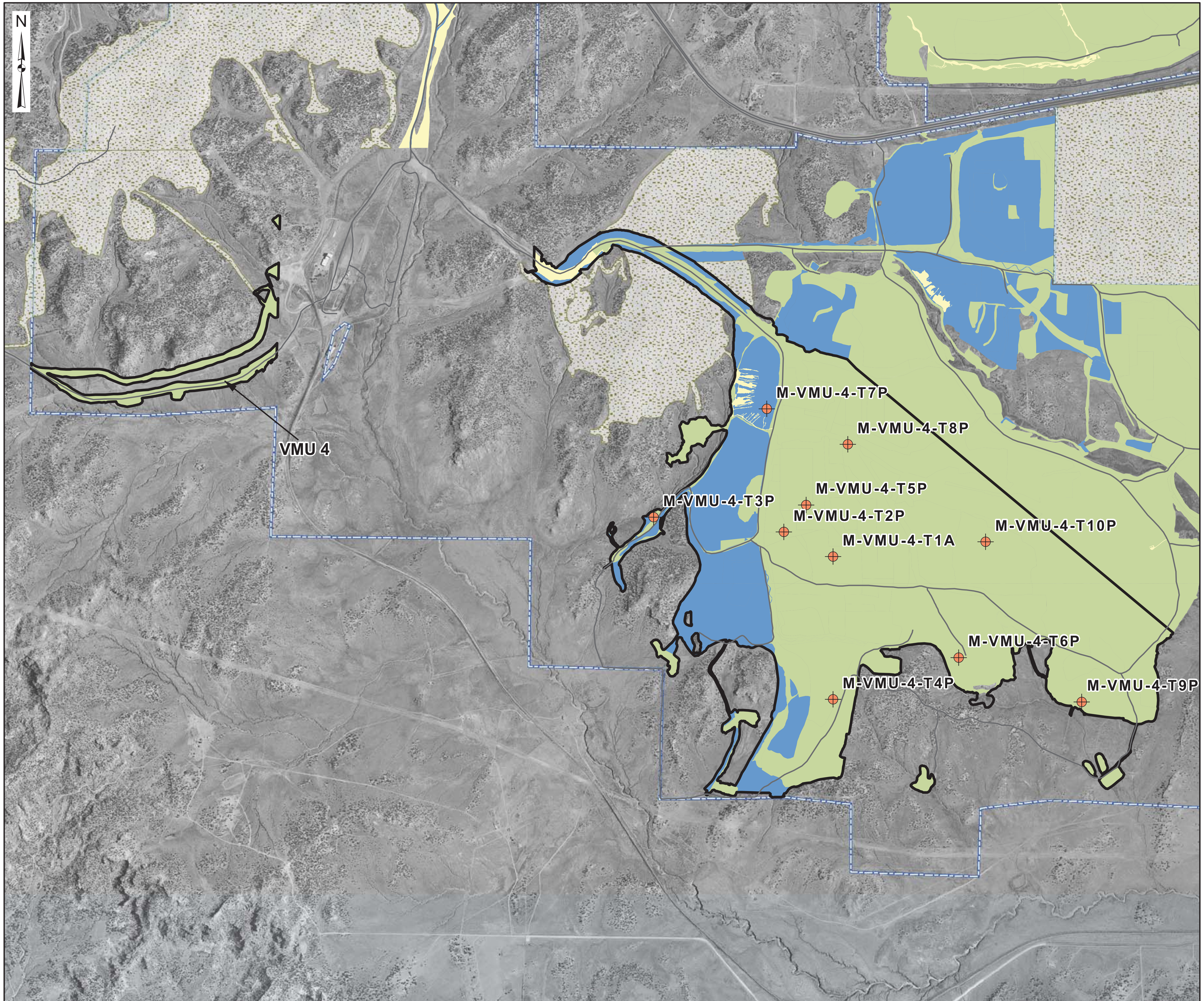


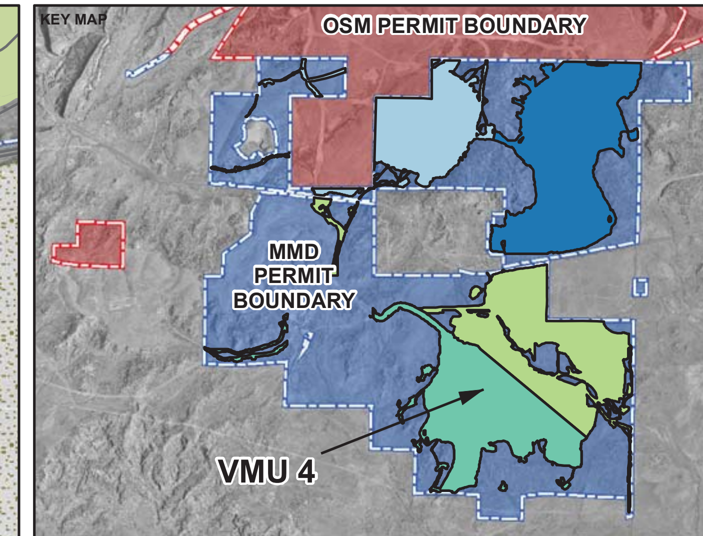
Figure 8: Stabilization of the Mean for Shrub Density - M-VMU-4



APPENDIX A

Vegetation Data Summary





LEGEND

- Transects for 2019 MMD PHIII Vegetation Sampling
- Two-tracks, Roads and Highways
- MMD VMU 4 (~ 1,238 acres)
- Liability Release
- MMD Permit Boundary

Seeded Areas by End_Year

- < 1997
- 1997 to 2013
- 2014 to 2018

TRANSECT LABEL EXPLANATION: M-VMU-1-T1P

- MMD Permit Area
- Vegetation Management Unit (VMU-#)
- Transect Number
- Primary (P) or Alternate (A)

0 2,000 4,000 Feet

1 inch = 2,000 feet

NOTE(S)

1. SEEDING AREA ATTRIBUTES WERE CLASSIFIED MANUALLY BASED ON SEED MIX VARIATIONS (<1997 AND 1997 TO 2013) WITH AN ADDITONAL CLASS FOR RECENT SEEDING (2014 TO 2018)

REFERENCE(S)

1. COORDINATE SYSTEM: NAD 1927, STATE PLANE - NEW MEXICO, WEST, FIPS 3003 (FEET)
2. ORTHO SOURCE: CHEVRON, 2013

CLIENT
CHEVRON MINING, INC. - MCKINLEY MINE
24 MILES, NW HWY 264
MENTMORE, NM 87319

PROJECT
MCKINLEY MINE - MMD PERMIT PHASE III BOND RELEASE
2019 VEGETATION SAMPLING PROGRAM

TITLE
SEEDED AREA CLASSIFICATION (YEAR) AND TRANSECT LOCATIONS SAMPLED VEGETATION MANAGEMENT UNIT 4 (M-VMU-4), 2019

CONSULTANT

GOLDER

YYYY-MM-DD	2019-12-13
DESIGNED	DSW
PREPARED	DSW
REVIEWED	DR
APPROVED	FR

PROJECT NO.	CONTROL	REV.	FIGURE
133-8105206	000624	--	A-1

PATH: W:\McKinley\MXDs\MMD_2019\1338105206_000624_FigA-1.mxd PRINTED ON: 2019-12-13 AT: 9:31:52 AM

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

Table A-1: M-VMU-4 Canopy Cover Data

Transect	M-VMU-4-T1A				M-VMU-4-T2P				M-VMU-4-T3P				M-VMU-4-T4P				M-VMU-4-T5P				M-VMU-4-T6P				M-VMU-4-T7P				M-VMU-4-T8P				M-VMU-4-T9P				M-VMU-4-T10P			
Quadrat	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Grasses																																								
Annuals																																								
BRAR5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.25	--	--	--	--	--	--	0.50	--
BRTE	--	--	--	--	--	--	--	--	25.00	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.20	--	3.80	2.00	15.00	--	--	--	--	--	--	--	--	--	--	--	--
Perennials																																								
BOGR2	0.03	--	--	2.10	--	0.35	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.65	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ELEL	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.50	1.50	--	2.50	1.00	--	2.00	3.50	--	--	--	--	1.00	--	--	--	--	--	--	--
ELLAL	--	34.00	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	9.50	--	--	--	--	--	--	--	--
ELTR7	--	0.40	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
HECO26	--	0.15	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.25	--	--	--	--	--	--	--	--	--	--	--	--	--	--
LEAM	--	--	--	--	18.00	24.00	18.00	31.00	--	--	--	--	12.50	6.20	25.00	41.50	26.00	--	--	17.00	--	--	--	--	5.00	--	--	--	75.00	20.75	25.00	3.90	--	--	--	--	--	--	--	--
PASM	10.00	11.50	20.00	34.00	--	--	--	--	0.50	36.00	10.00	50.00	--	--	--	--	--	--	--	--	--	--	--	--	--	1.75	4.00	23.50	--	--	5.00	22.00	--	--	--	--	--	--	--	--
PLJA	40.00	--	--	7.75	12.00	2.10	--	--	--	--	--	--	--	--	--	0.03	--	--	--	--	35.00	48.50	--	--	--	--	--	--	--	24.50	1.00	1.80	2.50	--	--	11.00	--	77.00	48.00	34.00
SPAI	--	--	--	--	--	5.75	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2.00	--	--	--	--	--	0.05	--	--	--
Forbs																																								
Annuals																																								
CHAL7	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.50	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CHIN2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.00	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CHLE4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.85	--	--	--	--	--	--
KOSC	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.75	--	--	--	--
MAFE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.25	--	--	--	--	--	--	--	--
SATR	--	--	--	0.10	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.50	--	6.00	0.45	--	--	--	--	--	--	0.10	--	1.50	4.90	40.00	1.20	--	--	--	--
UNKAF1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	9.00
Annual/Biennial																																								
DESO	--	--	--	--	--	--	--	--	--	2.75	--	--	--	--	--	--	--	--	--	--	15.00	--	--	--	--	1.55	--	12.00	--	--	--	--	--	--	--	--	--	--	--	--
LAOC3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.00	1.75	11.00	1.00	--	7.00	6.00	2.20	--	--	--	--	--	--	--	--	6.00	18.00	16.00	68.00
Perennials																																								
CHER	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.30	--	--
MENTZ	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	8.75	--	0.25	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
PEPA8	--	0.20	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
RACO3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.00	--	--	--	--	--	--	--	--	--	--	--	--	--
SPCO	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.00	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Shrubs, Trees and Cacti																																								
Perennials																																								
ATCA	--	2.10	0.10	--	--	--	--	0.30	50.00	48.00	--	0.05	--	--	27.00	--	10.00	--	--	--	--	10.25	0.10	49.00	30.00	42.50	12.00	21.00	--	3.00	--	52.50	0.03	--	7.00	--	--	9.00	10.00	4.50
ATCO	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.25	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.25	--	--	--	--
CHVI	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	20.00	--	--	--
ERNA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.03	--	--	--	--	--	--	--	--
KRLA	--	--	--	--	--	--	--	--	--	--	--	--	--	0.65	0.03	--	--	11.00	--	--	--	--	--	12.00	--	17.00	--	--	--	--	--	--	--	--	--	--	--	--	4.00	--
PUTR2	--	--	1.00	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cover Components																																								
Perennial/Biennial Vegetation Cover	50.0	48.4	21.1	43.9	30.0	32.2	18.0	31.3	50.5	86.8	10.0	50.1	12.5	6.9	52.0	47.8	36.0	11.0	0.0	17.0	56.5	71.4	11.1	65.8	36.0	70.1	25.0	62.2	75.0	48.3	33.0	89.7	3.5	0.0	7.0	12.3	26.1	104.3	78.0	106.5
Total Vegetation Cover	50.0	46.0	20.0	43.3	30.0	31.9	18.0	31.0	70.0	68.0	10.0	50.0	12.5	6.8	48.0	45.0	36.0	11.0	0.0	17.0	50.0	65.0	18.0	61.8	30.0	64.0	25.0	68.0	75.0	46.5	33.0	75.5	5.0	11.8	47.0	14.2	26.0	78.0	70.0	76.0
Rock	6.0	2.0	1.5	1.2	0.1	2.3	0.5	7.8	0.5	2.8	1.0	1.8	0.1	0.0	0.0	0.0	0.5	2.0	0.0	0.5	2.0	12.5	45.0	28.0	0.1	0.8	2.0	2.0	0.5	2.0	0.5	0.8	0.0	0.5	0.1	0.5	1.5	18.8	1.0	4.5
Litter	0.5	9.5	5.0	20.5	0.5	13.0	1.0	3.3	5.0	8.0	3.0	3.8	27.0	30.5	1.0	30.0	1.0	11.2	32.0	1.5	6.0	1.0	3.0	0.5	1.0	7.5	0.5	14.3	25.0	9.5	20.0	8.5	10.0	11.5	0.5	4.0	6.0	2.0	0.5	5.5
Base Soil	67.5	10.5	23.5	2.3	49.5	38.8	78.5	45.8	64.5	57.4	78.0	63.5	3.0	1.5	89.0	20.0	86.0	80.1	20.0	53.0	56.0	75.5	52.0	54.5	48.9	26.8	79.5	22.0	44.5	24.5	54.5	22.8	15.0	41.5	66.5	20.0	87.5	67.5	51.5	75.8

Notes:
Species codes defined in Table 3

Table A-2: M-VMU-4 Basal Cover Data

Transect	M-VMU-4-T1A				M-VMU-4-T2P				M-VMU-4-T3P				M-VMU-4-T4P				M-VMU-4-T5P				M-VMU-4-T6P				M-VMU-4-T7P				M-VMU-4-T8P				M-VMU-4-T9P				M-VMU-4-T10P			
Quadrat	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Grasses																																								
Annuals																																								
BRAR5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	T	--	--	--	--	--	--	T	--
BRTE	--	--	--	--	--	--	--	--	1.50	--	--	--	--	--	--	--	--	--	--	--	--	--	--	T	--	0.20	T	0.05	--	--	--	--	--	--	--	--	--	--	--	--
Perennials																																								
BOGR2	T	--	--	0.65	--	0.10	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.15	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ELEL	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.05	0.10	--	0.15	0.05	--	0.05	0.20	--	--	--	--	0.05	--	--	--	--	--	--	--
ELLAL	--	3.00	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.55	--	--	--	--	--	--	--	--
ELTR7	--	T	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
HECO26	--	T	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	T	--	--	--	--	--	--	--	--	--	--	--	--	--	--
LEAM	--	--	--	--	1.00	2.90	1.00	3.50	--	--	--	--	1.00	0.35	1.00	0.80	0.50	--	--	3.25	--	--	--	--	0.10	--	--	--	1.00	1.15	0.50	0.30	--	--	--	--	--	--	--	--
PASM	0.50	0.80	1.00	2.85	--	--	--	--	0.01	2.30	0.25	1.00	--	--	--	--	--	--	--	--	--	--	--	--	--	0.15	0.10	0.75	--	--	0.05	0.90	--	--	--	--	--	--	--	--
PLJA	6.00	--	--	1.40	1.00	0.30	--	--	--	--	--	--	--	--	--	T	--	--	--	--	4.00	3.50	--	--	--	--	--	--	--	2.25	0.05	0.10	0.50	--	--	1.10	--	5.75	3.00	5.00
SPAI	--	--	--	--	--	0.45	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.50	--	--	--	--	--	T	--	--	--
Forbs																																								
Annuals																																								
CHAL7	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	T	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CHIN2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	T	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CHLE4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.10	--	--	--	--	--	--
KOSC	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	T	--	--	--	--
MAFE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	T	--	--	--	--	--	--	--	--
SATR	--	--	--	T	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.01	--	T	T	--	--	--	--	--	--	T	--	T	0.05	0.05	T	--	--	--	--
UNKAF1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.80
Annual/Biennial																																								
DESO	--	--	--	--	--	--	--	--	--	T	--	--	--	--	--	--	--	--	--	--	T	--	--	--	--	0.05	--	0.10	--	--	--	--	--	--	--	--	--	--	--	--
LAOC3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	T	0.05	T	0.05	--	0.10	T	T	--	--	--	--	--	--	--	--	T	0.15	T	0.20
Perennials																																								
CHER	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	T	--	--
MENTZ	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.10	--	T	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
PEPA8	--	T	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
RACO3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	T	--	--	--	--	--	--	--	--	--	--	--	--	--
SPCO	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.05	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Shrubs, Trees and Cacti																																								
Perennials																																								
ATCA	--	0.25	T	--	--	--	--	0.05	2.00	0.95	--	T	--	--	2.00	--	0.50	--	--	--	--	0.30	T	0.60	1.00	1.00	1.00	0.70	--	0.10	--	0.30	T	--	0.10	--	--	0.15	0.50	0.05
ATCO	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.45	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	T	--	--	--	--
CHVI	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.50	--	--	--
ERNA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	T	--	--	--	--	--	--	--	--
KRLA	--	--	--	--	--	--	--	--	--	--	--	--	--	T	T	--	--	0.45	--	--	--	--	--	0.25	--	0.50	--	--	--	--	--	--	--	--	--	--	--	--	0.05	--
PUTR2	--	--	0.50	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cover Components																																								
Total Vegetation Cover	0.6	6.1	3.6	7.1	6.5	4.1	1.5	4.9	2.0	3.8	1.0	3.6	3.5	3.3	0.3	1.0	1.0	0.4	3.0	1.3	1.0	0.5	0.0	3.3	4.1	4.2	0.1	1.2	1.2	2.1	1.2	1.8	1.0	3.5	1.1	2.2	0.6	0.2	0.2	1.2
Rock	6.5	2.6	2.0	4.5	0.5	2.9	0.8	9.0	0.5	3.0	1.0	1.9	0.1	0.0	0.0	0.0	0.5	2.2	0.0	0.6	2.5	13.8	45.0	29.5	0.5	1.1	2.0	2.6	0.8	3.0	0.5	2.0	0.0	1.0	0.1	0.8	2.0	19.5	1.5	4.8
Litter	1.0	71.5	30.0	82.0	15.0	44.8	2.0	19.0	12.0	31.5	3.5	28.0	60.0	94.8	2.0	78.0	2.0	15.5	75.0	17.5	9.0	4.5	3.0	5.0	10.0	63.5	0.5	57.8	27.0	70.0	25.0	65.0	20.0	44.0	5.0	68.0	7.0	3.0	2.0	12.0
Base Soil	91.9	19.8	64.4	6.5	78.0	48.2	95.7	67.1	85.5	61.8	94.5	66.6	36.4	2.0	97.8	21.0	96.5	81.9	22.0	80.6	87.5	81.3	52.0	62.3	85.4	31.2	97.4	38.5	71.1	24.9	73.3	31.2	79.0	51.5	93.8	29.0	90.4	77.4	96.4	82.1

Notes:
Species codes defined in Table 3
T = trace cover

Table A-3: M-VMU-4 Frequency Data

Transect	M-VMU-4-T1A				M-VMU-4-T2P				M-VMU-4-T3P				M-VMU-4-T4P				M-VMU-4-T5P				M-VMU-4-T6P				M-VMU-4-T7P				M-VMU-4-T8P				M-VMU-4-T9P				M-VMU-4-T10P			
Quadrat	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Grasses																																								
Annuals																																								
BRAR5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2	--	--	--	--	--	--	1	--
BRTE	--	--	--	--	--	--	--	--	250	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	25	5	83	--	--	--	--	--	--	--	--	--	--	--	--
Perennials																																								
BOGR2	1	--	--	9	--	3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ELEL	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	12	7	--	14	6	--	6	8	--	--	--	--	8	--	--	--	--	--	--	--
ELLAL	--	47	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6	--	--	--	--	--	--	--	--
ELTR7	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
HECO26	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--
LEAM	--	--	--	--	10	28	10	24	--	--	--	--	25	7	24	62	15	--	--	10	--	--	--	--	6	--	--	--	25	21	14	3	--	--	--	--	--	--	--	--
PASM	5	23	14	54	--	--	--	--	6	57	3	75	--	--	--	--	--	--	--	--	--	--	--	--	--	9	4	27	--	--	3	25	--	--	--	--	--	--	--	--
PLJA	30	--	--	17	8	7	--	--	--	--	--	--	--	--	--	4	--	--	--	--	25	53	--	--	--	--	--	--	--	43	2	6	9	--	--	19	--	134	30	156
SPAI	--	--	--	--	--	9	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2	--	--	--	--	--	2	--	--	--
Forbs																																								
Annuals																																								
CHAL7	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CHIN2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CHLE4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	9	--	--	--	--	--	--
KOSC	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--
MAFE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--
SATR	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2	--	1	4	--	--	--	--	--	--	1	--	2	7	6	2	--	--	--	--
UNKAF1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	275
Annual/Biennial																																								
DESO	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	10	--	--	--	--	7	--	7	--	--	--	--	--	--	--	--	--	--	--	--
LAOC3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	4	7	2	7	--	11	4	8	--	--	--	--	--	--	--	--	1	38	6	86
Perennials																																								
CHER	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--
MENTZ	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	35	--	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
PEPA8	--	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
RACO3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--
SPCO	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	10	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Shrubs, Trees and Cacti																																								
Perennials																																								
ATCA	--	2	1	--	--	--	--	1	5	4	--	1	--	--	9	--	1	--	--	--	--	1	1	1	1	2	1	1	--	1	--	4	1	--	2	--	--	1	2	1
ATCO	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--
CHVI	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--
ERNA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--
KRLA	--	--	--	--	--	--	--	--	--	--	--	--	--	1	7	--	--	2	--	--	--	--	--	4	--	3	--	--	--	--	--	--	--	--	--	--	--	--	1	--
PUTR2	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Notes:
Species codes defined in Table 3

Table A-4: M-VMU-4 Air-dry Aboveground Annual Production Data

Transect	M-VMU-4-T1A				M-VMU-4-T2P				M-VMU-4-T3P				M-VMU-4-T4P				M-VMU-4-T5P				M-VMU-4-T6P				M-VMU-4-T7P				M-VMU-4-T8P				M-VMU-4-T9P				M-VMU-4-T10P			
Quadrat	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Grasses (g/m²)																																								
Non-Forage																																								
BRAR5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.51	--	--	--	--	--	--	0.41	--
BRTE	--	--	--	--	--	--	--	--	63.81	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.11	--	10.01	2.61	3.51	--	--	--	--	--	--	--	--	--	--	--	--
Forage																																								
BOGR2	0.61	--	--	1.41	--	0.31	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.31	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ELEL	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3.61	2.41	--	1.71	1.31	--	2.51	4.61	--	--	--	--	2.41	--	--	--	--	--	--	--
ELLAL	--	38.01	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	7.51	--	--	--	--	--	--	--	--
ELTR7	--	1.31	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
HECO26	--	0.21	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.31	--	--	--	--	--	--	--	--	--	--	--	--	--	--
LEAM	--	--	--	--	108.01	69.51	61.21	124.11	--	--	--	--	53.01	34.61	128.22	120.61	28.91	--	--	31.61	--	--	--	--	5.81	--	--	--	168.62	34.71	92.41	1.31	--	--	--	--	--	--	--	--
PASM	32.51	28.41	87.01	30.71	--	--	--	--	8.11	104.71	24.91	82.61	--	--	--	--	--	--	--	--	--	--	--	--	--	5.11	10.61	25.01	--	--	15.51	28.11	--	--	--	--	--	--	--	--
PLJA	69.61	--	--	21.21	17.61	2.31	--	--	--	--	--	--	--	--	--	0.00	--	--	--	--	90.51	39.01	--	--	--	--	--	--	--	24.21	2.11	5.31	12.21	--	--	30.11	--	60.51	58.31	22.41
SPAI	--	--	--	--	--	6.81	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	9.61	--	--	--	--	--	113.71	--	--	--
Forbs (g/m²)																																								
Non-forage																																								
CHAL7	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.51	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CHIN2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.21	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CHLE4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	25.41	--	--	--	--	--	--
KOSC	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.31	--	--	--	--
MAFE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.51	--	--	--	--	--	--	--	--
SATR	--	--	--	0.01	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.91	--	5.41	1.01	--	--	--	--	--	--	0.81	--	1.31	12.11	51.01	1.41	--	--	--	--
UNKAF1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.00
Forage																																								
CHER	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.21	--	--
DESO	--	--	--	--	--	--	--	--	--	3.01	--	--	--	--	--	--	--	--	--	--	5.91	--	--	--	--	4.01	--	15.41	--	--	--	--	--	--	--	--	--	--	--	--
LAOC3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	7.41	1.91	3.11	0.51	--	3.11	4.01	2.01	--	--	--	--	--	--	--	--	1.11	17.21	9.61	46.81
MENTZ	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	4.71	--	0.21	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
PEPA8	--	0.21	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
RACO3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.51	--	--	--	--	--	--	--	--	--	--	--	--	--
SPCO	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.51	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Shrubs, Trees and Cacti (g/m²)																																								
Forage																																								
ATCA	--	15.51	0.61	--	--	--	--	1.51	145.31	169.71	--	0.21	--	--	0.00	--	29.01	--	--	--	--	34.11	0.21	278.62	194.31	206.71	23.61	52.51	--	18.21	--	108.01	0.01	--	240.02	--	--	27.91	38.21	6.71
ATCO	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	49.91	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	14.81	--	--	--	--
CHVI	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	170.01	--	--	--
ERNA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.11	--	--	--	--	--	--	--	--
KRLA	--	--	--	--	--	--	--	--	--	--	--	--	--	2.31	4.01	--	--	23.31	--	--	--	--	--	42.81	--	53.01	--	--	--	--	--	--	--	--	--	--	--	--	9.51	--
PUTR2	--	--	2.71	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total Above Ground Biomass (g/m²)																																								
Non-forage	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	63.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.91	0.00	6.62	1.12	0.00	10.52	2.61	3.51	0.00	0.00	0.81	1.02	1.31	37.52	51.01	2.72	0.00	0.00	0.41	0.00
Forage	102.73	83.66	90.33	53.33	125.62	78.94	61.21	125.62	153.42	277.43	24.91	82.82	53.01	36.92	132.23	170.52	57.92	23.31	0.00	31.61	107.44	82.46	3.32	325.37	201.43	272.26	42.25	99.55	168.62	77.13	119.64	150.36	14.63	0.00	240.02	44.92	284.83	105.84	115.64	75.93
Total Production	102.73	83.66	90.33	53.34	125.62	78.94	61.21	125.62	217.23	277.43	24.91	82.82	53.01	36.92	132.23	170.52	57.92	23.31	0.00	31.61	109.35	82.46	9.94	326.49	201.43	282.78	44.86	103.06	168.62	77.13	120.45	151.38	15.94	37.52	291.03	47.64	284.83	105.84	116.05	75.93
Total Above Ground Biomass (lbs/ac)																																								
Non-forage	0	0	0	0	0	0	0	0	569	0	0	0	0	0	0	0	0	0	0	0	17	0	59	10	0	94	23	31	0	0	7	9	12	335	455	24	0	0	4	0
Forage	917	746	806	476	1121	704	546	1121	1369	2475	222	739	473	329	1180	1521	517	208	0	282	959	736	30	2903	1797	2429	377	888	1504	688	1067	1341	131	0	2141	401	2541	944	1032	677
Total Production	917	746	806	476	1121	704	546	1121	1938	2475	222	739	473	329	1180	1521	517	208	0	282	976	736	89	2913	1797	2523	400	919	1504	688	1075	1351	142	335	2597	425	2541	944	1035	677

Notes:
Species codes defined in Table 3
Non-forage and forage determintations are based on the permit (e.g. plants of perennial and/or biennial duration are forage and plants of annual duration are non-forage; noxious weeds are non-forage)

Table A-5: M-VMU-4 Shrub Belt Transect Data

Transect	M-VMU-4-T1A	M-VMU-4-T2P	M-VMU-4-T3P	M-VMU-4-T4P	M-VMU-4-T5P	M-VMU-4-T6P	M-VMU-4-T7P	M-VMU-4-T8P	M-VMU-4-T9P	M-VMU-4-T10P
Shrubs, Trees and Cacti										
ARLU	--	--	--	--	--	--	--	11	--	--
ATCA	9	8	35	5	10	13	23	10	14	32
ATCO	--	1	--	1	5	--	--	--	2	--
EPTR	--	--	--	--	3	--	--	--	--	--
ERNA	--	--	--	--	--	--	--	13	--	--
GUSA	--	--	--	--	--	--	--	2	--	2
KRLA	--	--	7	29	9	12	8	--	1	4
OPPO	--	--	--	--	--	--	--	--	--	1
PUTR2	5	--	--	--	--	--	--	1	--	--

Notes:

Code	Scientific Name	Common Name
ARLU	*Artemisia ludoviciana*	White sagebrush
ATCA	*Atriplex canescens*	Four-wing saltbush
ATCO	*Atriplex confertifolia*	Shadscale saltbush
EPTR	*Ephedra trifurca*	Longleaf jointfir
ERNA	*Ericameria nauseosa*	Rubber rabbitbrush
GUSA	*Gutierrezia sarothrae*	Broom snakeweed
KRLA	*Krascheninnikovia lanata*	Winterfat
OPPO	*Opuntia polyacantha*	Plains pricklypear
PUTR2	*Purshia tridentata*	Antelope bitterbrush

APPENDIX B

Quadrat Photographs

M-VMU-4-T1A

Q1

Q2

Q3

Q4

M-VMU-4-T2P	
	
Q1	Q2
	
Q3	Q4

M-VMU-4-T3P

Q1

Q2

Q3

Q4

M-VMU-4-T4P	
	
Q1	Q2
	Photo not available
Q3	Q4

M-VMU-4-T5P

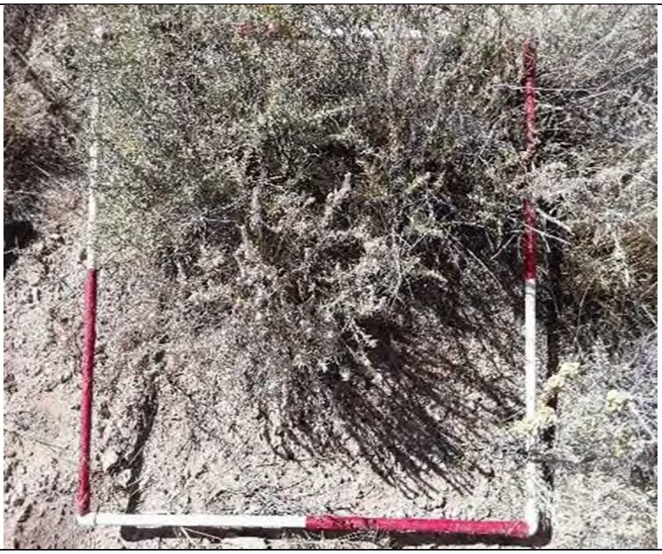
Q1

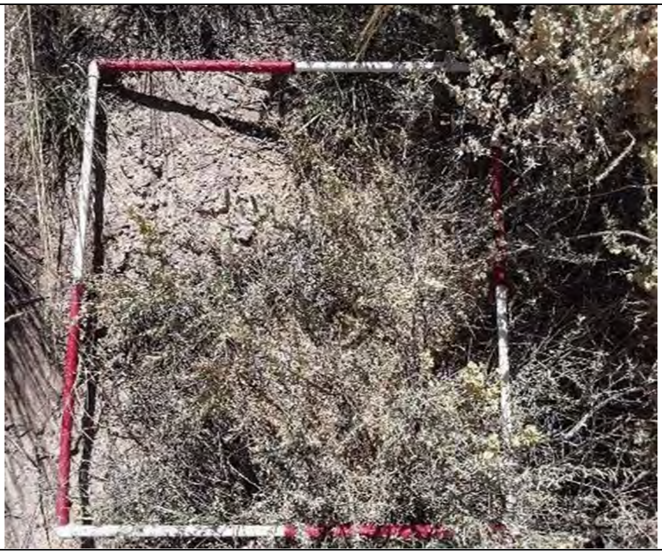
Q2

Q3

Q4

M-VMU-4-T6P	
	
Q1	Q2
	
Q3	Q4

M-VMU-4-T7P	
	
Q1	Q2
	
Q3	Q4

M-VMU-4-T8P	
	
Q1	Q2
	
Q3	Q4

M-VMU-4-T9P	
	
Q1	Q2
	
Q3	Q4

M-VMU-4-T10P	
	
Q1	Q2
	
Q3	Q4

APPENDIX C

Vegetation Statistical Analysis

Figure C-1: Pernnial/Biennial Cover Descriptive Statistics and Normality

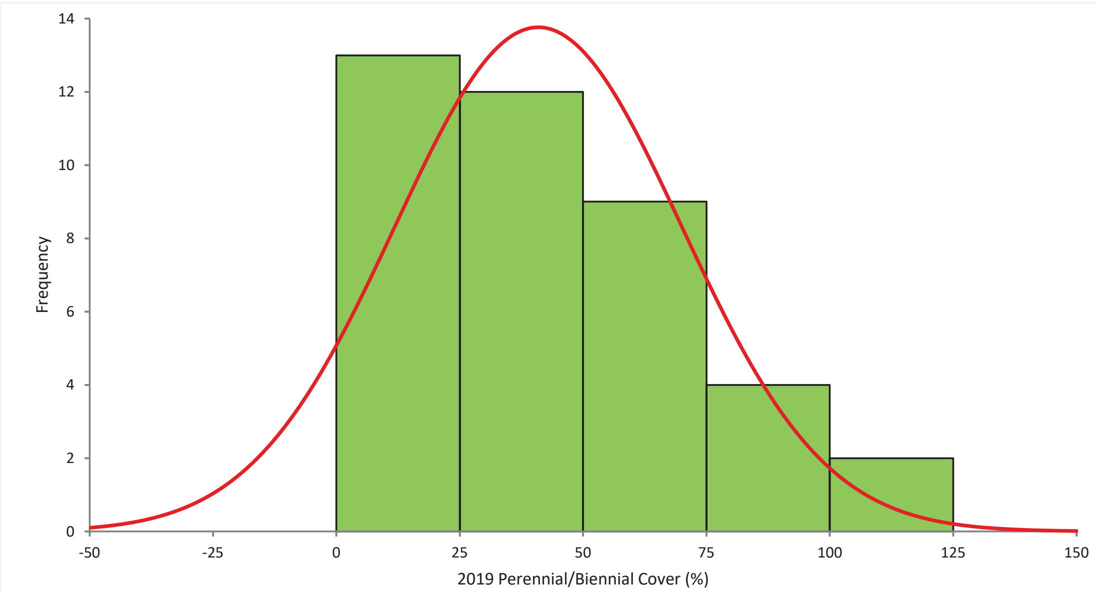
Distribution: 2019 Perennial/Biennial Cover

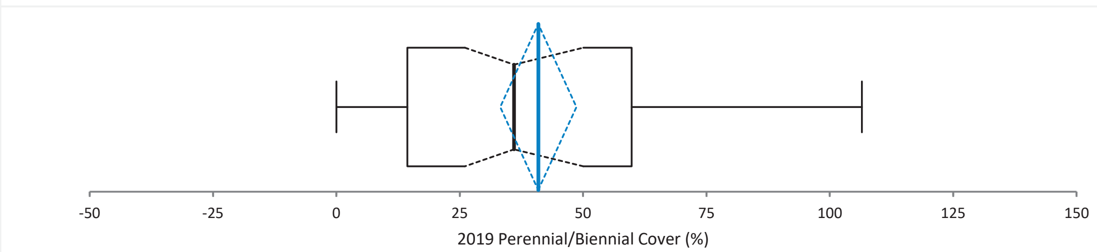
Analyse-it v5.40.2

M-VMU4_HypTest-RAWDATA-2019 A1:F41
Filter: No filter

Last updated 5 February 2020 at 8:53 by Ward, Dustin

Descriptives





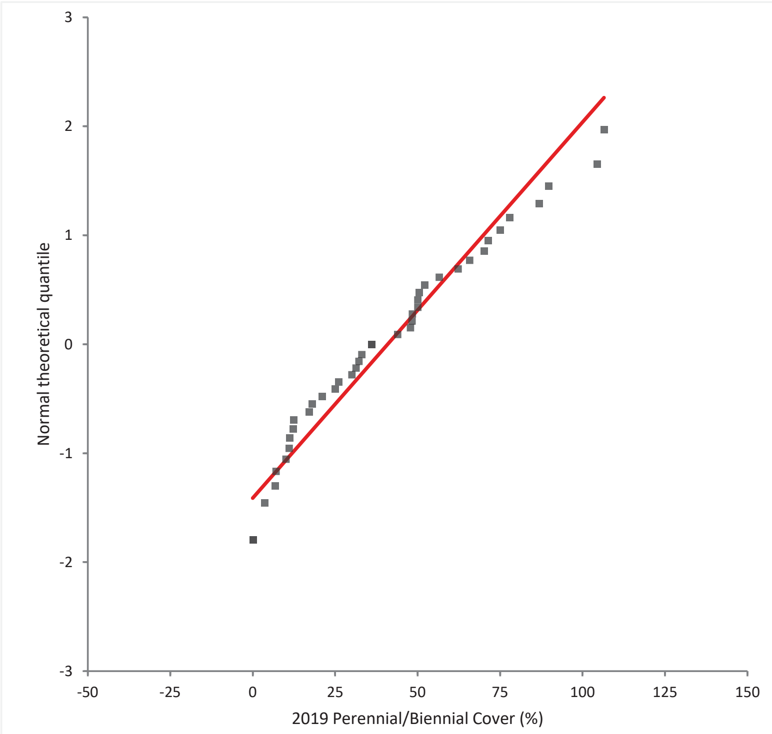
N	40

	Mean	90% CI	Mean SE	SD	Skewness	Kurtosis
2019 Perennial/Biennial Cover (%)	40.92	33.20 to 48.64	4.583	28.99	0.5	-0.48

GOLDER

Figure C-1: Pernnial/Biennial Cover Descriptive Statistics and Normality

Normality



Shapiro-Wilk test

W statistic	0.95
p-value	0.0757 [1]

H0: F(Y) = N(μ, σ)
The distribution of the population is normal with unspecified mean and standard deviation.
H1: F(Y) ≠ N(μ, σ)
The distribution of the population is not normal.

[1] Reject the null hypothesis in favour of the alternative hypothesis at the 10% significance level.

Figure C-2: Annual Forage Production Descriptive Statistics and Normality

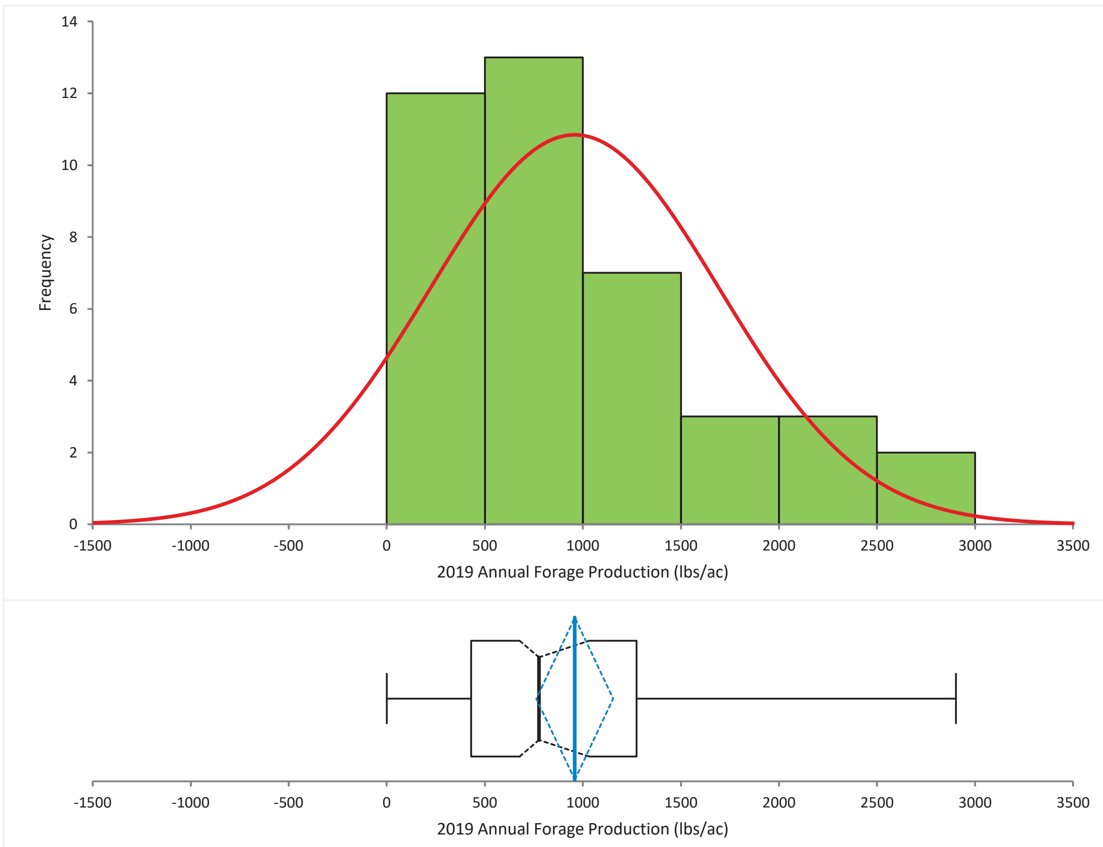
Distribution: 2019 Annual Forage Production

Analyse-it v5.40.2

M-VMU4_HypTest-RAWDATA-2019 A1:F41
Filter: No filter

Last updated 5 February 2020 at 9:42 by Ward, Dustin

Descriptives

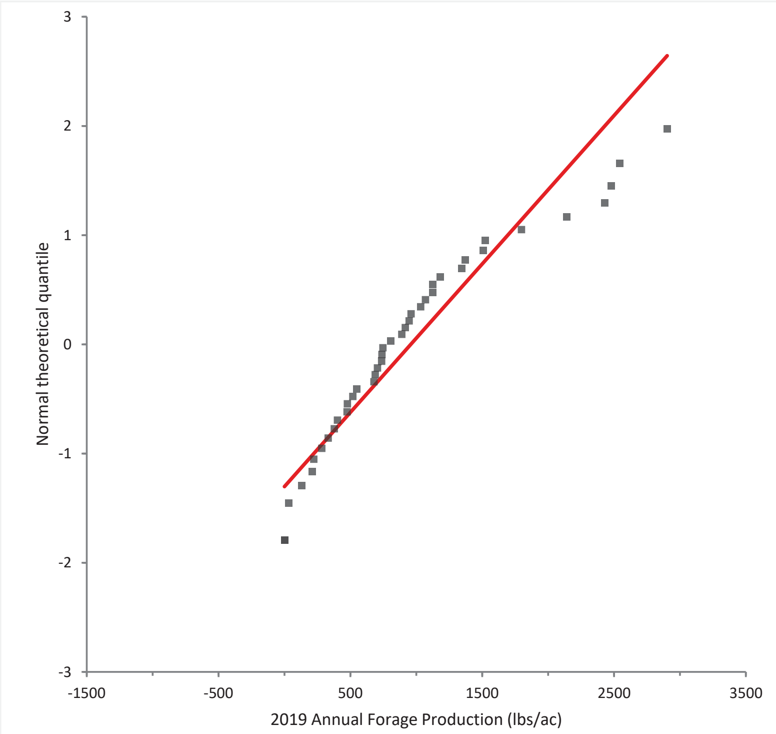


N	40

	Mean	90% CI	Mean SE	SD	Skewness	Kurtosis
2019 Annual Forage Production (lbs/ac)	958.5	762.4 to 1154.5	116.35	735.8	1.0	0.58

Figure C-2: Annual Forage Production Descriptive Statistics and Normality

Normality



Shapiro-Wilk test

W statistic	0.91
p-value	0.0033 [1]

H0: F(Y) = N(μ, σ)
The distribution of the population is normal with unspecified mean and standard deviation.
H1: F(Y) ≠ N(μ, σ)
The distribution of the population is not normal.

[1] Reject the null hypothesis in favour of the alternative hypothesis at the 10% significance level.

Figure C-3: Shrub Density by the Belt Transect Method Descriptive Statistics and Normality

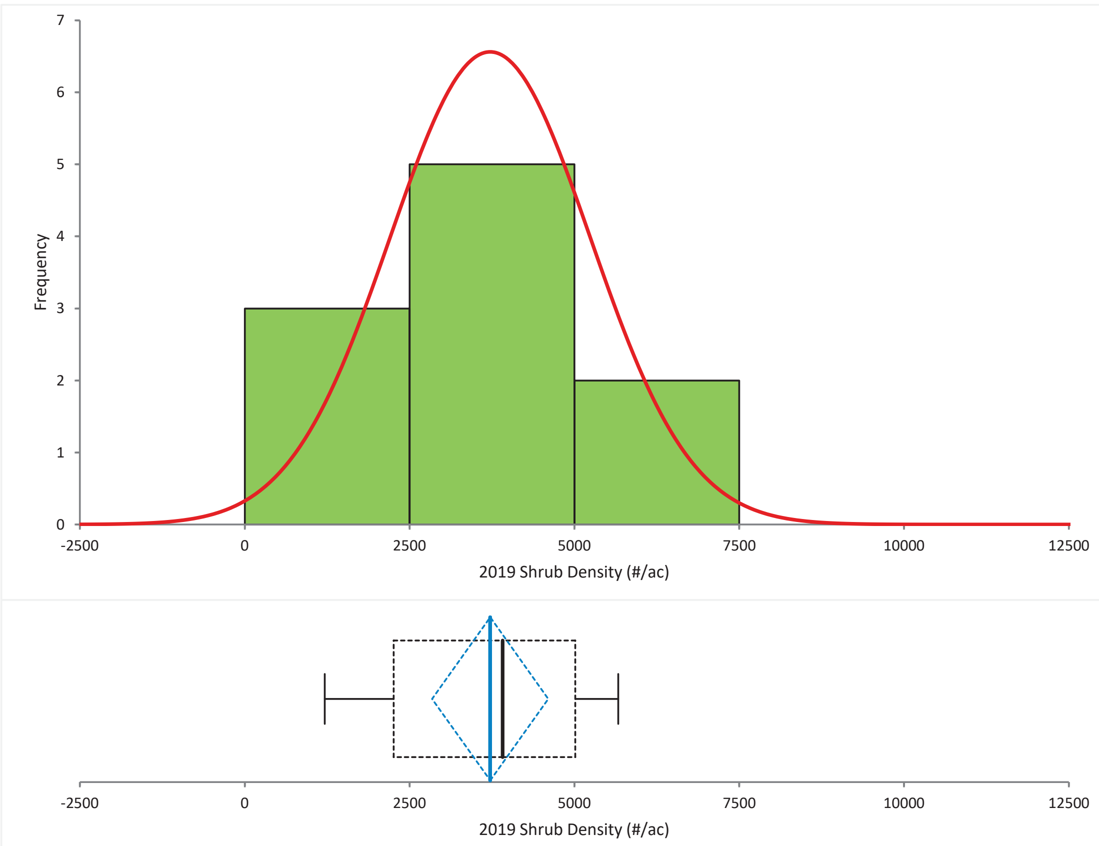
Distribution: 2019 Shrub Density

Analyse-it v5.40.2

M-VMU4_HypTest-RAWDATA-2019 A1:F41
Filter: No filter

Last updated 20 January 2020 at 12:25 by Ward, Dustin

Descriptives

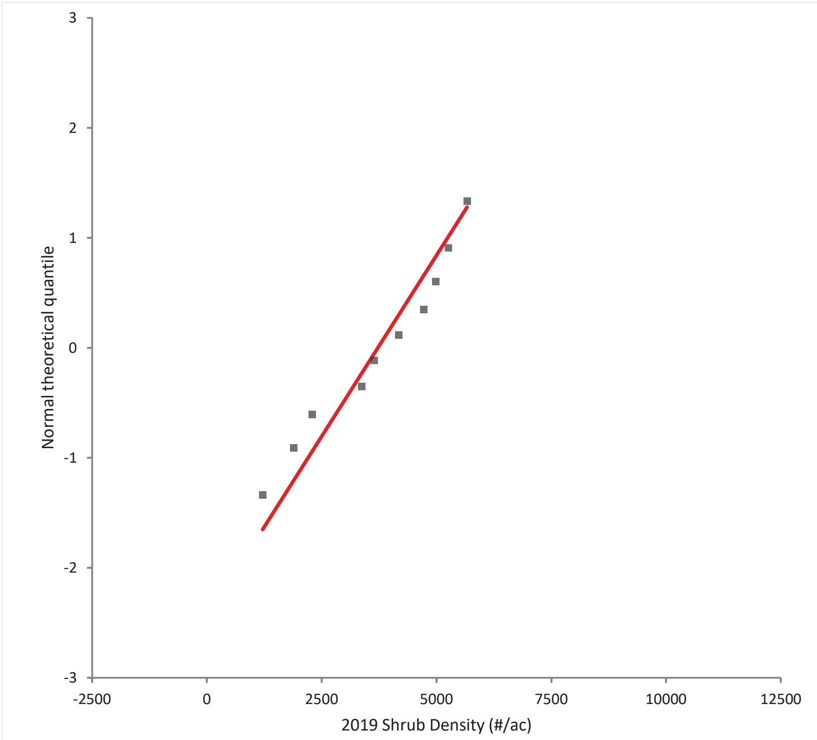


N	10

	Mean	90% CI	Mean SE	SD	Skewness	Kurtosis
2019 Shrub Density (#/ac)	3723.1	2842.1 to 4604.1	480.60	1519.8	-0.4	-1.12

Figure C-3: Shrub Density by the Belt Transect Method Descriptive Statistics and Normality

Normality



Shapiro-Wilk test

W statistic	0.94
p-value	0.5935[1]

H0: F(Y) = N(μ, σ)
The distribution of the population is normal with unspecified mean and standard deviation.
H1: F(Y) ≠ N(μ, σ)
The distribution of the population is not normal.

[1] Do not reject the null hypothesis at the 10% significance level.

Table C-1: Perennial/Biennial Canopy Cover, Method 5 - CMRP

Transect	Quad	2019 Perennial/Biennial Cover (%)	90% of Technical Standard	P/B CVR minus TS
M-VMU-4-T1A	1	50.0	13.5	36.5
	2	48.4	13.5	34.9
	3	21.1	13.5	7.6
	4	43.9	13.5	30.4
M-VMU-4-T2P	1	30.0	13.5	16.5
	2	32.2	13.5	18.7
	3	18.0	13.5	4.5
	4	31.3	13.5	17.8
M-VMU-4-T3P	1	50.5	13.5	37.0
	2	86.8	13.5	73.3
	3	10.0	13.5	-3.5
	4	50.1	13.5	36.6
M-VMU-4-T4P	1	12.5	13.5	-1.0
	2	6.9	13.5	-6.7
	3	52.0	13.5	38.5
	4	47.8	13.5	34.3
M-VMU-4-T5P	1	36.0	13.5	22.5
	2	11.0	13.5	-2.5
	3	0.0	13.5	-13.5
	4	17.0	13.5	3.5
M-VMU-4-T6P	1	56.5	13.5	43.0
	2	71.4	13.5	57.9
	3	11.1	13.5	-2.4
	4	65.8	13.5	52.3
M-VMU-4-T7P	1	36.0	13.5	22.5
	2	70.1	13.5	56.6
	3	25.0	13.5	11.5
	4	62.2	13.5	48.7
M-VMU-4-T8P	1	75.0	13.5	61.5
	2	48.3	13.5	34.8
	3	33.0	13.5	19.5
	4	89.7	13.5	76.2
M-VMU-4-T9P	1	3.5	13.5	-10.0
	2	0.0	13.5	-13.5
	3	7.0	13.5	-6.5
	4	12.3	13.5	-1.3
M-VMU-4-T10P	1	26.1	13.5	12.6
	2	104.3	13.5	90.8
	3	78.0	13.5	64.5
	4	106.5	13.5	93.0
			k	10
			n	40
			z	-3.00
Standard one-tailed normal curve area (Table C-3; MMD, 1999)				0.4987
			P	0.0013

Notes:
P/B CVR = Perennial/Biennial Cover
TS = 90% of the Technical Standard for Perennial/Biennial Cover
P = 0.5-Area = prob of observing z; <=0.1 performance standard met
z value calculation:

$$z = \frac{(k+0.5)-0.5n}{0.5\sqrt{n}}$$

Table C-2: Forage Production, Method 5 - CMRP

Transect	Quad	2019 Annual Forage Production (lbs/ac)	90% of Technical Standard	FP minus TS
M-VMU-4-T1A	1	916.5	315	601.5
	2	746.4	315	431.4
	3	805.9	315	490.9
	4	475.8	315	160.8
M-VMU-4-T2P	1	1120.8	315	805.8
	2	704.3	315	389.3
	3	546.1	315	231.1
	4	1120.8	315	805.8
M-VMU-4-T3P	1	1368.8	315	1053.8
	2	2475.2	315	2160.2
	3	222.2	315	-92.8
	4	738.9	315	423.9
M-VMU-4-T4P	1	472.9	315	157.9
	2	329.4	315	14.4
	3	1179.7	315	864.7
	4	1521.3	315	1206.3
M-VMU-4-T5P	1	516.8	315	201.8
	2	208.0	315	-107.0
	3	0.0	315	-315.0
	4	282.0	315	-33.0
M-VMU-4-T6P	1	958.6	315	643.6
	2	735.7	315	420.7
	3	29.6	315	-285.4
	4	2902.9	315	2587.9
M-VMU-4-T7P	1	1797.1	315	1482.1
	2	2429.1	315	2114.1
	3	376.9	315	61.9
	4	888.2	315	573.2
M-VMU-4-T8P	1	1504.4	315	1189.4
	2	688.1	315	373.1
	3	1067.4	315	752.4
	4	1341.5	315	1026.5
M-VMU-4-T9P	1	130.5	315	-184.5
	2	0.0	315	-315.0
	3	2141.4	315	1826.4
	4	400.8	315	85.8
M-VMU-4-T10P	1	2541.2	315	2226.2
	2	944.3	315	629.3
	3	1031.7	315	716.7
	4	677.4	315	362.4
			k	7
			n	40
			z	-3.95
Standard one-tailed normal curve area (Table C-3; MMD, 1999)				0.5000
			P	0.0000

Notes:
FP = Forage Production
TS = 90% of the Technical Standard for Annual Forage Production
P = 0.5-Area = prob of observing z; <=0.1 performance standard met
z value calculation:

$$z = \frac{(k+0.5)-0.5n}{0.5\sqrt{n}}$$

Table C-3: Shrub Density by the Belt Transect Method, Method 3 - CMRP

$$t^* = \frac{\bar{x} - 0.9\,(technical\ std)}{s/\sqrt{n}}$$

	2019 Shrub Density
Mean (stems/ac)	3,723
Standard Deviation (stems/ac)	1,520
Sample Size	10
Technical Standard (stems/ac)	150
t*	7.47
N_{min}	56
1-tail t (0.1, 9)	1.383

Notes:
stems/ac = Number of shrubs, trees and/or cacti per acre

Decision Rules (reverse null)

t < t (1-a; n-1), failure to meet std*
t >= t (1-a; n-1), performance std met*
t from Appendix Table C-1 (MMD, 1999)

GOLDER

golder.com

REPORT

Vegetation Management Unit 4
Vegetation Success Monitoring, 2020

McKinley Mine, New Mexico - Mining and Minerals Division Permit Area

Submitted to:

Chevron Environmental Management Company

Chevron Mining Inc. - McKinley Mine
24 Miles NW HWY 264
Mentmore, NM 87319

Submitted by:

Golder Associates Inc.

5200 Pasadena Avenue, N.E. Suite C
Albuquerque, New Mexico, USA 87113

+1 505 821-3043

133-8105207

February 19, 2021

Table of Contents

TABLES

FIGURES

APPENDICES

1.0 INTRODUCTION

Mining was completed in Mining and Minerals Division (MMD) jurisdictional lands at the McKinley Mine in 2007; most of the land is reclaimed, with only the facilities remaining. The lands mined and reclaimed included prelaw, initial-program, and permanent-program lands. Liability release has been completed on all prelaw and initial-program lands, and full bond release on a limited amount of permanent-program land.

Chevron Mining Inc. (CMI) is assessing the vegetation in the remaining permanent-program reclaimed areas in anticipation of future bond and liability releases. CMI understands the importance of returning the mined lands to productive traditional uses in a timely manner. In order to qualify for release, the lands must be in a condition that is as good as or better than the pre-mine conditions, stable, and capable of supporting the designated postmining land use of grazing and wildlife. The increment, or permit area as a whole, must meet vegetation establishment responsibility period criteria, which is a minimum of 10 years. Golder Associates Inc. (Golder) was retained to monitor and assess the vegetation relative to the established vegetation success standards in Permit # 2016-02.

1.1 Vegetation Management Unit 4

This report presents results from 2020 quantitative vegetation monitoring conducted in Vegetation Management Unit 4 (M-VMU-4), comprising about 1,240 acres of within Area 9 south and parts of Area 9 north (Figure 1). The elevation in this area ranges from about 6,700 to 7,000 feet above mean sea level. Permanent program reclamation in Area 9 started on lands disturbed after 1986, with the vast majority seeded by 2009. Thus, reclamation age in the majority of M-VMU-4 ranges from 8 to more than 30 years old. The configuration of the vegetation monitoring units within the MMD Permit Area, shown on Figure 1 were developed in consultation with MMD. This section provides a general description of the reclamation activities that were implemented. Additional details of the reclamation for specific areas can be obtained through review of McKinley's annual reports.

1.2 Reclamation and Revegetation Procedures

Reclamation methods applied in Area 9 included grading of the spoils to achieve a stable configuration, positive drainage, and approximate original contour. Graded spoil monitoring was then conducted to verify that the upper 42 inches of spoil was suitable for plant growth or if it required mitigation to establish a suitable root zone. A minimum of 6 inches of topsoil or topsoil substitute were then applied over suitable spoils.

After topsoil or topdressing placement, the surface was scarified in preparation for planting. Seeding was done using various implements that drilled and/or broadcast the seed. After the seeding, mulch consisting of either hay or straw was applied at a rate of about 2 tons/acre. The mulch was anchored 3 to 4 inches into the soil with a tractor-drawn straight coulter disc. The seeding was generally performed in the fall, which coincided with logical units for seeding that had been topdressed over the spring and summer. Seed mixes used at McKinley have varied over time but included both warm- and cool-season grasses, introduced and native forbs, and shrubs. The early seed mixes tended to emphasize the use of alfalfa and cool-season grasses. Over time the seed mixes shifted to include more warm-season grasses and a broader variety of native forbs.

1.3 Prevailing Climate Conditions

The amount and distribution of precipitation are important determinants for vegetation establishment and performance. Once vegetation is established, the precipitation dynamics affect the amount of vegetation cover and biomass on a year-to-year basis with grasses and forbs showing the most immediate response.

The South Mine Area has experienced several drought years recently and 2020 was characteristic of an exceptional drought year. Total annual precipitation has been below the regional average (about 11.8 inches at Window Rock) for the last five years (Table 1). Annual precipitation for 2020 was almost 55% (6.44 inches) of the long-term average for the region and monsoonal precipitation was well below average (about 27% of average). Figure 1 shows the location of the precipitation gages used for the South Mine. Departure of growing season precipitation (April through September) from long-term seasonal mean at Window Rock (1937-1999) for McKinley is shown on Figure 2 based on the South Tipple and Rain 9 gages. For the South Tipple rain gage, growing season precipitation has been 0.34 to 4.86 inches below average for the last four years. For the Rain 9 gage growing season precipitation from 2015 to 2020 has been below average in all years but 2015, when growing season total precipitation was 0.85 inches above average. Spatial variability is characteristic of monsoonal precipitation patterns during the growing season at McKinley Mine. At a little over 2 miles apart the Rain 9 gage appeared to receive much less precipitation in August and September in 2016, when compared to the South Tipple gage (Table 1). In 2016, growing season precipitation was 0.44 inches above average at the South Tipple gage, compared to 2.52 inches below average at the Rain 9 gage (Figure 2). From 2015 to 2020, peak growing season months have been relatively and increasingly dry with a pronounced deficit during the monsoon season, with rare exceptions.

1.4 Objectives

The intent of this report is to document the vegetation community attributes in M-VMU-4 and compare them to the Permit's vegetation success criteria. Section 2 describes the vegetation monitoring methods that were used in 2020. Section 3 presents the results of the investigation with respect to ground cover, annual production, shrub density, and composition and diversity. Section 4 is a summary of the results for M-VMU-4 with emphasis on vegetation success.

2.0 VEGETATION MONITORING METHODS

Vegetation attributes on M-VMU-4 in Area 9 were quantified using the methods described in Section 6.5 of the Permit. Fieldwork was conducted at the end of the growing season, but prior to the first killing frost. Vegetation monitoring in M-VMU-4 was conducted between September 8 and 10, 2020.

2.1 Sampling Design

A systematic random sampling procedure employing a transect/quadrat system was used to select sample sites within the reclaimed area. The transect locations were reviewed with MMD in advance of sampling. A 50-square foot grid was imposed over the VMU to delineate vegetation sample plots, and random points created in a geographic information system were used to select plots for vegetation sampling. The locations of randomly selected vegetation plots are shown on Figure 3 for M-VMU-4. In the field, the randomly selected transect locations were assessed in numerical order. If the transect location was determined to be unsuitable, the next alternative location was assessed for suitability. Unsuitable transects were those that fell on or would intersect roads, drainage ways, wildlife rock piles, or prairie dog colonies.

Transects originated from the southeastern corner of the vegetation plot. Each transect was 30 meters (m) long in a dog-leg pattern (Figure 4). Four 1-m^2 quadrats were located at pre-determined intervals along the transect for quantitative vegetation measurements. Each quadrat is considered an individual sample where measurements were made of production, total canopy, species canopy and basal cover, surface litter, surface rock fragments, and bare soil as discussed below.

2.2 Vegetation and Ground Cover

Relative and total canopy cover, basal cover, surface litter, rock fragments, and bare soil were estimated for each quadrat. Canopy cover estimates include the foliage and foliage interspaces of all individual plants rooted in the quadrat. Canopy cover is defined as the percentage of quadrat area included in the vertical projection of the canopy. The canopy cover estimates made on a species basis may exceed 100% in individual quadrats where the vegetation has multi-layered canopies. In contrast, the sum of the total canopy cover, surface litter, rock fragments, and bare soil does not exceed 100%.

Basal cover is defined as the proportion of the ground occupied by the crowns of grasses and rooting stems of forbs and shrubs. Basal cover estimates were also made for surface litter, rock fragments, and bare soil. Like the total cover estimates, the basal cover estimates do not exceed 100%. All cover estimates were made in 0.05% increments. Percent area cards were used to increase the accuracy and consistency of the cover estimates. Plant frequency was determined on a species-basis by counting the number of individual plants rooted in each quadrat.

2.3 Annual Forage and Biomass Production

Production was determined by clipping and weighing all annual (current year's growth) above-ground biomass within the vertical confines of a 1-m^2 quadrat. Grasses and forbs were clipped to within 5 centimeters (cm) of the soil surface, and the current year's growth was segregated from the previous year's growth (e.g., gray, weathered grass leaves and dried culms). For this sampling event, plants that were less than 5 cm tall or considered volumetrically insignificant were not collected. Production from shrubs was determined by clipping the current year's growth.

The plant tissue samples of every species collected were placed individually in labeled paper bags. The plant tissue samples were air-dried (> 90 days) until no weight changes were observed with repeated measurements on representative samples. The average tare weight of the empty paper bags was determined to correct the total sample weight to air-dry vegetation weights. The net weight of the air-dried vegetation was converted to a pounds per acre (lbs/ac) basis.

2.4 Shrub Density

Shrub density, or the number of plants per square meter, was determined using the frequency count data from the quadrats and the belt transect method (Bonham 1989). Shrub density was calculated from the quadrat data by dividing the total number of individual plants counted by the number of quadrats measured. The density per square meter was converted to density per acre.

Shrub density was also determined using a belt transect method (Bonham 1989). Shrub density was determined from a 1-meter wide; 30-meter long belt transect situated along the perimeter of the dog-legged transect (Figure 4). Shrubs rooted in the belt transect were counted on a species basis.

2.5 Statistical Analysis and Sample Adequacy

The procedures for financial assurance release as described in Coal Mine Reclamation Program (CMRP) Vegetation Standards (MMD 1999) and the Permit guided this statistical analysis. Statistical tests were performed using both Microsoft® Excel and Analyse-it (version 5.65.7), a statistical add-in for Excel. The normality of each dataset was first assessed using the Shapiro-Wilk test to determine the appropriate hypothesis test method (i.e., parametric versus nonparametric). Data were considered normal when the test statistic was significant (p-value > 0.10) for alpha (α) = 0.10. Thus, the null hypothesis that the population is normally distributed was accepted if the p-value > 0.10. In cases where the data were not normally distributed, a log transformation was applied to see if it normalized the data.

All hypothesis testing used to demonstrate compliance with the vegetation success standards was conducted using a reverse null approach. Because vegetation performance at McKinley is compared to technical standards, the one-sample, one-sided t-test (CMRP Method 3) is used for normally distributed data to evaluate the mean and the one-sample, one-sided sign test (CMRP Method 5) to analyze the median of data that are not normal (MMD 1999; McDonald and Howlin 2013). The one-sided hypothesis tests using the reverse null approach were designed as follows:

Perennial/Biennial Canopy Cover

H_0 : Reclaim < 90% of the Technical Standard (15%)

H_a : Reclaim ≥ 90% of the Technical Standard (15%)

Annual Forage Production

H_0 : Reclaim < 90% of the Technical Standard (350 lbs/ac)

H_a : Reclaim ≥ 90% of the Technical Standard (350 lbs/ac)

Shrub Density

H_0 : Reclaim < 90% of the Technical Standard (150 stems per acre [stems/ac])

H_a : Reclaim ≥ 90% of the Technical Standard (150 stems/ac)

where H_0 is the null hypothesis, that the parameter mean of the reclaimed area is less than 90% of the parameter mean of the technical standard and H_a is the alternative hypothesis, that the parameter mean of the reclaimed area is greater than or equal to 90% of the parameter mean of the technical standard. All hypothesis tests were performed with a 90% level of confidence.

Under the reverse null test, the revegetation success standard is met when H_0 is rejected and H_a is accepted. The decision criteria at 90% confidence under the reverse null hypothesis are as follows:

One-sample, one-sided t-test – Method 3 (CMRP)

If $t^* < t_{(1-\alpha;\, n-1)}$, conclude failure to meet the performance standard

If $t^* \geq t_{(1-\alpha;\, n-1)}$, conclude that the performance standard was met

One-sample, one-sided sign test – Method 5 (CMRP)

If P > 0.10, conclude failure to meet the performance standard

If P ≤ 0.10, conclude that the performance standard was met

Statistical hypothesis testing was performed on perennial/biennial cover, annual forage production, and shrub density (woody stem stocking) using the one-sample, one-sided t-test and the one-sample, one-sided sign test. The hypotheses testing used the reverse null hypothesis bond release testing procedure as described in the CMRP Vegetation Standards (MMD 1999).

Statistical adequacy is not required for vegetation success demonstrations at McKinley under the reverse null approach but is presented on the basis of the canopy cover, production, and shrub density data. The number of samples required to characterize a particular vegetation attribute depends on the uniformity of the vegetation and the desired degree of certainty required for the analysis.

The number of samples necessary to meet sample adequacy (N_{min}) was calculated assuming the data were normally distributed using Snedecor and Cochran (1967).

$$N_{min} = \frac{t^2 s^2}{(\overline{x}D)^2}$$

Where N_{min} equals minimum number of samples required, t is the two-tailed t-distribution value based on a 90% level of confidence with n-1 degrees of freedom, s is the standard deviation of the sample data, $\overline{x}$ is the mean, and D is the desired level of accuracy, which is 10 percent of the mean.

In addition to N_{min}, the 90% confidence interval (CI) of the sample mean and the level of confidence that the sample mean is within 10 percent of the true mean are reported.

It is often impractical to achieve sample adequacy in vegetation monitoring studies based on Snedecor and Cochran's equation, and a minimum sample number approach is taken. MMD recognizes the practical limitations of achieving statistical adequacy and has provided minimum sample sizes for various quantitative methods (MMD 1999). With normally distributed data where sample adequacy cannot be met because of operational constraints or for other reasons, 40 samples are often considered adequate. The 40-sample recommendation is based on an estimate of the number of samples needed for a t-test under a normal distribution (Sokal and Rohlf 1981). Schulz et al. (1961) demonstrated that 30 to 40 samples provide a robust estimate for most cover and density measurements with increased numbers of samples only slightly improving the precision of the estimate.

CMI collected 40 samples at the outset of sampling based on the guidance discussed above. The 40 samples came from ten transects each having four quadrats as described in Section 2.1. Each quadrat is considered a unique sampling unit. Additional analysis around sample adequacy was done to see the number of samples that would have been required for adequacy by the Snedecor and Cochran equation. Further analysis for sample adequacy of cover, production, and density attributes was also demonstrated using a graphical stabilization of the mean method (Clark 2001).

The emphasis on statistical adequacy assumes that parametric tests of normally distributed data will be conducted to demonstrate compliance with the vegetation success standards. It is important to note that normally distributed data and sample adequacy are not required for hypothesis testing. Nonparametric hypothesis tests are used to analyze data that are not normally distributed. When sample adequacy is not achieved, it is appropriate to use the reverse null approach for hypothesis testing. The reverse null is also generally recommended to evaluate reclamation success whether N_{min} is met or not (MMD 1999). This is because the reverse null is more defensible (compared to the classic approach) where the rejection of the null hypothesis definitively concludes that the reclamation mean is greater the technical standard (McDonald and Howlin 2013).

3.0 RESULTS

The vegetation community in M-VMU-4 is well established and dominated by perennial plants. A representative photograph of the vegetation and topography in M-VMU-4 is shown in Figure 5. The vegetation cover levels in

2019 and 2020 suggest that the site is progressing to achieve vegetation success standards for the Permit Area. Vegetation success standards consist of four vegetative parameters: ground cover, productivity, diversity, and woody stem stocking (Table 2). The ground cover requirement for live perennial/biennial cover on the reclamation is 15%. The productivity requirement is 350 air-dry lbs/ac perennial/biennial annual production. The woody stem stocking success standard is 150 live woody stems/ac.

Diversity is evaluated against numerical guidelines for different growth forms and photosynthetic pathways of the vegetation. In summary, the diversity guideline required by MMD would be met if at least two shrub or subshrub species with individual relative cover values of 1%; at least two perennial warm-season grass species have individual relative cover levels of at least 1%; at least one perennial cool-season grass species has an individual relative cover level of at least 1%; and three perennial or biennial forb species have a combined relative cover of at least 1%. MMD (1999) allows for the use of biennial forbs because they are technically monocarpic (single-flowering) perennials that annually produce a significant amount of seed and therefore as a species, they persist in the reclaimed plant community. Relative cover is the average percent cover of a perennial/biennial species divided by the total perennial/biennial cover of the sampling unit.

Diversity is also demonstrated by evidence of colonization or recruitment of native (not-seeded) plants from adjacent undisturbed native areas. Table 3 summarizes the attributes for plants recorded in the quadrats in addition to those encountered or observed but not recorded in the formal quantitative monitoring of M-VMU-4. Recruitment of these native plant species is indicative of ecological succession and the capacity of the site to support a self-sustaining ecosystem.

The field data for canopy and basal cover, density, production, and shrub density by the belt transect are included in Appendix A, accompanied by Figure A-1 and Table A-1 showing the 2020 transect locations within M-VMU-4. Figure A-1 also shows the seeded areas grouped by years and the 2019 transects. Photographs of the quadrats are included in Appendix B. Appendix C provides the statistical analysis equations (Table C-1), data (Table C-2) and outputs for perennial/biennial canopy cover (Table C-3 and Figure C-1), annual forage production (Table C-4 and Figure C-2), and shrub density by the belt transect method (Table C-5 and Figure C-3).

3.1 Ground Cover

Perennial/biennial canopy cover was calculated by summing the perennial/biennial species cover estimates after excluding the annual forbs and grasses. Any recorded noxious weeds are excluded from perennial/biennial cover. Average total ground cover in M-VMU-4 is 63.1% comprised of 40.0% total vegetation cover, 9.8% rock, and 13.3% litter on a canopy cover basis (Table 3). On a basal area basis, average ground cover is 55.5% with 4.1% vegetation, 11.5% rock, and 39.9% litter. Consistent with semi-arid rangelands the vegetation canopy cover in the individual quadrats varied, ranging from 6.0 to 73.0% (Table A-2). The mean perennial/biennial canopy cover was 41.5%, which exceeds the mean total vegetation canopy cover suggesting the occurrence of overlapping canopies. In 2019 and 2020 M-VMU-4 significantly exceeded the vegetation success standard of 15% perennial/biennial cover for total vegetation canopy cover and perennial/biennial canopy cover (Table 4). In 2020 the mean total vegetation canopy cover was 40.0% (± 4.6% [90% CI]) and mean perennial/biennial canopy cover was 41.5% (± 5.2%).

The perennial/biennial canopy cover data for M-VMU-4 was normally distributed (Figure C-1). The calculated minimum sample size needed to meet N_{min} was 46 samples for total cover and 66 samples for perennial/biennial canopy cover (Table 4). Because N_{min} was not met and called for a number of samples exceeding the sampling design, the perennial/biennial canopy cover data were evaluated using a stabilization of the mean approach

(Clark 2001) and with a one-sample, one-sided t-test using the reverse null (MMD 1999). Figure 6 illustrates the stabilization of the estimated mean for perennial/biennial canopy cover based on grouping four sample increments associated with a single transect. The samples were analyzed in four sample increments to allow an estimation of variability. The corresponding variability around the mean is expressed by the 90% CIs for each successive analytical increment. These data suggest that the mean perennial/biennial canopy cover was estimated to within the 90% CI of the estimated population mean (n=40) beginning after the twelfth sample, with the 90% CI tightening to no greater than about ± 6.0% perennial/biennial canopy cover after 28 samples. This analysis suggests that 40 samples were more than adequate, and that the collection of additional data would not improve the precision of the estimate of perennial/biennial cover.

The one-sided t-test calculated t*-statistic for M-VMU-4 perennial/biennial cover is 8.88, where the sample mean is 41.5% with a standard deviation of 19.9%, the technical standard is 15% and the sample size is 40. The one-tail $t_{(0.1,\ 39)}$ value is 1.304. Therefore, testing under the reverse null hypothesis ($t^* >= t_{(1-\alpha;\ n-1)}$), we conclude that the performance standard for perennial/biennial cover was met (Table C-3). In 2019, the perennial/biennial cover success standard was also met, but using the one-sample, one-sided sign test for not normally distributed data under the reverse null approach.

3.2 Production

Productivity for vegetation success is assessed for above-ground annual forage production, excluding annuals and noxious weeds in air dry pounds per acre (lbs/ac). Total annual production for all plant species is reported but not used in determining productivity success for the VMU. The 2020 annual forage production in M-VMU-4 was estimated to be 551 (± 85 [90% CI]) lbs/ac with an annual total production of 555 (± 85) lbs/ac (Table 4). The combined production for grasses, forbs, and shrubs based on an analysis of comparable ecological sites reported by Parametrix (2012) was 430.5 to 794.2 lbs/ac. The annual forage production performance of M-VMU-4 in 2019 (958 lbs/ac) and 2020 demonstrate the site's ability to exceed the minimum production values for comparable ecological sites. The high ratio of forage to total biomass suggests conditions are favorable with few undesirable species. Blue wildrye (*Elymus glaucus*), Colorado wildrye (*Leymus ambiguus*), and James' galleta (*Pleuraphis jamesii*) accounted for about 60% of the forage, while four-wing saltbush (*Atriplex canescens*) and winterfat (*Krascheninnikovia lanata*) accounted for an additional 21% (Table 3). Forage production for the top four most productive perennial grasses totaled 352 lbs/ac in M-VMU-4 meeting the vegetation success standard of 350 lbs/ac on their own.

The annual forage production data for M-VMU-4 was normally distributed (Figure C-2). The calculated minimum sample size needed to meet N_{min} at the 90% confidence level for annual forage production was estimated to be 102 samples (Table 4). Because N_{min} was not met and called for an unreasonable number of samples, the data were evaluated using a stabilization of the mean (Clark 2001) and with a one-sample, one-sided t-test using the reverse null (MMD 1999). Figure 7 illustrates the stabilization of the estimated mean and 90% CI for annual forage production. These data indicate that the mean annual forage production was estimated to within the 90% CI of the estimated population mean (n=40) after 28 samples, with the 90% CI tightening to no greater than 100 lbs/ac after 32 samples. This analysis suggests that 40 samples were more than adequate, and that the collection of additional data would not improve the precision of the estimate of forage production.

The one-sided t-test calculated t*-statistic for M-VMU-4 annual forage production is 4.51, where the sample mean is 551 lbs/ac with a standard deviation of 331 lbs/ac, the technical standard is 350 lbs/ac, and the sample size is 40. The one-tail $t_{(0.1,\ 39)}$ value is 1.304. Therefore, testing under the reverse null hypothesis ($t^* >= t_{(1-\alpha;\ n-1)}$), we conclude that the performance standard for annual forage production was met (Table C-4). In 2019, the annual forage production success standard was also met, but using the one-sample, one-sided sign test for not normally distributed data under the reverse null approach.

3.3 Shrub Density

Shrub density ranged from an average of 3,116 (± 1,015 [90% CI]) stems/ac based on the belt transect method to 4,350 (± 1,314) stems/ac for quadrat method (Table 4). In M-VMU-4, 15 shrub species were encountered in the belt transects (Table A-5) compared to nine species in the quadrats (Table 3), reflecting the increased area of analysis associated with the belt transects. Four-wing saltbush and winterfat were the most common shrubs encountered under both measurement methods.

The shrub density data by the belt transect method were normally distributed (Figure C-3) and the calculated minimum sample size needed to meet N_{min} at the 90% confidence level was estimated to be 132 samples (Table 4). Because N_{min} was not met and called for an unreasonable number of samples, the shrub density belt transect data were evaluated using a stabilization of the mean (Clark 2001) and a one-sample, one-sided t-test using the reverse null (MMD 1999). Figure 8 illustrates the stabilization of the mean for shrub density based on individual belt transect data. The corresponding variability around the mean is expressed by the 90% CIs for each successive analytical increment. These data suggest that the mean shrub density was estimated to within the 90% CI of the estimated population mean (n=10) after five samples, with the 90% CI tightening to no greater than about ± 1,200 stems/ac after 8 samples. The variability of the estimate slightly decreased with the collection of additional data, but not to a meaningful degree. This analysis suggests that 10 samples were more than adequate, and that the collection of additional data would not improve the precision of the estimate of shrub density, which is well above the performance standard.

The one-sided t-test calculated t*-statistic for M-VMU-4 shrub density is 4.83, where the sample mean is 3,116 stems/ac with a standard deviation of 1,952, the technical standard is 150 stems/ac and the sample size is 10. The one-tail $t_{(0.1, 9)}$ value is 1.383. Therefore, testing under the reverse null hypothesis ($t^* >= t_{(1-\alpha; n-1)}$), we conclude that the performance standard for shrub density (i.e., woody stem stocking) was met (Table C-5).

3.4 Composition and Diversity

Grasses dominated the canopy cover with Colorado wildrye, James' galleta, and other wheatgrass or wildrye species (*Elymus species*) most prevalent (Table 3). Cool-season perennial grasses contribute almost 66% to perennial/biennial canopy cover in M-VMU-4 reflecting the past seed mixes and season of seeding. Four-wing saltbush and winterfat dominate the shrub component of the reclamation plant community in M-VMU-4, contributing about 15% relative cover to the perennial/biennial canopy cover. Forbs are minor contributors to the cover in M-VMU-4 even though numerous species occurred. The annual forb Russian thistle (*Salsola tragus*) contributes the most absolute cover to the forb component but is not included in relative cover calculations for ground cover or diversity success.

Diversity is assessed through comparing the relative cover of various life-forms, based on their duration to the perennial/biennial cover of the vegetation management unit. In this context, relative cover is the average percent cover of a perennial/biennial species divided by the mean perennial/biennial cover of the sampling unit. Relative canopy cover of individual species contributing to perennial cover are listed in Table 3.

The diversity standard for cool-season grasses is achieved by several species that exceed 1% relative cover including Colorado wildrye (39.63%), thickspike wheatgrass (6.34%, *Elymus lanceolatus ssp. lanceolatus*), and western wheatgrass (5.84%, *Pascopyrum smithii*).

The diversity standard for warm-season grasses is achieved by two species that exceed 1% relative cover including James' galleta (12.70%) and alkali sacaton (1.10%, *Sporobolus airoides*). Also recorded in 2020 was Blue grama (0.65%, *Bouteloua gracilis*), a warm-season perennial grasses, but it did not meet the 1% relative cover standard. Four other warm-season perennial grasses occur on M-VMU-4 but have not been recorded between 2019 and 2020. Thus, the warm-season perennial grass standard was achieved in M-VMU-4.

The diversity standard for forbs requires a minimum of three non-annual forb taxa combining to contribute at least 1% relative cover. The combined relative cover of 5 non-annual forbs is 2.21%, dominated by two native perennial forbs, gray globemallow (0.96%, *Sphaeralcea incana*) and Palmer's penstemon (0.72%, *Penstemon palmeri*). Additional forbs contributing to the diversity standard are rose heath (0.20%, *Chaetopappa ericoides*), bastardsage (0.16%, *Eriogonum wrightii*), and scarlet globemallow (0.17%, *Sphaeralcea coccinea*). Based on 2020 sampling, 5 non-annual forbs have a combined relative cover greater than 1%, meeting the diversity standard for forbs on the M-VMU-4 reclamation.

The diversity standard for shrubs requires two species with a minimum relative cover of 1% for each species. The diversity standard for shrubs is achieved by four-wing saltbush (11.99%), and winterfat (3.45%). Additional native shrubs recorded in the quadrats but not exceeding the relative cover requirement include big sagebrush (0.63%, *Artemisia tridentata*), shadscale saltbush (0.26%, *Atriplex confertifolia*), and Mormon tea (0.23%, *Ephedra viridis*).

Based on the 2020 vegetation monitoring, 91 different plant species were present within the reclamation areas of M-VMU-4 (Table 3). We encountered 42 forbs, 24 grasses, and 25 shrubs, trees, and cacti. Of the 42 forbs, 16 are considered annuals whereas the remaining 26 have variable durations or are purely perennial. Of the 24 grasses, 14 are cool-season perennials, seven are warm-season perennials, and three are cool-season annuals. Cacti (one species) and trees (three species) were rare on the reclamation, while shrubs and subshrubs were more commonly observed (17 species).

During the 2020 monitoring program, we infrequently encountered one Class B and four Class C noxious weeds (NMDA 2020) on M-VMU-4. Class B noxious weeds are those that are isolated in the state and managed such that they are contained and spread should be stopped. Class C noxious weeds are generally widespread in the state and managed at the local level based on feasibility of control and level of infestation. No noxious weeds were recorded in the quadrats and were therefore not used in the assessment of revegetation success. The noxious weeds observed on M-VMU-4 include one Class B noxious weed halogeton (*Halogeton glomeratus*) and several Class C noxious weeds cheatgrass (*Bromus tectorum*), musk thistle (*Carduus nutans*), saltcedar (*Tamarix ramosissima*), and Siberian elm (*Ulmus pumila*). The contribution of these species to the vegetation community is insignificant with densities much lower than native rangeland beyond the permit boundary. CMI continues to monitor for noxious weeds and actively controls them through husbandry practices that include annual services for weed control. Further, competition from desirable seeded and native species is expected to inhibit any substantial increase of noxious weeds in the reclamation.

The recruitment of native plants and establishment of seeded species within M-VMU-4 is indicative of ecological succession and the capacity of the site to support a diverse and self-sustaining ecosystem.

4.0 SUMMARY

McKinley Mine's vegetation success standards for the post-mining land uses of grazing and wildlife are based on canopy cover, production, shrub density, and plant diversity (Table 2). The vegetation survey in 2020 was the second year of the past two years evaluating vegetation success in M-VMU-4 and we summarize our general findings here:

1. Despite the prolonged drought, the reclamation has been resilient and successful for cover, productivity, and shrub density for both 2019 and 2020 – demonstrating permanence.
2. In 2019 the diversity parameter for the warm-season grass standard was not met since only one species (a minimum of two needed) exceeded 1% relative cover. However, in 2020 the diversity standards for cool- and warm-season grasses, forbs, and shrubs were all met in M-VMU-4. This demonstrates the sites capacity to exceed all of the diversity parameters even under exceptional drought conditions.

For 2020, M-VMU-4 exceeded the success parameters for cover, productivity, shrub density, and all of the diversity parameters (Tables 5 and 6). For 2019, M-VMU-4 only fell short with the warm-season grass diversity component. Results for both years indicate that the vegetation community in M-VMU-4 is progressing well, is capable of meeting all success parameters, and in 2020 achieved full compliance with the vegetation success standards.

Precipitation is a key environmental factor affecting vegetation establishment and performance. Cumulative water year (WY) precipitation is shown in Figure 9 for the South Tipple gage and the Window Rock long-term averages. Precipitation patterns at the South Tipple gage were below the long-term average with clear deficits during the peak growing season favoring cool-season grasses and shrubs. Typical precipitation gains at Window Rock occur between June and September where cumulative precipitation increases at a greater rate than the rest of the WY. At the South Tipple gage the greatest precipitation gains occurred outside the typical growing season between October and May (8.68 inches, WY2019) and between November and March (5.85 inches, WY2020). In WY2019, June through August only saw 0.6 inches of precipitation when almost 4.3 inches is normal at Window Rock (Table 1). In WY2020, the total growing season precipitation (April through September) was 1.74 inches, or 26% of average, with just over one inch of that total falling in July. Vegetation performance for M-VMU-4 exceeded all of the vegetation success parameters amidst exceptionally dry conditions indicates a permanent, established, and resilient plant community.

Between 2019 and 2020, the estimated population means for perennial/biennial canopy cover (%) and annual forage production (lbs/ac) exceed their corresponding technical standards (Figure 9b and 9c). Shrub density based on the belt transect method ranged from an average of 3,723 stems/ac in 2019 to 3,116 stems/ac in 2020: each far exceeding the technical standard of 150 live stems/ac (Figure 9d). Based on the 2020 statistical hypothesis testing for M-VMU-4, perennial/biennial canopy cover, annual forage production, and shrub density exceed their respective technical standards (Table 5). In 2020, the diversity standards for cool- and warm-season grasses, forbs, and shrubs were all met in M-VMU-4 (Table 6). In 2019, the diversity standards for cool-season grasses, forbs, and shrubs were met in M-VMU-4, but the diversity standard for warm-season grasses was not met.

Overall, vegetation performance in M-VMU-4 is encouraging considering below-average precipitation for the past 5 years including a two-year drought in 2017 and 2018 and the exceptional drought this past year. The continued presence of feral horses is also likely to negatively affect cover and production, especially when forage is scarce. The performance of the vegetation under these conditions suggests that the reclaimed plant communities are resilient and capable of sustaining themselves under adverse conditions that are characteristic of this region.

5.0 REFERENCES

Bonham, C.D. 1989. Measurements for Terrestrial Vegetation. John Wiley & Sons. New York, NY.

Clark, D.L. 2001. Stabilization of the mean as a demonstration of sample adequacy. American Society for Surface Mining and Reclamation Annual Meeting. Albuquerque, NM. June 3-7, 2001. ASSMR, Lexington, KY.

Mining and Minerals Division (MMD). 1999. Coal Mine Reclamation Program Vegetation Standards. Santa Fe, NM. April 30.

McDonald, L., and S. Howlin. 2013. Evaluation and comparison of hypothesis testing techniques for bond release application. University of Wyoming, Laramie, WY.

Parametrix. 2012. Revegetation Success Standards Report: McKinley Mine – Response to OSM. Prepared by Jim Nellessen of Parametrix, Albuquerque, New Mexico. April 2012.

New Mexico Department of Agriculture (NMDA). 2020. New Mexico Noxious Weed List Update. New Mexico State University, Las Cruces, NM. June 2020.

Sokal, R.R. and F.J. Rohlf. 1981. Biometry (2nd edit.). W. H. Freeman and Co., San Francisco.

Schulz, A. M., R. P. Gibbens, and L. F. DeBano. 1961. Artificial populations for teaching and testing range techniques. J. Range Management. 14:236-242.

Snedecor, G.W. and W.G. Cochran. 1967. Statistical methods applied to experiments in agriculture and biology. 6th ed. Ames, Iowa: Iowa State University Press.

Golder and the G logo are trademarks of Golder Associates Corporation

https://golderassociates.sharepoint.com/sites/127720/project files/6 deliverables/2020_phiii-veg/1_mmd_veg-phiii_2020/m-vmu-4/2_text/1338105207-r-rev0-m-vmu-4_2020veg-20210219.docx

Tables

Table 1: South Mine Seasonal and Annual Precipitation (2015-2020)

Year	Station	Area	Precipitation (inches)													
			January	February	March	April	May	June	July	August	September	October	November	December	Annual Total	Growing Season Total
2015	Tipple	South Shop	2.05	1.59	0.11	0.52	1.64	1.11	2.37	1.62	0.30	1.36	1.31	0.76	**14.74**	*7.56*
	Rain 9	9				0.50	1.38	1.22	2.88	1.25	0.22	1.13	0.99			*7.45*
	Rain 10	10				0.42	1.32	1.11	2.59	1.39	0.30	1.10	0.78			*7.13*
	Rain 11	11				0.48	1.88	1.02	2.80	1.69	0.26	0.97	1.08			*8.13*
2016	Tipple	South Shop	0.62	0.22	0.05	1.31	0.80	0.07	1.37	1.74	1.75	0.40	1.57	1.84	**11.74**	*7.04*
	Rain 9	9				0.22	0.62	0.45	1.24	0.50	1.05	1.05	0.00			*4.08*
	Rain 10	10				0.13	0.55	0.20	2.75	0.38	0.99	0.14	0.02			*5.00*
	Rain 11	11				0.28	0.77	0.64	1.61	0.42	1.09	0.09	0.04			*4.81*
2017	Tipple	South Shop	1.25	1.64	0.48	0.35	0.77	0.42	2.48	0.90	1.34	0.15	0.09	0.02	**9.89**	*6.26*
	Rain 9	9				1.20	1.02	0.01	0.82	1.40	1.64	0.37	0.91			*6.09*
	Rain 10	10				1.00	0.67	0.08	0.94	1.63	1.36	0.34	0.81			*5.68*
	Rain 11	11				1.23	1.16	0.05	0.86	2.00	1.85	0.34	0.49			*7.15*
2018	Tipple	South Shop	0.35	0.79	0.54	0.09	0.29	0.51	2.61	1.34	1.10	1.65	0.19	0.29	**9.75**	*5.94*
	Rain 9	9				0.07	0.27	0.25	2.16	0.74	0.67	1.31	0.00			*4.16*
	Rain 10	10				0.08	0.20	0.27	3.05	1.15	0.92	1.51	0.00			*5.67*
	Rain 11	11				0.09	0.29	0.26	1.92	1.00	0.89	1.45	0.00			*4.45*
2019	Tipple	South Shop	1.30	1.81	1.23	0.44	1.77	0.33	0.22	0.05	1.59	0.09	1.14	0.85	**10.82**	*4.40*
	Rain 9	9				0.16	1.36	0.24	0.46	0.37	1.84	0.05	0.07			*4.43*
	Rain 10	10				0.20	1.49	0.37	0.19	0.27	1.34	0.03	0.05			*3.86*
	Rain 11	11				0.20	1.50	0.19	0.44	0.20	1.72	0.06	0.08			*4.25*
2020	Tipple	South Shop	0.98	1.44	1.35	0.17	0.01	0.04	1.13	0.24	0.15	0.26	0.40	0.27	**6.44**	*1.74*
	Rain 9	9				0.16	0.02	0.11	0.60	0.06	0.14	0.08	0.45			*1.09*
	Rain 10	10				0.11	0.02	0.13	0.79	0.14	0.14	0.16	0.09			*1.33*
	Rain 11	11				0.22	0.00	0.05	0.63	0.69	0.20	0.30	0.41			*1.79*
Window Rock, Long-term (029410)			0.72	0.68	0.88	0.61	0.49	0.47	1.75	2.05	1.23	1.14	0.83	0.95	**11.80**	*6.60*

Notes:
Long-term averages are from Window Rock, Arizona Station (029410) for 1937 to 1999 (Western Regional Climate Center, 2020).
Growing season total precipitation is the sum of monthly totals between April and September

Table 2: Revegetation Success Standards for the Mining and Minerals Division Permit Area

Vegetative Parameter	Success Standard
Ground Cover	15% live perennial/biennial cover
Productivity	350 air-dry pounds per acre perennial/biennial annual production
Diversity	A minimum of 2 shrub or subshrub taxa contributing at least 1% relative cover each.
	A minimum of 2 perennial warm-season grass taxa contributing at least 1% relative cover each.
	A minimum of 1 perennial cool-season grass contributing at least 1% relative cover.
	A minimum of 3 perennial/biennial forb taxa combining to contribute at least 1% relative cover.
Woody Stem Stocking	150 live woody stems per acre

Notes:

Diversity criteria are assessed through evaluating individual perennial/biennial species relative cover, as agreed upon by MMD and CMI in June 2019. Further, relative cover is the average percent cover of a perennial/biennial species divided by the total perennial/biennial cover of the sampling unit.

Table 3: Vegetation Cover, Density, and Production by Species, M-VMU-4, 2020

Scientific Name	Common Name	Code	Mean Vegetation Cover (%)			Mean Density (#/ac)	Mean Annual Production (lbs/ac)
			Canopy	Basal	Relative Canopy[a]		
Cool-Season Grasses (17)							
Annuals (3)							
Bromus arvensis	Field brome	BRAR5	obs	obs	obs	obs	obs
Bromus tectorum	Cheatgrass	BRTE	obs	obs	obs	obs	obs
Hordeum vulgare	Common barley	HOVU	obs	obs	obs	obs	obs
Perennials (14)							
Achnatherum hymenoides	Indian ricegrass	ACHY	1.03	0.09	2.48	1,113	9
Agropyron cristatum	Crested wheatgrass	AGCR	obs	obs	obs	obs	obs
Bromus inermis	Smooth brome	BRIN2	obs	obs	obs	obs	obs
Elymus elymoides	Bottlebrush squirreltail	ELEL	1.48	0.11	3.55	3,845	13
Elymus glaucus	Blue wildrye	ELGL	2.15	0.15	5.18	7,082	29
Elymus lanceolatus ssp. lanceolatus	Thickspike wheatgrass	ELLAL	2.63	0.27	6.34	9,712	18
Elymus trachycaulus	Slender wheatgrass	ELTR7	0.41	<0.05	0.99	1,922	3
Hesperostipa comata	Needle and thread	HECO26	0.55	<0.05	1.33	1,113	9
Hordeum jubatum	Foxtail barley	HOJU	obs	obs	obs	obs	obs
Leymus ambiguus	Colorado wildrye	LEAM	16.45	2.39	39.63	19,931	258
Pascopyrum smithii	Western wheatgrass	PASM	2.43	0.13	5.84	12,646	9
Pseudoroegneria spicata	Bluebunch wheatgrass	PSSP6	obs	obs	obs	obs	obs
Thinopyrum intermedium	Intermediate wheatgrass	THIN6	obs	obs	obs	obs	obs
Thinopyrum ponticum	Tall wheatgrass	THPO7	0.20	<0.05	0.48	304	2
Warm-Season Grasses (7)							
Perennials (7)							
Aristida purpurea	Purple threeawn	ARPU	obs	obs	obs	obs	obs
Bouteloua curtipendula	Sideoats grama	BOCU	obs	obs	obs	obs	obs
Bouteloua gracilis	Blue grama	BOGR2	0.27	<0.05	0.65	1,113	1
Bouteloua hirusta	Hairy grama	BOHI2	obs	obs	obs	obs	obs
Panicum virgatum	Switchgrass	PAVI2	obs	obs	obs	obs	obs
Pleuraphis jamesii	James' galleta	PLJA	5.27	0.41	12.70	15,682	47
Sporobolus airoides	Alkali sacaton	SPAI	0.46	<0.05	1.10	1,416	4

Table 3: Vegetation Cover, Density, and Production by Species, M-VMU-4, 2020

Scientific Name	Common Name	Code	Mean Vegetation Cover (%)			Mean Density (#/ac)	Mean Annual Production (lbs/ac)
			Canopy	Basal	Relative Canopy[a]		
Forbs (42)							
Annuals (16)							
Alyssum desertorum	Desert madwort	ALDE	obs	obs	obs	obs	obs
Alyssum simplex	Alyssum	ALSI8	obs	obs	obs	obs	obs
Chenopodium album	Lambsquarters	CHAL7	obs	obs	obs	obs	obs
Chenopodium incanum	Mealy goosefoot	CHIN2	obs	obs	obs	obs	obs
Chenopodium leptophyllum	Narrowleaf goosefoot	CHLE4	obs	obs	obs	obs	obs
Cordylanthus wrightii	Wright's bird's beak	COWR2	obs	obs	obs	obs	obs
Eriogonum cernuum	Nodding buckwheat	ERCE2	obs	obs	obs	obs	obs
Eriogonum divaricatum	Divergent buckwheat	ERDI5	obs	obs	obs	obs	obs
Halogeton glomeratus	Halogeton	HAGL	obs	obs	obs	obs	obs
Helianthus annuus	Common sunflower	HEAN3	obs	obs	obs	obs	obs
Kochia scoparia	Kochia	KOSC	obs	obs	obs	obs	obs
Malacothrix fendleri	Fendler's desertdandelion	MAFE	obs	obs	obs	obs	obs
Polygonum erectum	Erect knotweed	POER2	obs	obs	obs	obs	obs
Salsola tragus	Russian thistle	SATR	1.43	<0.05	--	52,609	5
Unknown Annual Forb	Unknown annual forb	UNKAF	obs	obs	obs	obs	obs
Xanthium strumarium	Rough cocklebur	XAST	obs	obs	obs	obs	obs
Perennials/Biennials (26)							
Achillea millefolium	Common yarrow	ACMI2	obs	obs	obs	obs	obs
Calochortus nuttallii	Sego lily	CANU3	obs	obs	obs	obs	obs
Carduus nutans	Musk thistle	CANU4	obs	obs	obs	obs	obs
Chaetopappa ericoides	Rose heath	CHER	0.08	<0.05	0.20	101	<1
Conyza canadensis	Horseweed	COCA	obs	obs	obs	obs	obs
Descurainia sophia	Flixweed	DESO	obs	obs	obs	obs	obs
Eriogonum wrightii	Bastardsage	ERWR	0.07	<0.05	0.16	4,047	<1
Ipomopsis longiflora	Flaxflowered ipomopsis	IPLO	obs	obs	obs	obs	obs
Lappula occidentalis	Flatspine stickseed	LAOC3	obs	obs	obs	obs	obs
Machaeranthera canescens	Purple aster	MACA	obs	obs	obs	obs	obs
Machaeranthera tanacetifolia	Tanseyleaf tansyaster	MATA	obs	obs	obs	obs	obs
Marrubium vulgare	Horehound	MAVU	obs	obs	obs	obs	obs
Mentzelia species	Unknown blazingstar species	MENTZ	obs	obs	obs	obs	obs
Melilotus officinalis	Yellow sweetclover	MEOF	obs	obs	obs	obs	obs
Medicago sativa	Alfalfa	MESA	obs	obs	obs	obs	obs
Mirabilis multiflora	Colorado four o'clock	MIMU	obs	obs	obs	obs	obs
Penstemon palmeri	Palmer's penstemon	PEPA8	0.30	<0.05	0.72	506	11
Polygonum aviculare	Prostrate knotweed	POAV	obs	obs	obs	obs	obs
Ratibida columnifera	Upright prairie coneflower	RACO3	obs	obs	obs	obs	obs
Rumex crispus	Curly dock	RUCR	obs	obs	obs	obs	obs
Sisymbrium altissimum	Tall tumblemustard	SIAL2	obs	obs	obs	obs	obs
Sphaeralcea coccinea	Scarlet globemallow	SPCO	0.07	<0.05	0.17	506	<1
Sphaeralcea emoryi	Emory's globemallow	SPEM	obs	obs	obs	obs	obs
Sphaeralcea grossulariifolia	Gooseberryleaf globemallow	SPGR2	obs	obs	obs	obs	obs
Sphaeralcea incana	Gray globemallow	SPIN2	0.40	<0.05	0.96	304	5
Tragopogon dubius	Yellow salsify	TRDU	obs	obs	obs	obs	obs

Table 3: Vegetation Cover, Density, and Production by Species, M-VMU-4, 2020

Scientific Name	Common Name	Code	Mean Vegetation Cover (%)			Mean Density (#/ac)	Mean Annual Production (lbs/ac)
			Canopy	Basal	Relative Canopy[a]		
Shrubs, Trees and Cacti (25)							
Perennials (25)							
Artemisia frigida	Prairie sagewort	ARFR4	obs	obs	obs	obs	obs
Artemisia ludoviciana	White sagebrush	ARLU	obs	obs	obs	obs	obs
Artemisia tridentata	Big sagebrush	ARTR2	0.26	<0.05	0.63	101	5
Atriplex canescens	Four-wing saltbush	ATCA	4.97	0.23	11.99	2,023	92
Atriplex confertifolia	Shadscale saltbush	ATCO	0.11	<0.05	0.26	101	2
Atriplex corrugata	Mat saltbush	ATCO4	obs	obs	obs	obs	obs
Atriplex gardneri	Gardner's saltbush	ATGA	0.05	<0.05	0.12	101	<1
Atriplex obovata	Mound saltbush	ATOB	obs	obs	obs	obs	obs
Atriplex species	Unknown saltbush species	ATRIP	<0.05	<0.05	<0.01	101	<1
Chrysothamnus viscidiflorus	Yellow rabbitbrush	CHVI	obs	obs	obs	obs	obs
Ephedra trifurca	Longleaf jointfir	EPTR	obs	obs	obs	obs	obs
Ephedra viridis	Mormon tea	EPVI	0.09	<0.05	0.23	405	3
Ericameria nauseosa	Rubber rabbitbrush	ERNA	<0.05	<0.05	0.01	101	<1
Eriogonum leptophyllum	Slenderleaf buckwheat	ERLE10	obs	obs	obs	obs	obs
Fallugia paradoxa	Apache plume	FAPA	obs	obs	obs	obs	obs
Gutierrezia sarothrae	Broom snakeweed	GUSA	0.33	<0.05	0.80	202	2
Heterotheca villosa	Hairy false goldenaster	HEVI	obs	obs	obs	obs	obs
Krascheninnikovia lanata	Winterfat	KRLA	1.43	0.06	3.45	1,214	24
Opuntia polyacantha	Plains pricklypear	OPPO	obs	obs	obs	obs	obs
Pinus edulis	Piñon pine	PIED	obs	obs	obs	obs	obs
Purshia mexicana	Mexican cliffrose	PUME	obs	obs	obs	obs	obs
Purshia tridentata	Antelope bitterbrush	PUTR2	obs	obs	obs	obs	obs
Sarcobatus vermiculatus	Greasewood	SAVE4	obs	obs	obs	obs	obs
Tamarix ramosissima	Saltcedar	TARA	obs	obs	obs	obs	obs
Ulmus pumila	Siberian elm	ULPU	obs	obs	obs	obs	obs
Cover Components							
Perennial/Biennial Vegetation Cover			41.5	4.1			
Total Vegetation Cover			40.0	4.1			
Rock			9.8	11.5			
Litter			13.3	39.9			
Bare Soil			36.9	44.4			

Notes:
[a] = relative cover is the average percent cover of a perennial/biennial species divided by the total perennial/biennial cover of the sampling unit
-- = this parameter is not calculated for this attribute
#/ac = number of plants per acre
lbs/ac = air-dry forage pounds per acre
obs = observed on vegetation management unit during monitoring, but not recorded in the quadrats
Ps Pathway or growing season for the grasses is from Allred (2005)
Duration for plants is from the USDA Plants Database

Table 4: Summary Statistics for M-VMU-4

	2019	2020	Technical Standard
Total Vegetation Canopy Cover (%)			
Mean	39.6	40.0	None
Standard Deviation	23.4	16.2	
90% Confidence Interval	6.1	4.2	
Nmin[1]	99	46	
Probability within true mean[2]	0.64	0.60	
Perennial/Biennial Canopy Cover (%)			
Mean	40.9	41.5	15.0
Standard Deviation	29.0	19.9	
90% Confidence Interval	7.5	5.2	
Nmin[1]	142	66	
Probability within true mean[2]	0.67	0.62	
Basal Cover (%)			
Mean	2.2	4.1	None
Standard Deviation	1.9	3.2	
90% Confidence Interval	0.5	0.8	
Nmin[1]	198	170	
Probability within true mean[2]	0.70	0.69	
Annual Forage Production (lbs/ac)			
Mean	958	551	350
Standard Deviation	736	331	
90% Confidence Interval	191	86	
Nmin[1]	167	102	
Probability within true mean[2]	0.69	0.65	
Annual Total Production (lbs/ac)			
Mean	1,000	555	None
Standard Deviation	764	326	
90% Confidence Interval	199	85	
Nmin[1]	166	98	
Probability within true mean[2]	0.68	0.64	
Shrub Density (stems/acre) from Quadrats			
Mean	6,778	4,350	150
Standard Deviation	11,238	5,052	
90% Confidence Interval	2,923	1,314	
Nmin[1]	780	383	
Probability within true mean[2]	0.85	0.77	
Shrub Density (stems/acre) from Belt Transect			
Mean	3,723	3,116	150
Standard Deviation	1,520	1,952	
90% Confidence Interval	791	1,015	
Nmin[1]	56	132	
Probability within true mean[2]	0.55	0.58	

Notes:

1 Minimum number of samples required to obtain 90 percent probability that the sample mean is within 10 percent of the population mean

2 Probability the true value of the mean is within 10 percent of the mean for the sample size

Table 5: Statistical Analysis Results for Cover, Production, and Woody Plant Density, 2019 to 2020

Parameter[1]		Standard	90% of Standard	M-VMU-4			
				2019		2020	
				Result[2]	Tested[3]	Result[2]	Tested[3]
Cover	Live perennial/biennial cover	≥ 15%	≥ 13.5%	40.9%	Pass	41.5%	Pass
Productivity	Air-dry pounds per acre perennial/biennial annual production	≥ 350 lb/ac	≥ 315 lb/ac	958	Pass	551	Pass
Woody Stem Stocking	Live woody stems per acre	≥ 150 stems/ac	≥ 135 stems/ac	3,723	Pass	3,116	Pass

Notes:

[1] Each parameter and corresponsing standards are explained in Table 2 of the Vegetation Survey Report

[2] Table 4 of each report presents results for these values

[3] Appendix C of each report presents the statistical analysis of each parameter; A "pass" or "Fail" indicates the result concerning the statistical testing required based on distribtution of data

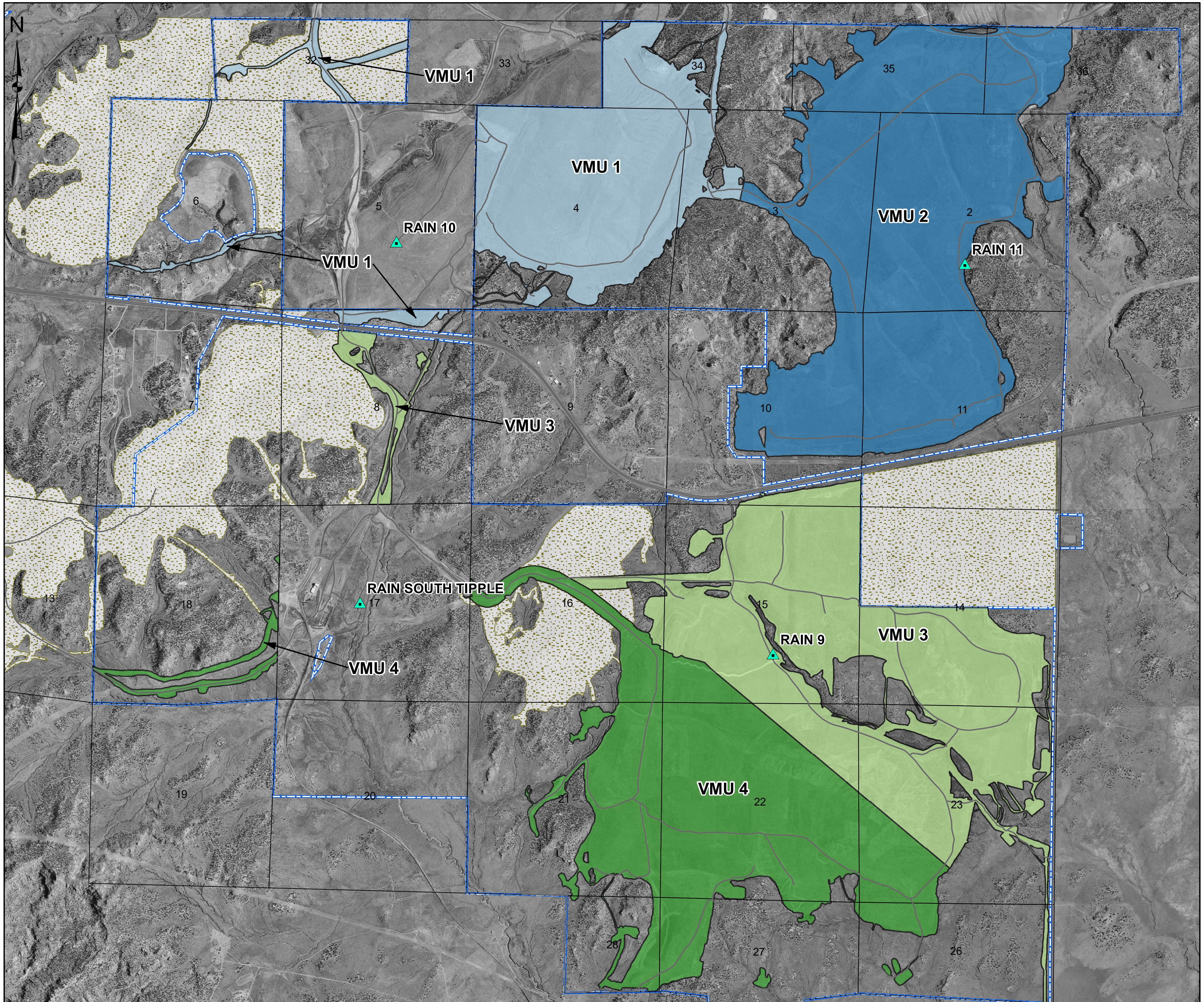
RED highlighting indicates an unmet parameter

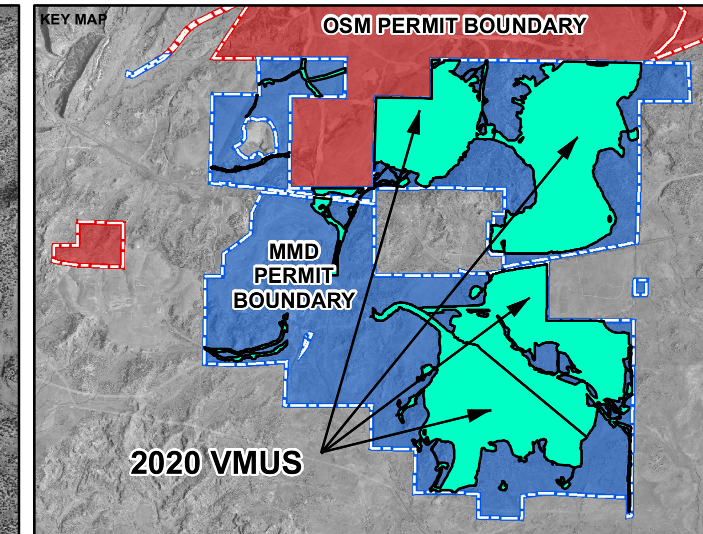
Table 6: Results for Diversity, 2019 to 2020

	Parameter[1]	Standard	M-VMU-4			
			2019		2020	
			Result[2]	Species	Result[2]	Species
Diversity	**Subshrub or shrubs**			**(6 spp.)**		**(9 spp.)**
	Shrub 1 (in % relative cover) - Required	≥ 1.0%	26.56%	Four-wing saltbush	11.99%	Four-wing saltbush
	Shrub 2 (in % relative cover) - Required	≥ 1.0%	2.73%	Winterfat	3.45%	Winterfat
	Shrub 3 (in % relative cover) (Bonus)	--	1.22%	Yellow rabbitbrush	0.80%	Broom snakeweed
	Perennial warm-season grasses			**(3 spp.)**		**(3 spp.)**
	Warm-season grass 1 (in % relative cover) - Required	≥ 1.0%	21.09%	James' galleta	12.70%	James' galleta
	Warm-season grass 2 (in % relative cover) - Required	≥ 1.0%	0.48%	Alkali sacaton	1.10%	Alkali sacaton
	Warm-season grass 3 (in % relative cover) (bonus)	--	0.19%	Blue grama	0.65%	Blue grama
	Perennial cool-season grasses			**(6 spp.)**		**(9 spp.)**
	Cool-season grass 1 (in % relative cover) - Required	≥ 1.0%	21.31%	Colorado wildrye	39.63%	Colorado wildrye
	Cool-season grass 2 (in % relative cover) (bonus)	--	13.94%	Western wheatgrass	6.34%	Thickspike wheatgrass
	Perennial/biennial forbs (combined relative cover)	**≥ 1.0%**	**11.34%**	**(7 spp.)**	**2.21%**	**(5 spp.)**
	Forb 1 - Required	--	8.73%	Flatspine stickseed	0.96%	Gray globemallow
	Forb 2 - Required	--	1.91%	Flixweed	0.72%	Palmer's penstemon
	Forb 3 - Required	--	0.55%	Blazingstar species	0.20%	Rose heath
	Forb 3 (Bonus)	--	0.06%	Upright prairie coneflower	0.17%	Scarlett globemallow

Notes:
[1] Each parameter and corresponsing standards are explained in Table 2 of the Vegetation Survey Report
[2] Text Section 3.4 and Table 3 from each report explain the diversity results that are summarized in this table
RED highlighting indicates an unmet parameter

Figures





LEGEND

- Rain Gauges
- Two-tracks, Roads and Highways
- PLSS - Sections
- MMD VMU 1 (~ 838 acres)
- MMD VMU 2 (~ 1,518 acres)
- MMD VMU 3 (~ 1,284 acres)
- MMD VMU 4 (~ 1,238 acres)
- Liability Release
- MMD Permit Boundary

0 3,000 6,000 Feet

1 inch = 2,667 feet

NOTE(S)

1. VMU = VEGETATION MANAGEMENT UNIT FOR VEGETATION SAMPLING PLAN

REFERENCE(S)

1. COORDINATE SYSTEM: NAD 1927, STATE PLANE - NEW MEXICO, WEST, FIPS 3003 (FEET)

CLIENT
CHEVRON MINING, INC. - MCKINLEY MINE
24 MILES, NW HWY 264
MENTMORE, NM 87319

PROJECT
MCKINLEY MINE - MMD PERMIT PHASE III BOND RELEASE
2020 VEGETATION SAMPLING PROGRAM

TITLE
GENERAL OVERVIEW OF MCKINLEY SOUTH MINE AREA VEGETATION MANAGEMENT UNITS (VMU), 2020

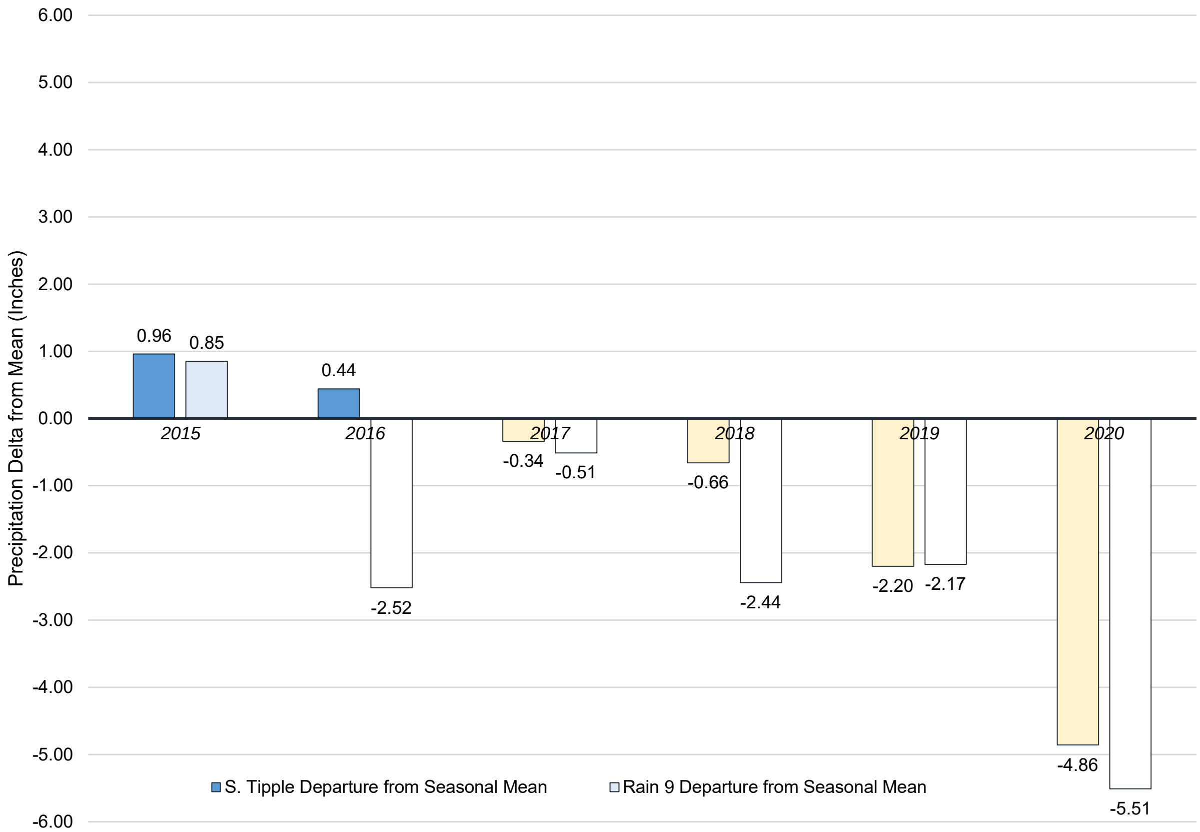
CONSULTANT: GOLDER

YYYY-MM-DD	2020-11-05
DESIGNED	DSW
PREPARED	DSW
REVIEWED	DR
APPROVED	FR

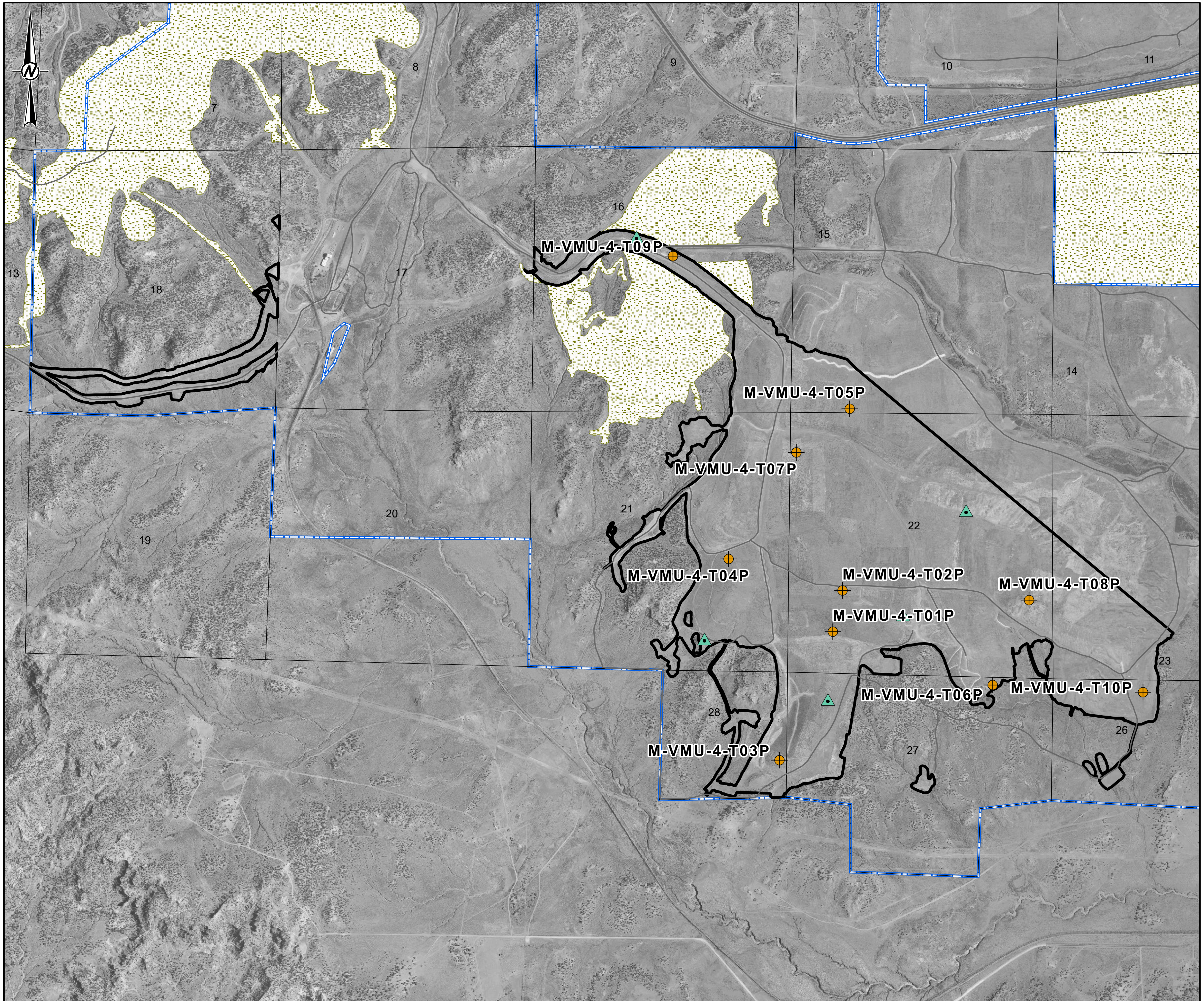
PROJECT NO.	CONTROL	REV.	FIGURE
133-8105207	000630	--	1

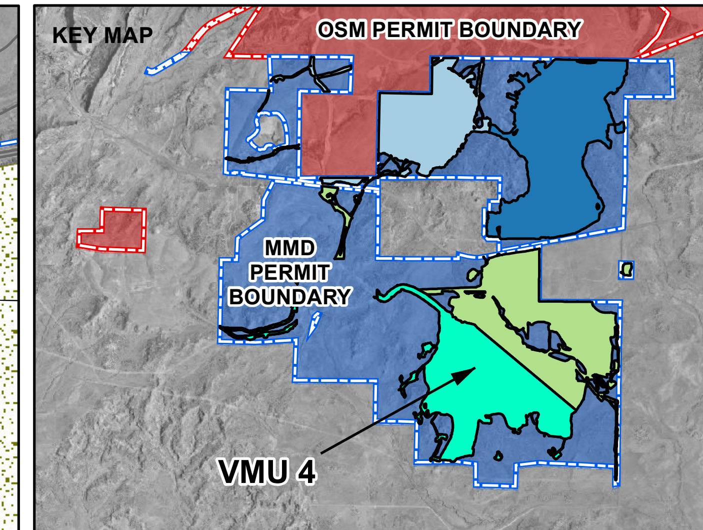
IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

Figure 2: Departure of Growing Season Precipitation from Long-Term Seasonal Mean at Window Rock; S. Tipple and Rain 9 Gages



Notes:
Long-term averages are from Window Rock, Arizona Station (029410) for 1937 to 1999 (Western Regional Climate Center, 2020).
Growing season total precipitation is the sum of monthly totals between April and September
Source data is in Table 1





LEGEND

- Vegetation Transect - Sampled
- Vegetation Transect - Deselected
- Vegetation Transect - Additional Alternate
- Two-tracks, Roads and Highways
- PLSS - Sections
- MMD VMU 4 (~ 1,238 acres)
- Liability Release
- MMD Permit Boundary

TRANSECT LABEL EXPLANATION:

M-VMU-1-T1P

- MMD Permit Area
- Vegetation Management Unit (VMU-#)
- Transect Number
- Primary (P) or Alternate (A)

0 | 1,000 | 2,000 | 4,000

1 inch = 2,000 feet FEET

NOTE(S)

1. KEY MAP SCALE IS DIFFERENT FROM OVERVIEW OF VMUS.

REFERENCE(S)

1. COORDINATE SYSTEM: NAD 1927, STATE PLANE – NEW MEXICO, WEST, FIPS 3003 (FEET).
2. ORTHO SOURCE: CHEVRON, 2013.

CLIENT

CHEVRON MINING, INC. – MCKINLEY MINE
24 MILES, NW HWY 264
MENTMORE, NM 87319

PROJECT

MCKINLEY MINE – MMD PERMIT PHASE III BOND RELEASE
2020 VEGETATION SAMPLING PROGRAM

TITLE

VEGETATION MONITORING TRANSECTS, 2020
VEGETATION MANAGEMENT UNIT 4

CONSULTANT

GOLDER

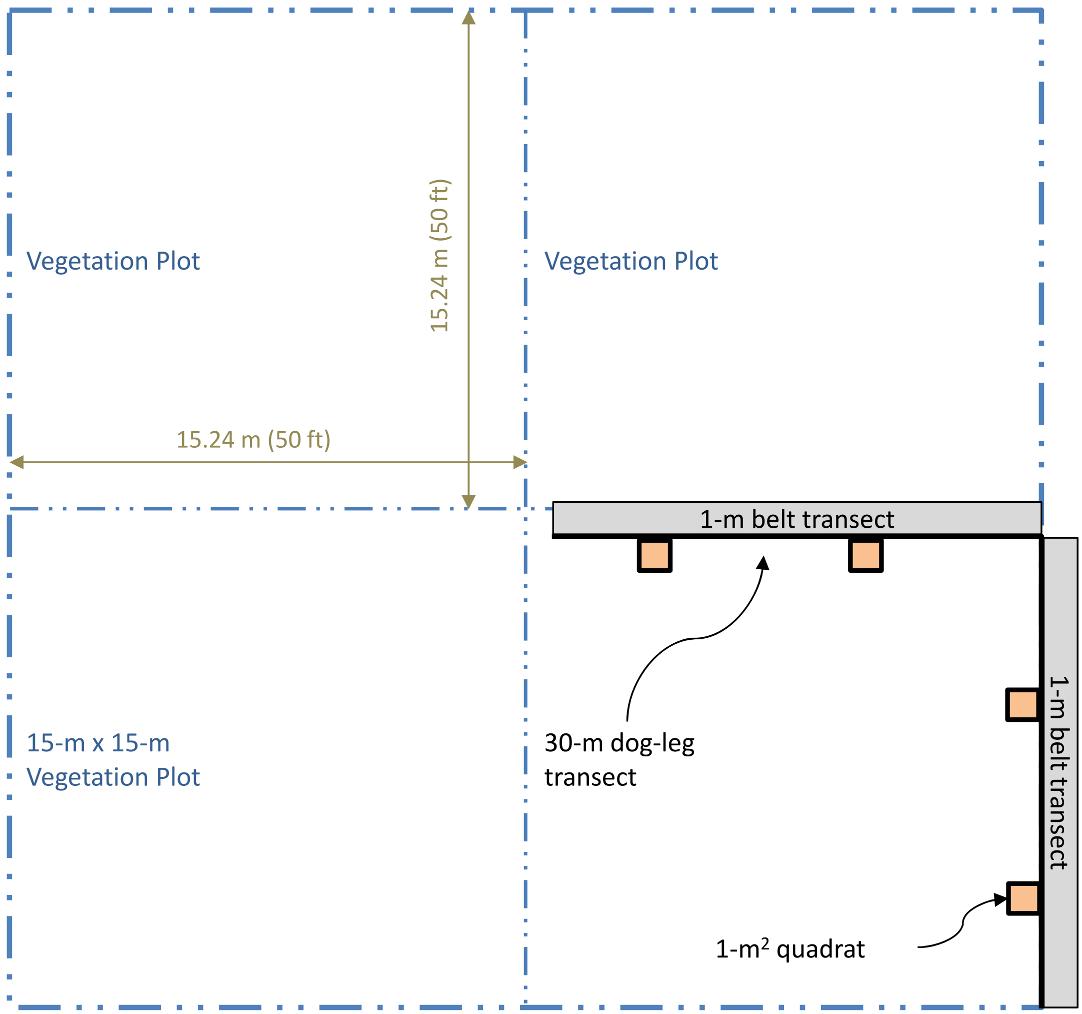
YYYY-MM-DD	2020-11-20
DESIGNED	GFD
PREPARED	GFD
REVIEWED	DSW
APPROVED	DR

PROJECT NO.	CONTROL	REV.	FIGURE
1338105207	B004	0	3

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

PATH: G:\Projects\Chevron_Environmental_Management\McKinley_Mine\99_PROJECTS\1338105207_McKinley_Onsite_Support_2020\B_Vegetation_Monitoring_Deliverables\02_PRODUCTION\MXD\1338105207_B004_MMD_VMU_4_2020.mxd

Figure 4: Vegetation Plot, Transect, and Quadrat Layout



not to scale

Figure 5: Typical Grass-Shrubland Vegetation in M-VMU-4, September 2020

Figure 6: Stabilization of the Mean for Perennial/Biennial Cover - M-VMU-4, 2020

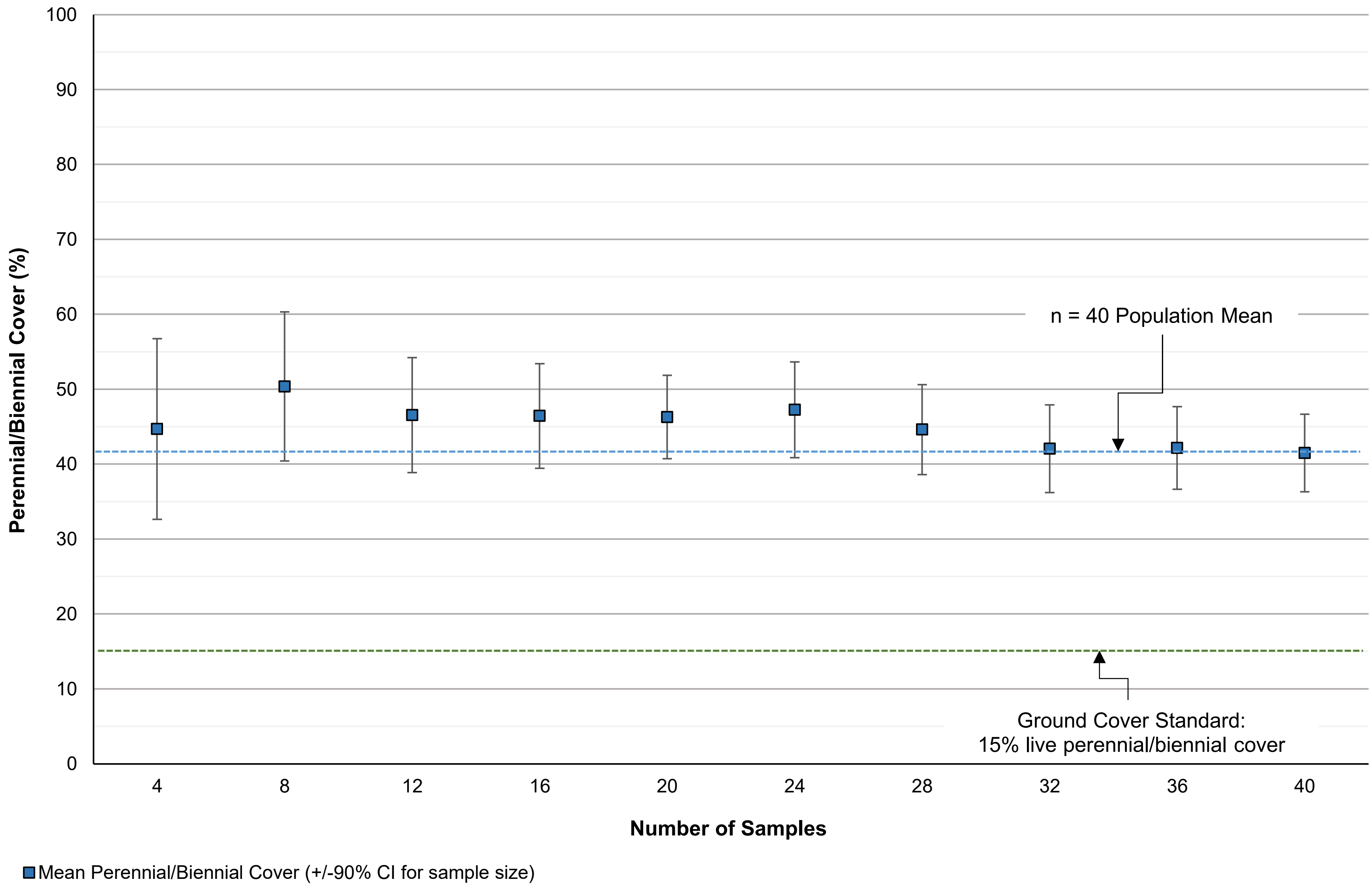


Figure 7: Stabilization of the Mean for Annual Forage Production - M-VMU-4, 2020

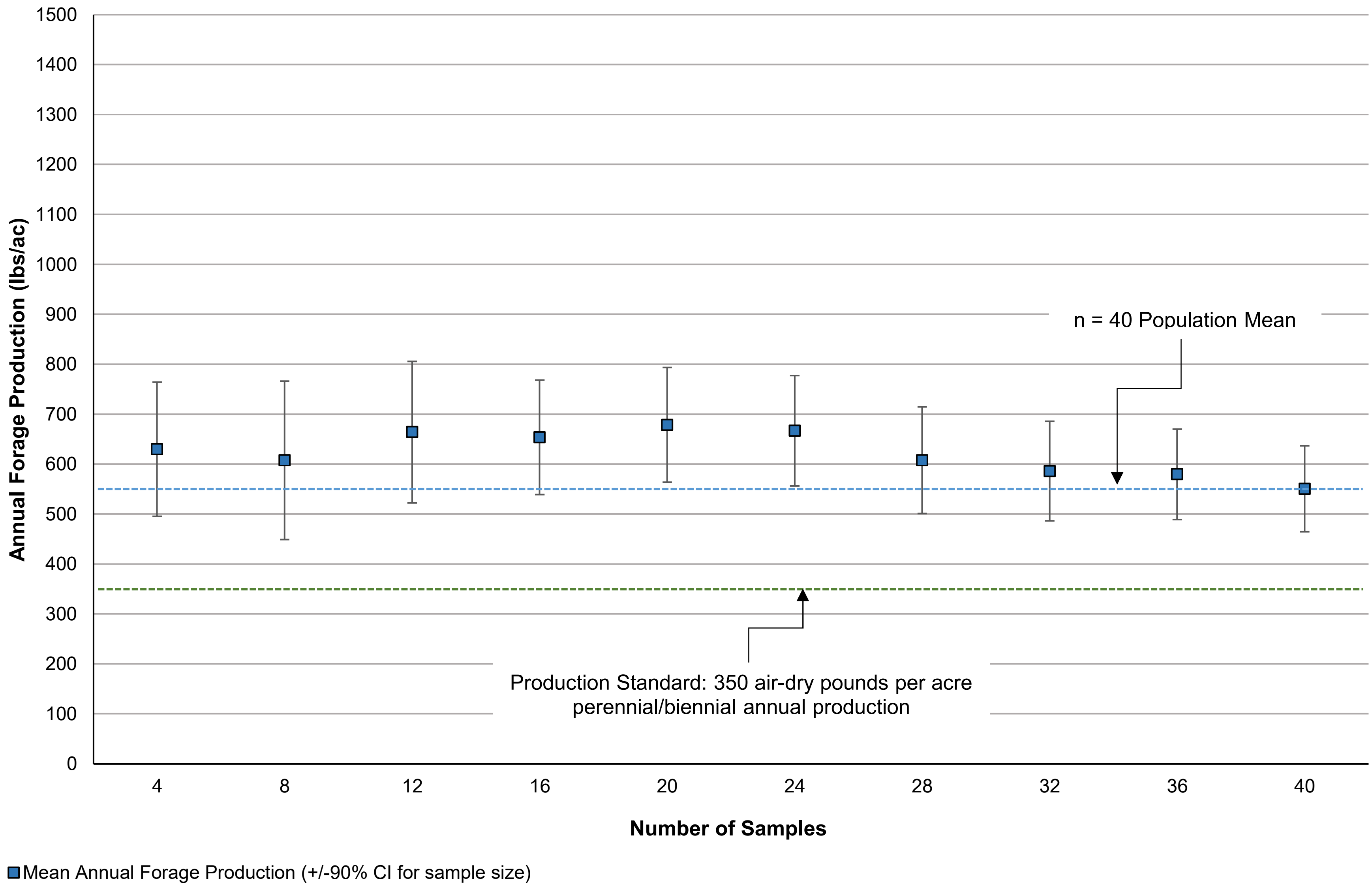


Figure 8: Stabilization of the Mean for Shrub Density - M-VMU-4, 2020

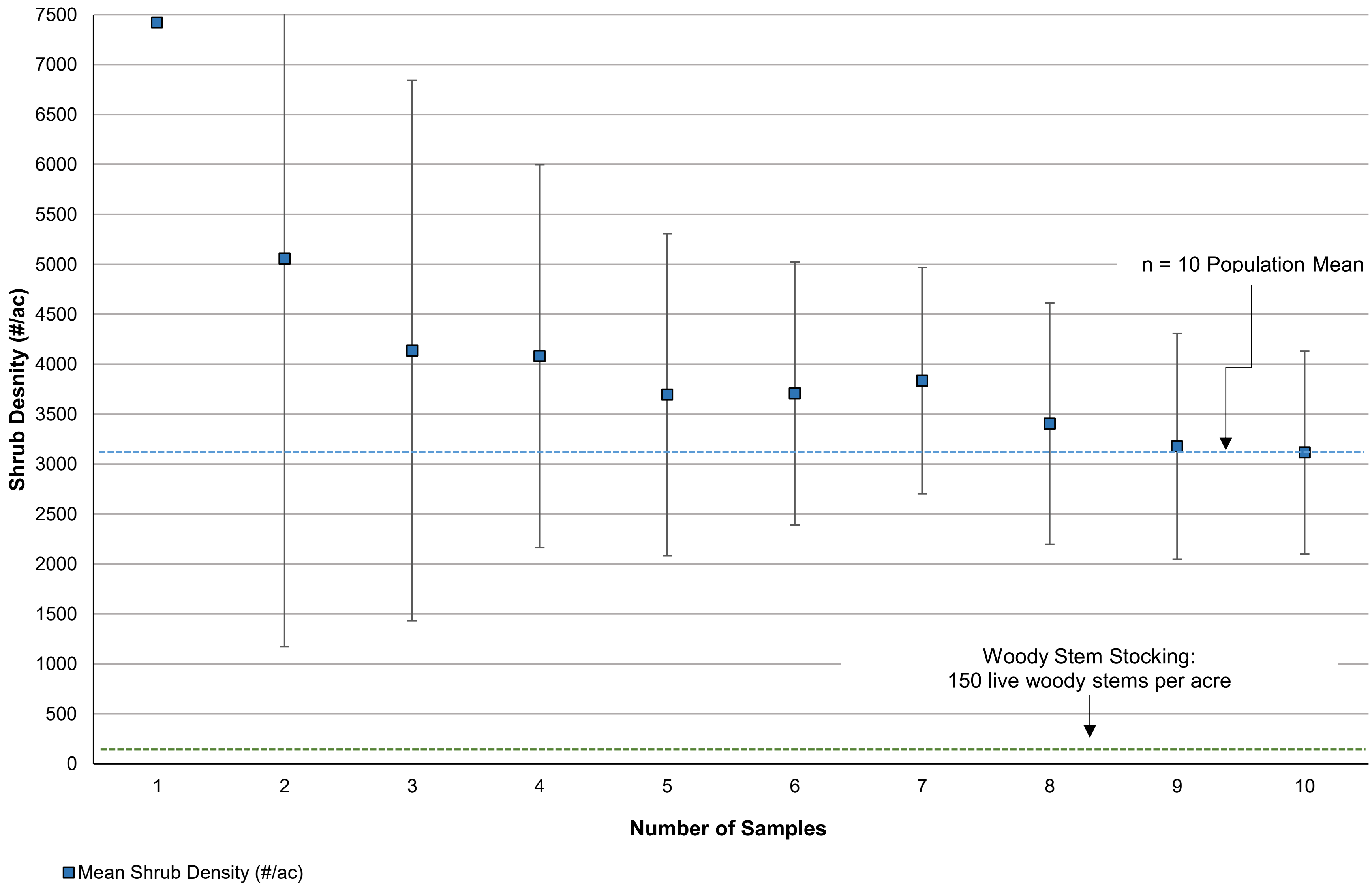


Figure 9: Graphical Summary of Water Year (WY) Precipitation Totals and Vegetation Parameters - M-VMU-4, 2019 to 2020

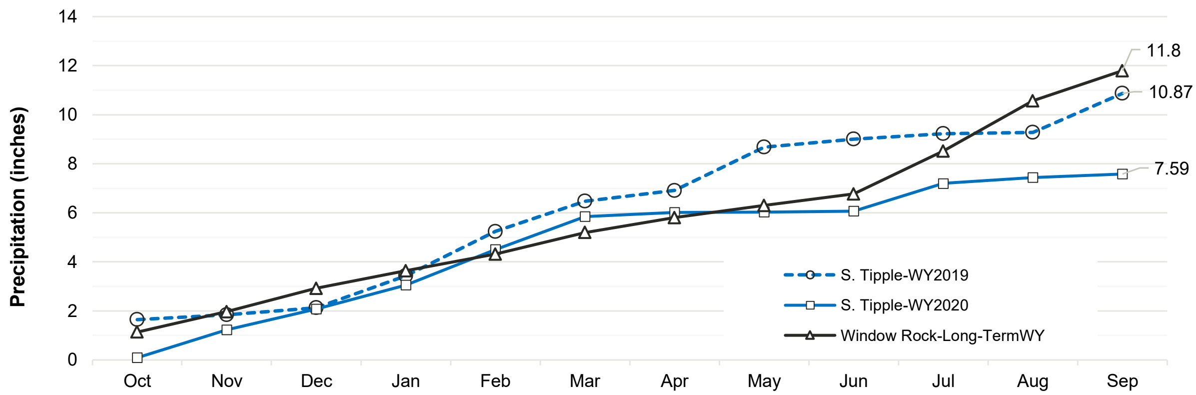


Figure 9a: Water Year (WY) Precipitation for the South Tipple location (WY2019 and WY 2020), compared to Window Rock

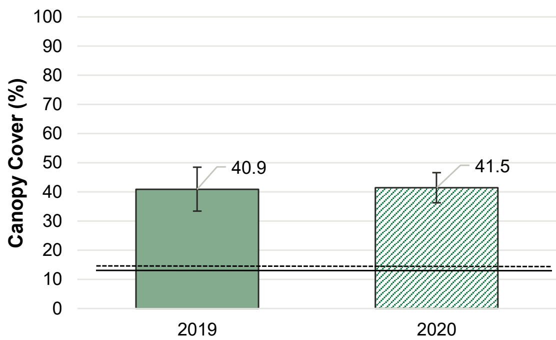


Figure 9b: M-VMU-4, Perennial/Biennial Canopy Cover (%) with Technical Standard (15%) and 90% of Technical Standard (13.5%)

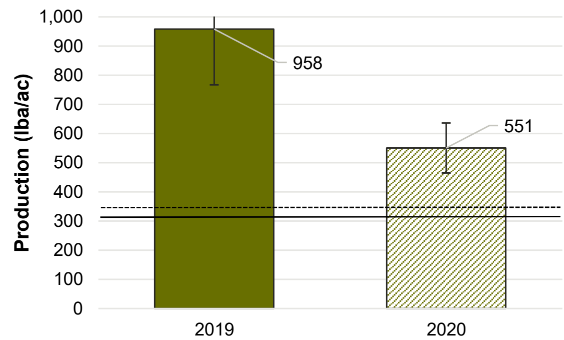


Figure 9c: M-VMU-4, Annual Forage Production (lbs/ac) with Technical Standard (350 lbs/ac) and 90% of Technical Standard (315 lbs/ac)

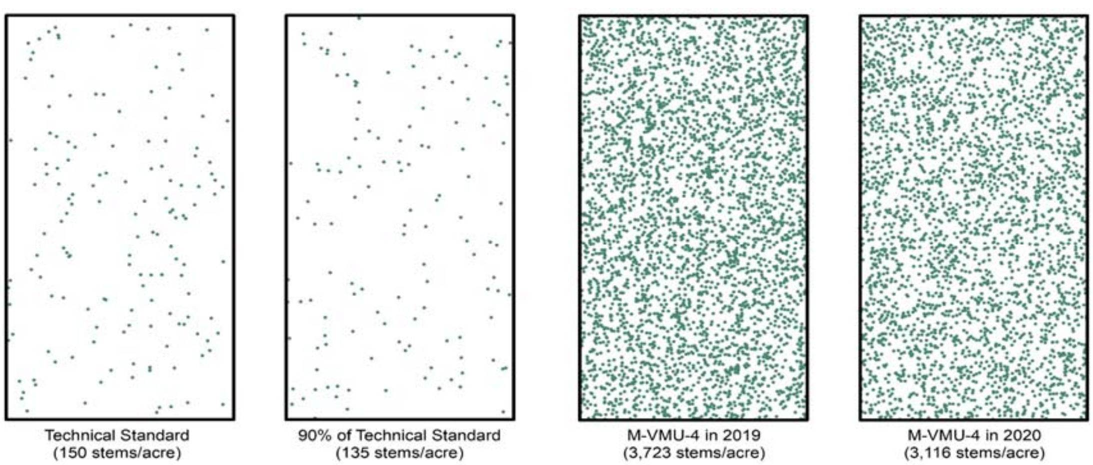


Figure 9d: M-VMU-4, Shrub Density (stems/acre) from Belt Transect with Technical Standard (150 stems/acre) and 90% of Technical Standard (135 stems/ac)

Notes:

WY = Water Year; an example is WY 2019: this includes the monthly totals for October (2018) through September (2019)

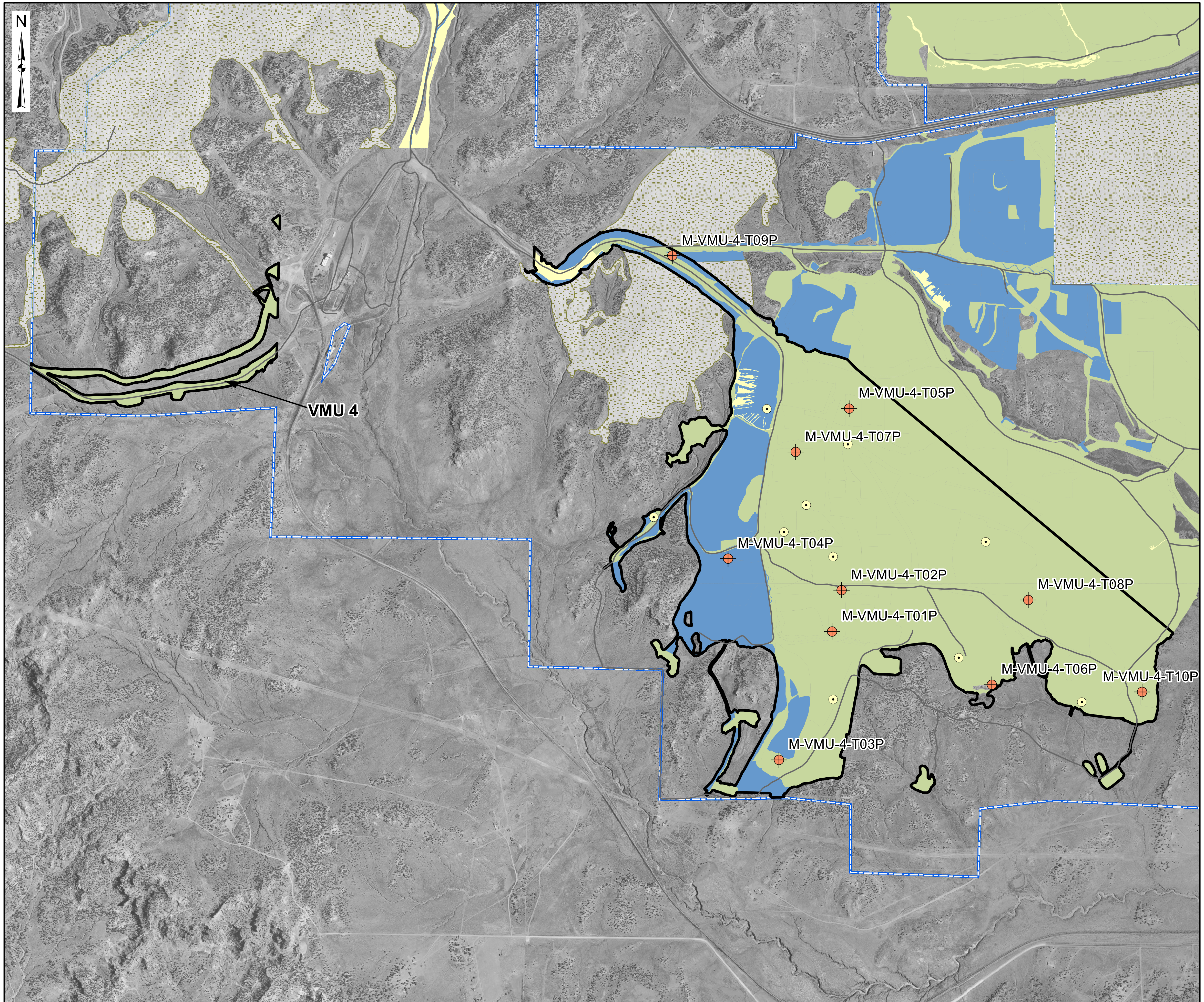
9a: Long-term averages are from Window Rock, Arizona Station (029410) for 1937 to 1999 (WRRC, 2020) and the source data is from Table 1

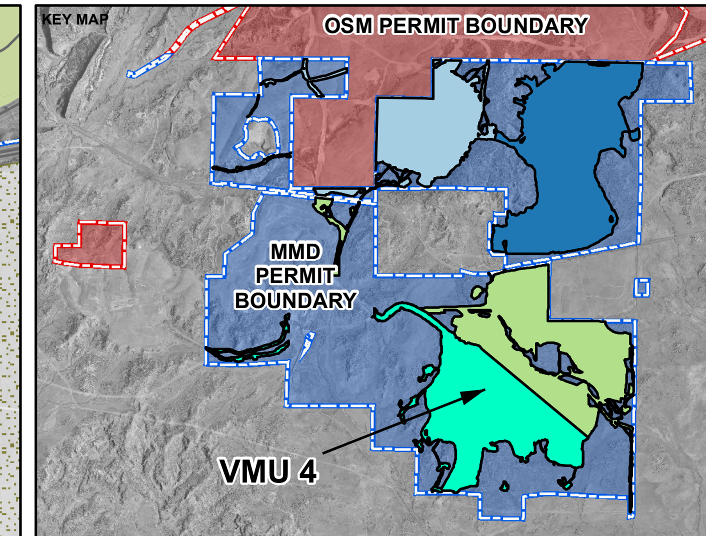
9b, c and d: Source data is from Table 4

9d: Plots represent one acre (not to scale), points represent a randomized density and do not represent the actual distribution, size, form or cover of woody plants

APPENDIX A

Vegetation Data Summary





LEGEND

- Transects for 2020 MMD PHIII Vegetation Sampling
- 2019 PHIII Transects
- Two-tracks, Roads and Highways
- MMD VMU 4 (~ 1,238 acres)
- Liability Release
- MMD Permit Boundary

Seeded Areas by End_Year

- < 1997
- 1997 to 2013
- 2014 to 2018

TRANSECT LABEL EXPLANATION: M-VMU-1-T1P

MMD Permit Area; Vegetation Management Unit (VMU-#); Transect Number; Primary (P) or Alternate (A)

0 — 2,000 — 4,000 Feet

1 inch = 2,000 feet

NOTE(S)

1. SEEDING AREA ATTRIBUTES WERE CLASSIFIED MANUALLY BASED ON SEED MIX VARIATIONS (<1997 AND 1997 TO 2013) WITH AN ADDITONAL CLASS FOR RECENT SEEDING (2014 TO 2018)

REFERENCE(S)

1. COORDINATE SYSTEM: NAD 1927, STATE PLANE - NEW MEXICO, WEST, FIPS 3003 (FEET)
2. ORTHO SOURCE: CHEVRON, 2013

CLIENT

CHEVRON MINING, INC. - MCKINLEY MINE
24 MILES, NW HWY 264
MENTMORE, NM 87319

PROJECT

MCKINLEY MINE - MMD PERMIT PHASE III BOND RELEASE
2020 VEGETATION SAMPLING PROGRAM

TITLE

SEEDED AREA CLASSIFICATION (YEAR) AND TRANSECT LOCATIONS SAMPLED VEGETATION MANAGEMENT UNIT 4 (M-VMU-4), 2020

CONSULTANT

GOLDER

YYYY-MM-DD	2021-02-04
DESIGNED	DSW
PREPARED	DSW
REVIEWED	DR
APPROVED	FR

PROJECT NO.	CONTROL	REV.	FIGURE
133-8105207	000624	--	A-1

Table A-1: M-VMU-4 Selected Transect Locations, 2020

Transect	Longitude (x)	Latitude (y)
M-VMU-4-T01P	-108.9517335	35.5973173
M-VMU-4-T02P	-108.9511034	35.5996216
M-VMU-4-T03P	-108.9552746	35.5901190
M-VMU-4-T04P	-108.9589070	35.6013080
M-VMU-4-T05P	-108.9507458	35.6097632
M-VMU-4-T06P	-108.9407673	35.5944442
M-VMU-4-T07P	-108.9543556	35.6072978
M-VMU-4-T08P	-108.9383494	35.5991984
M-VMU-4-T09P	-108.9629513	35.6181694
M-VMU-4-T10P	-108.9305020	35.5941323

Table A-2: M-VMU-4 Canopy Cover Data, 2020

Transect	M-VMU-4-T01P				M-VMU-4-T02P				M-VMU-4-T03P				M-VMU-4-T04P				M-VMU-4-T05P			
Quadrat	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Grasses																				
Perennials																				
ACHY	--	--	--	--	--	--	--	--	--	0.50	--	--	--	--	--	--	1.20	--	--	--
BOGR2	--	--	--	--	--	--	--	--	--	--	--	3.25	--	--	--	--	--	--	--	--
ELEL	--	--	--	--	--	--	--	--	2.00	--	0.50	--	--	--	--	--	--	--	--	--
ELGL	--	--	--	--	--	35.00	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ELLAL	--	--	--	--	--	--	--	55.00	--	--	--	--	--	--	--	--	--	--	--	--
ELTR7	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
HECO26	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
LEAM	33.00	45.00	17.50	32.00	--	--	45.00	18.00	--	--	--	37.50	54.00	52.00	9.25	42.00	43.00	31.00	28.50	40.00
PASM	--	--	--	--	27.00	--	3.50	--	--	--	--	--	--	--	--	--	--	--	--	--
PLJA	12.50	--	--	7.00	--	10.50	9.50	--	--	--	--	--	--	--	--	--	6.25	12.50	16.50	3.00
SPAI	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
THPO7	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Forbs																				
Annual																				
SATR	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Perennials																				
CHER	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ERWR	--	--	--	--	--	--	--	--	--	1.20	1.50	--	--	--	--	--	--	--	--	--
PEPA8	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SPCO	--	--	--	--	1.25	1.50	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SPIN2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Shrubs, Trees and Cacti																				
Perennials																				
ARTR2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ATCA	--	--	--	8.00	--	--	--	--	30.00	25.00	53.00	--	6.25	4.00	4.00	11.00	--	--	--	--
ATCO	--	--	--	4.25	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ATGA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2.00	--	--	--	--
ATRIP	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
EPVI	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ERNA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
GUSA	--	--	--	--	--	--	--	--	--	--	--	1.20	--	--	--	--	--	--	--	--
KRLA	4.00	3.50	6.00	6.00	--	18.00	--	--	--	--	--	--	--	--	--	--	--	--	0.75	--
Cover Components																				
Perennial/Biennial Vegetation Cover	49.5	48.5	23.5	57.3	28.3	65.0	58.0	73.0	32.0	26.7	55.0	42.0	60.3	56.0	13.3	55.0	50.5	43.5	45.8	43.0
Total Vegetation Cover	44.0	46.0	23.5	46.5	28.3	60.0	57.5	73.0	30.0	26.0	53.0	41.5	57.0	56.0	13.3	53.0	50.3	42.5	45.0	43.0
Rock	1.0	1.0	2.0	0.5	23.0	3.5	1.0	0.0	61.5	60.0	12.0	33.0	2.0	2.0	1.5	0.3	1.5	0.5	0.5	2.5
Litter	6.0	38.0	9.5	8.0	6.0	5.0	2.0	23.0	4.5	2.5	12.0	18.0	22.0	15.0	22.5	6.0	4.5	24.0	24.0	12.0
Base Soil	49.0	15.0	65.0	45.0	42.8	31.5	39.5	4.0	4.0	11.5	23.0	7.5	19.0	27.0	62.8	40.8	43.8	33.0	30.5	42.5

Transect	M-VMU-4-T06P				M-VMU-4-T07P				M-VMU-4-T08P				M-VMU-4-T09P				M-VMU-4-T10P			
Quadrat	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Grasses																				
Perennials																				
ACHY	6.25	7.25	--	--	5.00	--	--	--	--	--	--	--	--	--	--	--	--	--	--	21.00
BOGR2	7.50	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ELEL	1.25	19.00	4.00	18.00	--	--	--	--	1.25	7.25	5.50	0.25	--	--	--	--	--	--	--	--
ELGL	--	--	--	--	--	--	--	--	--	--	--	--	45.00	--	--	--	--	--	--	6.00
ELLAL	--	--	--	--	--	--	--	--	7.00	--	--	--	2.00	--	--	--	--	23.00	11.00	7.25
ELTR7	--	--	--	--	--	--	5.25	11.25	--	--	--	--	--	--	--	--	--	--	--	--
HECO26	2.00	16.00	1.00	--	--	2.75	--	--	--	--	--	--	0.40	--	--	--	--	--	--	--
LEAM	--	--	--	--	17.00	7.00	2.80	8.25	--	--	--	--	--	45.00	11.00	39.00	--	--	--	--
PASM	--	--	--	--	--	--	--	--	--	--	--	--	10.00	--	1.25	--	6.25	20.00	29.00	--
PLJA	13.00	23.00	--	11.00	7.50	2.10	28.50	--	10.50	30.00	--	--	7.50	--	--	--	--	--	--	--
SPAI	7.50	--	--	--	--	--	--	--	--	--	--	--	0.75	10.00	--	--	--	--	--	--
THPO7	--	--	--	--	--	--	--	--	8.00	--	--	--	--	--	--	--	--	--	--	--
Forbs																				
Annual																				
SATR	--	--	--	--	--	--	--	--	--	--	25.00	32.00	--	--	--	--	--	--	--	--
Perennials																				
CHER	--	3.25	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ERWR	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
PEPA8	--	--	--	--	--	--	--	--	11.00	1.00	--	--	--	--	--	--	--	--	--	--
SPCO	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SPIN2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5.00	11.00
Shrubs, Trees and Cacti																				
Perennials																				
ARTR2	--	--	--	--	10.50	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ATCA	--	23.00	5.00	15.00	--	--	--	--	--	--	14.50	--	--	--	--	--	--	0.20	--	--
ATCO	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ATGA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ATRIP	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.10	--	--
EPVI	--	--	--	--	2.50	--	--	--	--	--	--	--	--	--	--	--	--	--	1.25	--
ERNA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.20	--	--
GUSA	--	--	--	12.00	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
KRLA	--	--	--	13.50	--	--	1.75	3.00	--	--	--	--	0.75	--	--	--	--	--	--	--
Cover Components																				
Perennial/Biennial Vegetation Cover	37.5	91.5	10.0	69.5	42.5	11.9	38.3	22.5	37.8	38.3	20.0	0.3	66.4	55.0	12.3	39.0	6.3	43.5	46.3	45.3
Total Vegetation Cover	33.0	71.0	6.0	38.0	39.5	11.9	38.0	22.5	37.5	35.3	42.0	32.3	57.5	54.0	12.3	39.0	6.3	43.0	46.0	45.0
Rock	15.5	5.0	26.0	8.0	1.5	57.0	4.8	2.0	15.0	9.0	6.0	15.0	0.0	0.0	6.0	7.0	1.5	3.3	0.8	0.0
Litter	12.5	10.0	7.0	14.0	8.3	1.5	1.8	2.3	3.0	2.0	2.0	10.0	40.0	29.0	8.0	11.0	60.0	4.0	33.0	7.5
Base Soil	39.0	14.0	61.0	40.0	50.8	29.7	55.5	73.2	44.5	53.8	50.0	42.8	2.5	17.0	73.8	43.0	32.3	49.8	20.3	47.5

Notes:
Species codes defined in Table 3

Table A-3: M-VMU-4 Basal Cover Data, 2020

Transect	M-VMU-4-T01P				M-VMU-4-T02P				M-VMU-4-T03P				M-VMU-4-T04P				M-VMU-4-T05P				M-VMU-4-T06P				M-VMU-4-T07P				M-VMU-4-T08P				M-VMU-4-T09P				M-VMU-4-T10P			
Quadrat	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
Grasses																																								
Perennials																																								
ACHY	--	--	--	--	--	--	--	--	--	T	--	--	--	--	--	--	T	--	--	--	0.35	0.25	--	--	0.10	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3.00
BOGR2	--	--	--	--	--	--	--	--	--	--	--	0.65	--	--	--	--	--	--	--	--	1.20	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ELEL	--	--	--	--	--	--	--	--	0.15	--	0.05	--	--	--	--	--	--	--	--	--	0.15	1.25	0.25	1.00	--	--	--	--	0.15	0.90	0.60	T	--	--	--	--	--	--	--	--
ELGL	--	--	--	--	--	3.00	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2.25	--	--	--	--	--	--	0.55
ELLAL	--	--	--	--	--	--	--	4.75	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.50	--	--	--	0.35	--	--	--	--	2.30	1.75	1.20
ELTR7	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.15	0.75	--	--	--	--	--	--	--	--	--	--	--	--
HECO26	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.15	1.35	0.15	--	--	0.20	--	--	--	--	--	--	T	--	--	--	--	--	--	--
LEAM	2.70	3.25	0.55	3.00	--	--	12.50	1.20	--	--	--	4.25	5.75	10.50	0.90	14.50	4.50	6.25	4.00	7.25	--	--	--	--	2.50	0.50	0.15	0.90	--	--	--	--	--	4.75	1.25	4.50	--	--	--	--
PASM	--	--	--	--	1.30	--	0.10	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.75	--	0.05	--	0.35	1.00	1.50	--
PLJA	1.00	--	--	0.50	--	0.70	0.55	--	--	--	--	--	--	--	--	--	0.30	0.95	1.10	0.15	0.80	1.50	--	1.30	0.60	0.25	2.10	--	1.50	3.00	--	--	0.25	--	--	--	--	--	--	--
SPAI	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.15	0.75	--	--	--	--	--	--
THPO7	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.50	--	--	--	--	--	--	--	--	--	--	--
Forbs																																								
Annual																																								
SATR	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.80	1.10	--	--	--	--	--	--	--	--
Perennials																																								
CHER	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.15	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ERWR	--	--	--	--	--	--	--	--	--	0.05	0.05	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
PEPA8	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.55	T	--	--	--	--	--	--	--	--	--	--
SPCO	--	--	--	--	T	0.05	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SPIN2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.25	1.25
Shrubs, Trees and Cacti																																								
Perennials																																								
ARTR2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.35	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ATCA	--	--	--	0.20	--	--	--	--	0.80	0.60	3.50	--	0.15	0.10	0.20	0.30	--	--	--	--	--	1.30	0.20	1.75	--	--	--	--	--	--	0.15	--	--	--	--	--	--	T	--	--
ATCO	--	--	--	0.20	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ATGA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.05	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ATRIP	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	T	--	--
EPVI	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.15	--	--	--	--	--	--	--	--	--	--	--	--	--	0.05	--
ERNA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	T	--	--
GUSA	--	--	--	--	--	--	--	--	--	--	--	0.05	--	--	--	--	--	--	--	--	--	--	--	0.40	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
KRLA	1.00	0.25	0.20	0.50	--	0.25	--	--	--	--	--	--	--	--	--	--	--	--	T	--	--	--	--	0.10	--	--	0.05	0.05	--	--	--	--	0.10	--	--	--	--	--	--	--
Cover Components																																								
Perennial/Biennial Vegetation Cover	4.7	3.5	0.8	4.4	1.3	4.0	13.2	6.0	1.0	0.7	3.6	5.0	5.9	10.6	1.1	14.9	4.8	7.2	5.1	7.4	2.7	5.8	0.6	4.6	3.7	1.0	2.5	1.7	3.2	3.9	0.8	0.0	3.9	5.5	1.3	4.5	0.4	3.4	3.6	6.0
Total Vegetation Cover	4.7	3.5	0.8	4.4	1.3	4.0	13.2	6.0	1.0	0.7	3.6	5.0	5.9	10.6	1.1	14.9	4.8	7.2	5.1	7.4	2.7	5.8	0.6	4.6	3.7	1.0	2.5	1.7	3.2	3.9	1.6	1.1	3.9	5.5	1.3	4.5	0.4	3.4	3.6	6.0
Rock	1.2	1.0	2.2	0.8	23.5	4.0	1.1	0.0	66.0	75.0	26.0	36.0	2.3	3.5	1.6	0.3	1.9	0.6	0.5	3.2	19.3	6.8	27.8	8.8	1.5	57.3	5.0	2.3	16.0	9.5	8.3	22.0	0.0	0.0	12.3	8.0	1.5	3.6	0.9	0.0
Litter	34.0	76.0	22.5	40.0	29.0	50.0	33.0	86.5	28.0	9.0	14.0	50.0	69.0	53.0	30.5	42.0	25.0	57.0	62.0	41.0	35.5	68.5	9.0	45.0	42.5	5.4	35.0	17.0	20.0	30.0	12.0	14.0	91.3	72.0	14.0	42.0	62.5	9.5	75.0	44.0
Base Soil	60.1	19.5	74.6	54.9	46.2	42.0	52.8	7.6	5.1	15.3	56.4	9.1	22.9	32.9	66.8	42.9	68.3	35.2	32.4	48.4	42.6	19.0	62.7	41.7	52.3	36.4	57.6	79.0	60.8	56.6	78.2	62.9	4.9	22.5	72.5	45.5	35.7	83.5	20.6	50.0

Notes:
Species codes defined in Table 3
T = Trace amount of cover; 0.033 is the trace value used for data analysis purposes

Table A-4: M-VMU-4 Frequency Data (counts), 2020

Transect	M-VMU-4-T01P				M-VMU-4-T02P				M-VMU-4-T03P				M-VMU-4-T04P				M-VMU-4-T05P				M-VMU-4-T06P				M-VMU-4-T07P				M-VMU-4-T08P				M-VMU-4-T09P				M-VMU-4-T10P			
Quadrat	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
Grasses																																								
Perennials																																								
ACHY	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	2	--	--	--	3	1	--	--	3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1
BOGR2	--	--	--	--	--	--	--	--	--	--	--	4	--	--	--	--	--	--	--	--	7	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ELEL	--	--	--	--	--	--	--	--	1	--	1	--	--	--	--	--	--	--	--	--	2	9	3	8	--	--	--	--	2	7	4	1	--	--	--	--	--	--	--	--
ELGL	--	--	--	--	--	52	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	10	--	--	--	--	--	--	8
ELLAL	--	--	--	--	--	--	--	65	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	10	--	--	--	4	--	--	--	--	8	5	4
ELTR7	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	4	15	--	--	--	--	--	--	--	--	--	--	--	--
HECO26	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	6	1	--	--	2	--	--	--	--	--	--	1	--	--	--	--	--	--	--
LEAM	4	6	2	8	--	--	1	1	--	--	--	8	17	14	3	15	2	3	7	5	--	--	--	--	11	29	6	7	--	--	--	--	--	24	7	17	--	--	--	--
PASM	--	--	--	--	28	--	24	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	15	--	1	--	7	23	27	--
PLJA	8	--	--	4	--	3	10	--	--	--	--	--	--	--	--	--	6	14	25	2	14	7	--	4	17	3	23	--	4	9	--	--	2	--	--	--	--	--	--	--
SPAI	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5	--	--	--	--	--	--	--	--	--	--	--	1	8	--	--	--	--	--	--
THPO7	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3	--	--	--	--	--	--	--	--	--	--	--
Forbs																																								
Annual																																								
SATR	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	240	280	--	--	--	--	--	--	--	--
Perennials																																								
CHER	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ERWR	--	--	--	--	--	--	--	--	--	32	8	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
PEPA8	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3	2	--	--	--	--	--	--	--	--	--	--
SPCO	--	--	--	--	3	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SPIN2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	2
Shrubs, Trees and Cacti																																								
Perennials																																								
ARTR2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ATCA	--	--	--	2	--	--	--	--	2	1	1	--	2	2	1	1	--	--	--	--	--	2	1	1	--	--	--	--	--	--	2	--	--	--	--	--	--	2	--	--
ATCO	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ATGA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ATRIP	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--
EPVI	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--
ERNA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--
GUSA	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
KRLA	1	2	1	2	--	1	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	1	--	--	1	1	--	--	--	--	1	--	--	--	--	--	--	--

Notes:
Species codes defined in Table 3
The quadrat (plot) size is one square meter ($1m^2$; see Figure 4); plants rooted in the quadrat were counted on an individual basis

Table A-5: M-VMU-4 Air-dry Aboveground Annual Production Data, 2020

Transect	M-VMU-4-T01P				M-VMU-4-T02P				M-VMU-4-T03P				M-VMU-4-T04P				M-VMU-4-T05P				M-VMU-4-T06P				M-VMU-4-T07P				M-VMU-4-T08P				M-VMU-4-T09P				M-VMU-4-T10P			
Quadrat	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Grasses (g/m²)																																								
Forage																																								
ACHY	--	--	--	--	--	--	--	--	--	0.57	--	--	--	--	--	--	0.75	--	--	--	8.92	4.36	--	--	10.89	--	--	--	--	--	--	--	--	--	--	--	--	--	--	14.38
BOGR2	--	--	--	--	--	--	--	--	--	--	--	1.25	--	--	--	--	--	--	--	--	5.25	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ELEL	--	--	--	--	--	--	--	--	1.12	--	0.93	--	--	--	--	--	--	--	--	--	1.60	20.24	5.35	11.22	--	--	--	--	0.67	12.32	2.74	0.53	--	--	--	--	--	--	--	--
ELGL	--	--	--	--	--	56.06	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	63.27	--	--	--	--	--	--	11.31
ELLAL	--	--	--	--	--	--	--	25.95	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3.63	--	--	--	1.07	--	--	--	--	17.26	17.35	14.65
ELTR7	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.29	6.74	--	--	--	--	--	--	--	--	--	--	--	--
HECO26	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3.77	35.33	0.61	--	--	0.67	--	--	--	--	--	--	0.87	--	--	--	--	--	--	--
LEAM	68.77	63.07	39.01	46.59	--	--	64.27	37.78	--	--	--	94.94	62.40	85.22	26.03	62.81	155.89	52.67	37.40	88.00	--	--	--	--	6.75	2.84	1.30	7.61	--	--	--	--	--	54.35	21.01	77.16	--	--	--	--
PASM	--	--	--	--	7.86	--	2.48	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3.48	--	0.60	--	2.92	3.45	20.47	--
PLJA	2.27	--	--	3.31	--	14.98	12.27	--	--	--	--	--	--	--	--	--	3.07	4.33	5.62	1.00	9.98	26.68	--	13.37	6.91	1.44	23.56	--	7.73	72.32	--	--	3.93	--	--	--	--	--	--	--
SPAI	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.23	--	--	--	--	--	--	--	--	--	--	--	0.54	9.93	--	--	--	--	--	--
THPO7	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	10.04	--	--	--	--	--	--	--	--	--	--	--
Forbs (g/m²)																																								
Non-forage																																								
SATR	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	12.28	8.52	--	--	--	--	--	--	--	--
Forage																																								
CHER	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3.12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ERWR	--	--	--	--	--	--	--	--	--	0.95	1.02	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
PEPA8	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	49.01	2.18	--	--	--	--	--	--	--	--	--	--
SPCO	--	--	--	--	0.78	1.52	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SPIN2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5.22	19.00
Shrubs, Trees and Cacti (g/m²)																																								
Forage																																								
ARTR2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	20.48	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ATCA	--	--	--	18.06	--	--	--	--	129.23	32.40	85.24	--	9.94	7.46	4.41	17.30	--	--	--	--	--	45.33	16.64	14.62	--	--	--	--	--	--	33.30	--	--	--	--	--	--	0.66	--	--
ATCO	--	--	--	8.90	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ATGA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3.26	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ATRIP	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.56	--	--
EPVI	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	11.16	--	--	--	--	--	--	--	--	--	--	--	--	--	1.86	--
ERNA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.50	--	--
GUSA	--	--	--	--	--	--	--	--	--	--	--	0.85	--	--	--	--	--	--	--	--	--	--	--	10.30	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
KRLA	4.02	8.02	7.04	13.36	--	38.37	--	--	--	--	--	--	--	--	--	--	--	--	0.73	--	--	--	--	29.55	--	--	2.50	4.32	--	--	--	--	1.36	--	--	--	--	--	--	--
Total Air-dry Aboveground Annual Production (g/m²)																																								
Non-forage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.28	8.52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Forage	75.07	71.10	46.06	90.24	8.65	110.94	79.03	63.74	130.36	33.93	87.20	97.05	72.35	92.69	30.45	83.38	159.71	57.01	43.76	89.01	35.77	135.08	22.61	79.08	56.21	4.96	33.66	18.68	71.10	86.83	36.05	0.53	74.54	64.29	21.62	77.16	2.92	22.45	44.91	59.35
Total Production	75.07	71.10	46.06	90.24	8.65	110.94	79.03	63.74	130.36	33.93	87.20	97.05	72.35	92.69	30.45	83.38	159.71	57.01	43.76	89.01	35.77	135.08	22.61	79.08	56.21	4.96	33.66	18.68	71.10	86.83	48.33	9.06	74.54	64.29	21.62	77.16	2.92	22.45	44.91	59.35
Total Air-dry Aboveground Annual Production (lbs/ac)																																								
Non-forage	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	110	76	0	0	0	0	0	0	0	0
Forage	670	634	411	805	77	990	705	569	1163	303	778	866	645	827	272	744	1425	509	390	794	319	1205	202	705	501	44	300	167	634	775	322	5	665	574	193	688	26	200	401	530
Total Production	670	634	411	805	77	990	705	569	1163	303	778	866	645	827	272	744	1425	509	390	794	319	1205	202	705	501	44	300	167	634	775	431	81	665	574	193	688	26	200	401	530

Notes:
g/m^2 = grams per square meter
lbs/ac = pounds per acre
1 gram per square meter (g/m^2) is equal to 8.922 pounds per acre (lbs/ac)
Species codes defined in Table 3
Non-forage and forage determinations are based on the permit (e.g. plants of perennial and/or biennial duration are forage and plants of annual duration are non-forage; noxious weeds are non-forage)

Table A-6: M-VMU-4 Shrub Belt Transect Data, 2020

Transect	M-VMU-4-T01P	M-VMU-4-T02P	M-VMU-4-T03P	M-VMU-4-T04P	M-VMU-4-T05P	M-VMU-4-T06P	M-VMU-4-T07P	M-VMU-4-T08P	M-VMU-4-T09P	M-VMU-4-T10P
Shrubs, Trees and Cacti										
ATCA	8	7	10	22	2	18	8	3	1	--
ATCO	--	--	--	4	--	--	3	--	--	--
ATCO4	--	2	--	--	--	--	1	--	--	--
ATGA	2	--	--	--	--	--	2	--	--	--
ATOB	--	--	--	--	--	--	2	--	--	--
ATRIP	--	--	--	--	--	--	--	--	--	4
CHVI	--	--	--	--	--	1	--	--	--	1
EPVI	--	--	--	--	--	--	5	--	--	--
ERLE10	--	--	--	--	--	1	--	--	--	--
ERNA	--	--	--	--	--	--	--	--	1	13
FAPA	--	--	--	--	--	2	--	--	--	--
GUSA	--	2	7	--	--	--	--	--	--	--
KRLA	45	8	--	--	14	6	13	--	8	--
PUTR2	--	1	--	--	--	--	--	--	--	1
SAVE4	--	--	--	3	--	--	--	--	--	--

Notes:

The shnrub belt transect area (plot) is 30m2 (1mx30m; see Figure 4); shrubs rooted in the belt transect were counted on an individual basis

Code	Scientific Name	Common Name
ATCA	*Atriplex canescens*	Four-wing saltbush
ATCO	*Atriplex confertifolia*	Shadscale saltbush
ATCO4	*Atriplex corrugata*	Mat saltbush
ATGA	*Atriplex gardneri*	Gardner's saltbush
ATOB	*Atriplex obovata*	Mound saltbush
ATRIP	*Atriplex species*	Unknown saltbush species
CHVI	*Chrysothamnus viscidiflorus*	Yellow rabbitbrush
EPVI	*Ephedra viridis*	Mormon tea
ERLE10	*Eriogonum leptophyllum*	Slenderleaf buckwheat
ERNA	*Ericameria nauseosa*	Rubber rabbitbrush
FAPA	*Fallugia paradoxa*	Apache plume
GUSA	*Gutierrezia sarothrae*	Broom snakeweed
KRLA	*Krascheninnikovia lanata*	Winterfat
PUTR2	*Purshia tridentata*	Antelope bitterbrush
SAVE4	*Sarcobatus vermiculatus*	Greasewood

APPENDIX B

Quadrat Photographs

M-VMU-4-T01P	
	
Q1	Q2
	
Q3	Q4

M-VMU-4-T02P	
	
Q1	Q2
	
Q3	Q4

M-VMU-4-T03P	
	
Q1	Q2
	
Q3	Q4

M-VMU-4-T04P

Q1

Q2

Q3

Q4

M-VMU-4-T05P	
	
Q1	Q2
	
Q3	Q4

M-VMU-4-T06P

Q1

Q2

Q3

Q4

M-VMU-4-T07P	
	
Q1	Q2
	
Q3	Q4

M-VMU-4-T08P	
	
Q1	Q2
	
Q3	Q4

M-VMU-4-T09P	
	
Q1	Q2
	
Q3	Q4

M-VMU-4-T10P	
	
Q1	Q2
	
Q3	Q4

APPENDIX C

Vegetation Statistical Analysis

Table C-1: Equations for Vegetation Data Analysis

Attribute	Equation	Where
Sample Size / Count	$n = \sum samples$	n = number of samples ∑ = sum
Mean	$\bar{x} = \frac{\sum x}{n}$	$\bar{x}$ = sample mean ∑x = sum of values for variable n = number of samples
Standard Deviation	$s = \sqrt{\frac{\sum(\bar{x} - x)^2}{n - 1}}$	s = standard deviation ∑ = sum $\bar{x}$ = sample mean n = number of samples
Variance	$s^2 = \frac{\sum (x_i - \bar{x})^2}{n-1}$	s^2 = variance ∑ = sum x_i = Value of variable for sample *i* $\bar{x}$ = sample mean n = number of samples
t-distribution	t = 1-α, v	t = two tailed t-distribution value based on a 90% level of confidence with n-1 degrees of freedom α = significance level (0.10) v = degrees of freedom (n-1)
90% Confidence Interval	$\bar{x} \pm t \frac{s}{\sqrt{n}}$	$\bar{x}$ = sample mean t = two tailed t-distribution value based on a 90% level of confidence with n-1 degrees of freedom s = standard deviation n = number of samples
N_{min} (Sample Adequacy - Normal Data)	$N_{min} = \frac{t^2 s^2}{(\bar{x}D)^2}$	N_{min} = number of samples required t = two tailed t-distribution value based on a 90% level of confidence with n-1 degrees of freedom s = standard deviation (s^2 = variance) $\bar{x}$ = sample mean D = the desired level of accuracy, which is 10 percent of the mean
Probaility of True Mean	$T = 1 - t\left(\frac{\sqrt{n(0.1xs)'^2}}{\bar{x}, 2, n, 1}\right)$	T = Probability the true value of the mean is within 10 percent of the mean for the sample size t = two tailed t-distribution value based on a 90% level of confidence with n-1 degrees of freedom n = number of samples s = standard deviation $\bar{x}$ = sample mean
one-sample, one-sided t test Method 3 (CMRP)	$t^* = \frac{\bar{x} - 0.9\,(technical\ std)}{s/\sqrt{n}}$	t* = calculated t-statistic $\bar{x}$ = sample mean s = standard deviation n = sample size
one-sample, one-sided sign test Method 5 (CMRP)	$z = \frac{(k+0.5)-0.5n}{0.5\sqrt{n}}$	z = sign test statistic k = test statistic resulting from the number of values falling below 90% of the technical standard n = sample size
Relative Cover	$R_{cvr} = Cvr_{sp.}/Cvr_{Abs.}$	R_{cvr} = Calculated Relative Cover for a Species $Cvr_{sp.}$ = Mean Absolute Cover of a Perennial/Biennial Species $Cvr_{abs.}$ = Mean Absolute Perennial/Biennial Cover
Logarithmic Transformation	Y' = log(Y + k)	log = logarithmic function Y = attribute value k = constant, here we use 1

Table C-2: M-VMU-4 2020 Data for Normal Distribution and Variance Analysis

Plot	Transect	Quadrat	Raw Data			Transformed Data		
			2020 Perennial / Biennial Cover (%)	2020 Annual Forage Production (lbs/ac)	2020 Woody Plant Density (#/ac)	Log P/B Cover (2020)	Log AFP (2020)	Log WPD (2020)
M-VMU-4	M-VMU-4-T01P	1	49.5	670	7,419	1.70	2.83	3.87
		2	48.5	634		1.69	2.80	
		3	23.5	411		1.39	2.61	
		4	57.3	805		1.77	2.91	
	M-VMU-4-T02P	1	28.3	77	2,698	1.47	1.89	3.43
		2	65.0	990		1.82	3.00	
		3	58.0	705		1.77	2.85	
		4	73.0	569		1.87	2.76	
	M-VMU-4-T03P	1	32.0	1,163	2,293	1.52	3.07	3.36
		2	26.7	303		1.44	2.48	
		3	55.0	778		1.75	2.89	
		4	42.0	866		1.63	2.94	
	M-VMU-4-T04P	1	60.3	645	3,912	1.79	2.81	3.59
		2	56.0	827		1.76	2.92	
		3	13.3	272		1.15	2.44	
		4	55.0	744		1.75	2.87	
	M-VMU-4-T05P	1	50.5	1,425	2,158	1.71	3.15	3.33
		2	43.5	509		1.65	2.71	
		3	45.8	390		1.67	2.59	
		4	43.0	794		1.64	2.90	
	M-VMU-4-T06P	1	37.5	319	3,777	1.59	2.51	3.58
		2	91.5	1,205		1.97	3.08	
		3	10.0	202		1.04	2.31	
		4	69.5	705		1.85	2.85	
	M-VMU-4-T07P	1	42.5	501	4,586	1.64	2.70	3.66
		2	11.9	44		1.11	1.66	
		3	38.3	300		1.59	2.48	
		4	22.5	167		1.37	2.22	
	M-VMU-4-T08P	1	37.8	634	405	1.59	2.80	2.61
		2	38.3	775		1.59	2.89	
		3	20.0	322		1.32	2.51	
		4	0.3	5		0.10	0.76	
	M-VMU-4-T09P	1	66.4	665	1,349	1.83	2.82	3.13
		2	55.0	574		1.75	2.76	
		3	12.3	193		1.12	2.29	
		4	39.0	688		1.60	2.84	
	M-VMU-4-T10P	1	6.3	26	2,563	0.86	1.43	3.41
		2	43.5	200		1.65	2.30	
		3	46.3	401		1.67	2.60	
		4	45.3	530		1.67	2.72	

Mean	41.5	551	3116	1.55	2.60	3.40
Standard Deviation	19.9	331	1952	0.34	0.47	0.34
Count	40	40	10	40	40	10
Variance	397.3	109528	3811006	0.12	0.22	0.12
90% Confidence Interval	5.2	86	1015	0.09	0.12	0.18

Notes:

2020 Perennial / Biennial Cover (%) Data source is Appendix A, Table A-2; Perennial/biennial cover is the sum of individual perennial/biennial species cover estimates after excluding the annual forbs and grasses and noxious weeds

2020 Annual Forage Production (lbs/ac) Data source is Appendix A, Table A-5; Annual Forage Production is the sum of perennial/biennial species production after excluding annual forbs and grasses and noxious weeds; units are pounds of air dry forage per acre (lbs/ac)

2020 Woody Plant Density (#/ac) Data is derived from Appendix A, Table A-6; Woody Plant Density is the density of subshrubs, shrubs, cacti, or trees rooted within the belt transect, converted to stems per acre (#/ac)

Table C-3: Perennial / Biennial Cover, Method 3 - CMRP

$$t^* = \frac{\bar{x} - 0.9\ (technical\ std)}{s/\sqrt{n}}$$

	2020 Perennial / Biennial Cover (%)
Mean (%)	41.5
Standard Deviation (%)	19.9
Sample Size	40
Technical Standard (%)	15
t*	8.88
N_{min}	66
1-tail t (0.1, 39)	1.304

Notes:
% = percent perennial/biennial species canopy cover, excluding annual forbs and grasses and noxious weeds

Decision Rules (reverse null)

t < t (1-a; n-1), failure to meet std*
t >= t (1-a; n-1), performance std met*
t from Appendix Table C-1 (MMD, 1999)

Table C-4: Annual Forage Production, Method 3 - CMRP

$$t^* = \frac{\bar{x} - 0.9\ (technical\ std)}{s/\sqrt{n}}$$

	2020 Annual Forage Production (lbs/ac)
Mean (%)	551
Standard Deviation (%)	331
Sample Size	40
Technical Standard (%)	350
t*	4.51
N_{min}	102
1-tail t (0.1, 39)	1.304

Notes:
lbs/ac = pounds of air dry forage per acre

Decision Rules (reverse null)

t < t (1-a; n-1), failure to meet std*
t >= t (1-a; n-1), performance std met*
t from Appendix Table C-1 (MMD, 1999)

Table C-5: Shrub Density by the Belt Transect Method, Method 3 - CMRP

$$t^* = \frac{\bar{x} - 0.9\,(technical\ std)}{s/\sqrt{n}}$$

	2020 Woody Plant Density (#/ac)
Mean (#/ac)	3,116
Standard Deviation (#/ac)	1,952
Sample Size	10
Technical Standard (#/ac)	150
t*	4.83
N_{min}	132
1-tail t (0.1, 9)	1.383

Notes:

#/ac = Number of shrubs, trees and/or cacti per acre

Decision Rules (reverse null)

t < t (1-a; n-1), failure to meet std*

t >= t (1-a; n-1), performance std met*

t from Appendix Table C-1 (MMD, 1999)

Figure C-1: Perennial/Biennial Cover (%) Descriptive Statistics and Normality, 2020

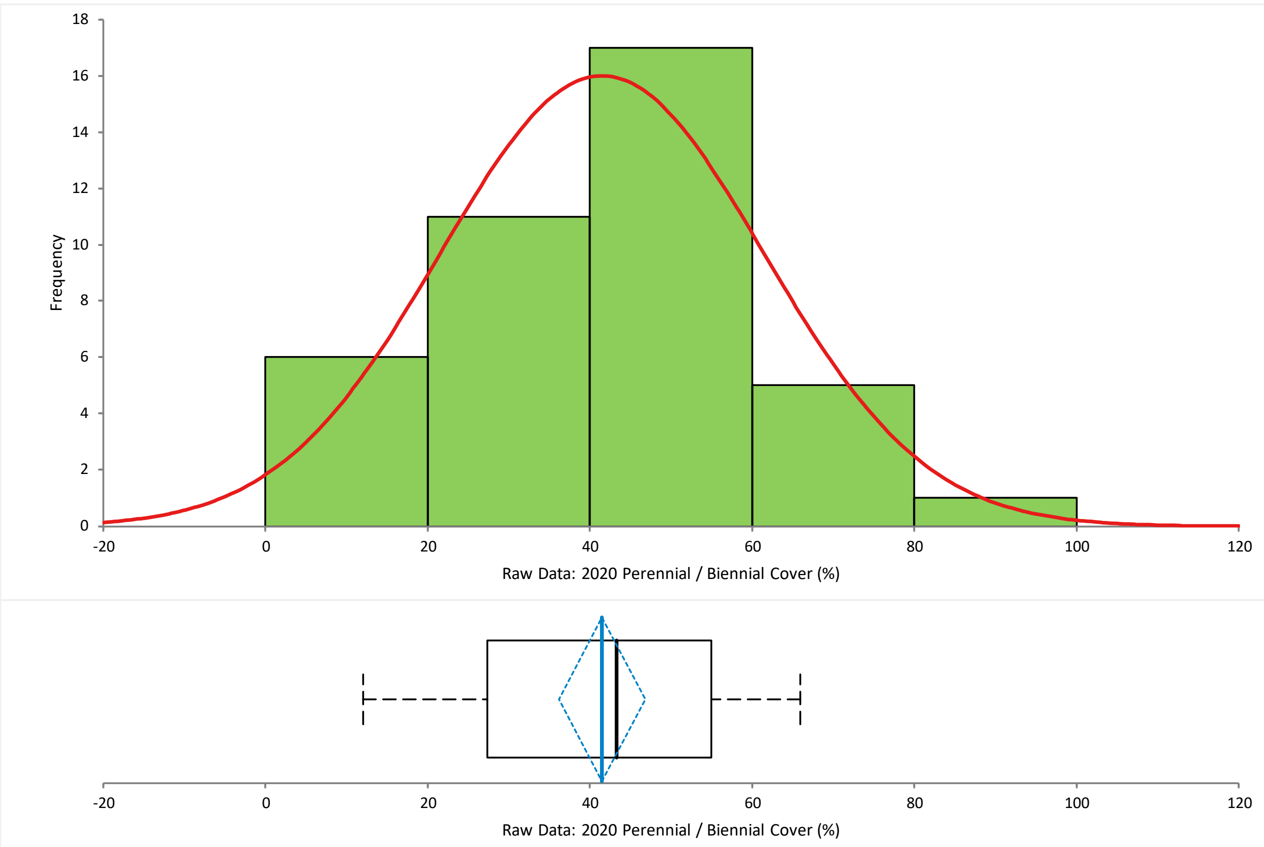
Distribution: Raw Data: 2020 Perennial / Biennial Cover

Analyse-it v5.65.7

Table C-2: M-VMU-4 2020 Data for Normal Distribution and Variance Analysis
Filter: No filter

Last updated 11 February 2021 at 14:33 by Ward, Dustin

Descriptives



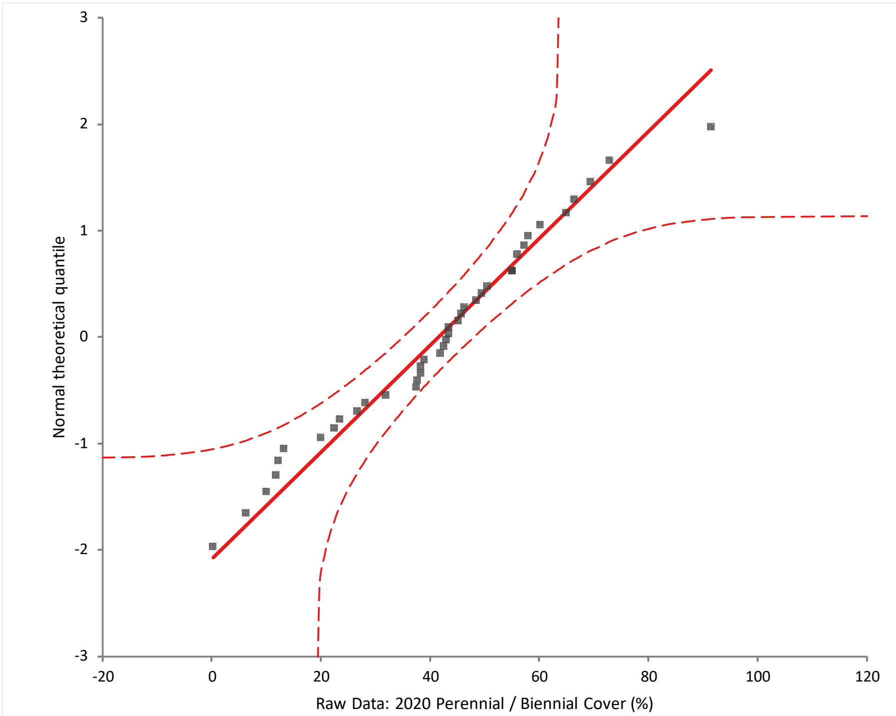
N	40

	Mean	90% CI	Mean SE	SD	Skewness	Kurtosis
Raw Data: 2020 Perennial / Biennial Cover (%)	41.49	36.18 to 46.80	3.152	19.93	0.0	-0.01

	1st quartile	Median	3rd quartile
Raw Data: 2020 Perennial / Biennial Cover (%)	27.35	43.25	55.00

Figure C-1: Perennial/Biennial Cover (%) Descriptive Statistics and Normality, 2020

Normality



Shapiro-Wilk test

W statistic	0.98
p-value	0.7241[1]

H0: F(Y) = N(μ, σ)
The distribution of the population is normal with unspecified mean and standard deviation.
H1: F(Y) ≠ N(μ, σ)
The distribution of the population is not normal.

[1] Do not reject the null hypothesis at the 10% significance level.

Figure C-2: Annual Forage Production (lbs/ac) Descriptive Statistics and Normality, 2020

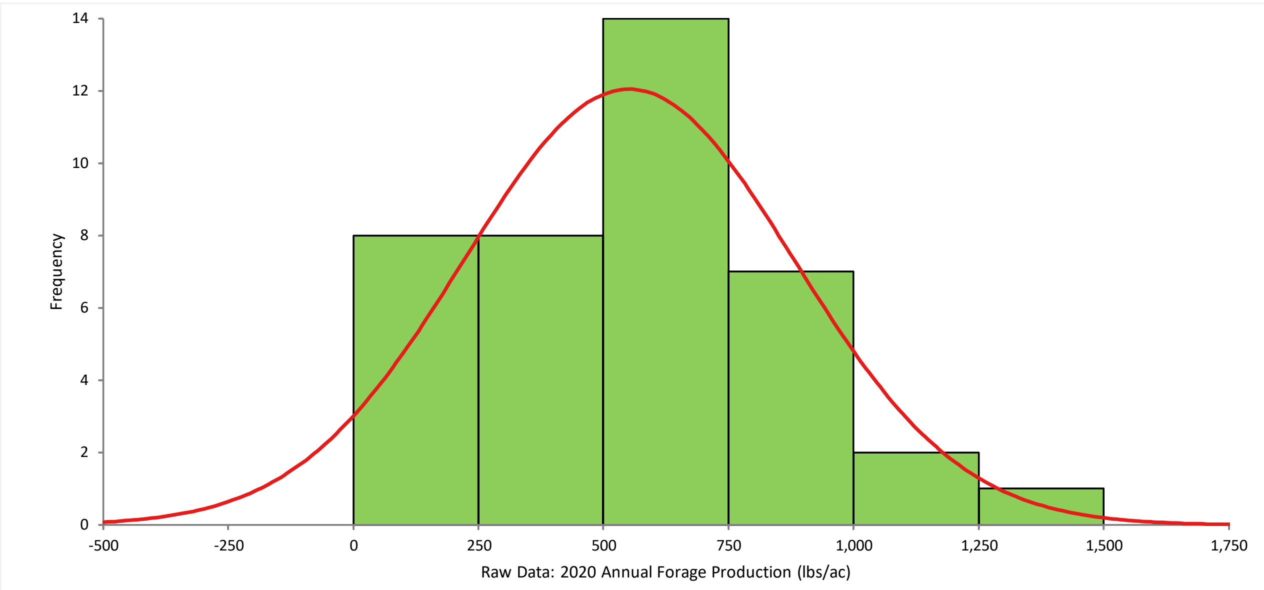
Distribution: Raw Data: 2020 Annual Forage Production

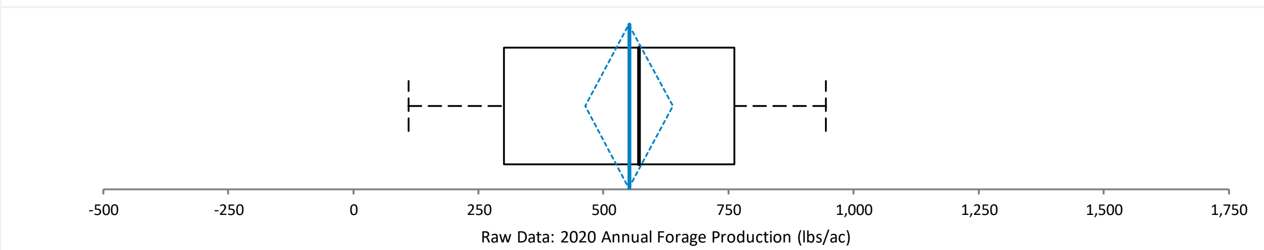
Analyse-it v5.65.7

Table C-2: M-VMU-4 2020 Data for Normal Distribution and Variance Analysis
Filter: No filter

Last updated 11 February 2021 at 14:34 by Ward, Dustin

Descriptives





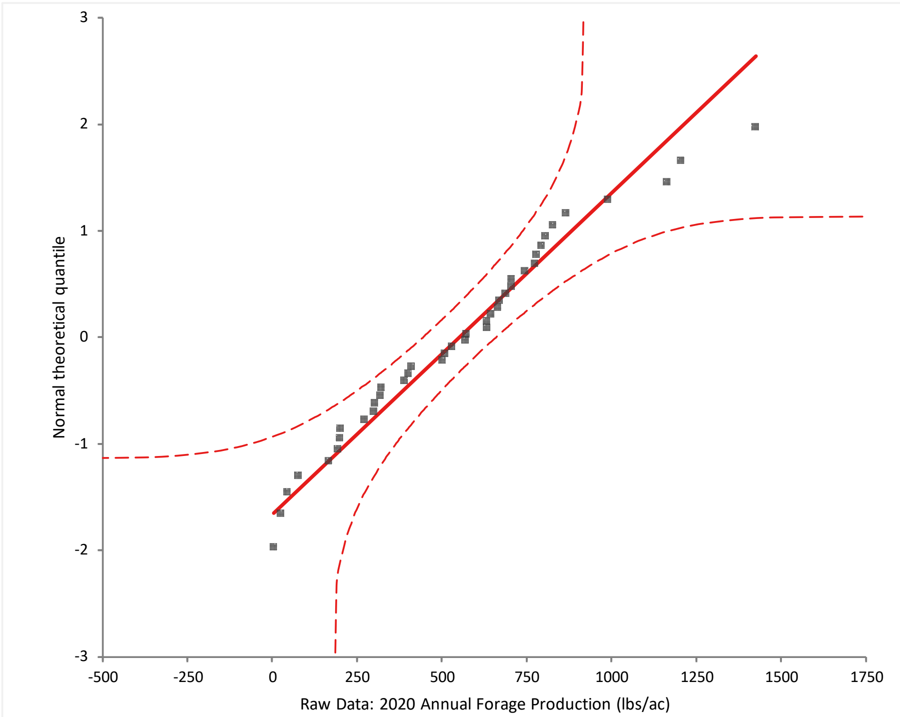
N	40

	Mean	90% CI	Mean SE	SD	Skewness	Kurtosis
Raw Data: 2020 Annual Forage Production (lbs/ac)	550.8	462.6 to 638.9	52.3	330.9	0.4	0.11

	1st quartile	Median	3rd quartile
Raw Data: 2020 Annual Forage Production (lbs/ac)	301.3	571.1	761.8

Figure C-2: Annual Forage Production (lbs/ac) Descriptive Statistics and Normality, 2020

Normality



Shapiro-Wilk test

W statistic	0.97
p-value	0.3365 [1]

H0: F(Y) = N(μ, σ)
The distribution of the population is normal with unspecified mean and standard deviation.
H1: F(Y) ≠ N(μ, σ)
The distribution of the population is not normal.

[1] Do not reject the null hypothesis at the 10% significance level.

Figure C-3: Shrub Density (#/ac) by the Belt Transect Method Descriptive Statistics and Normality, 2020

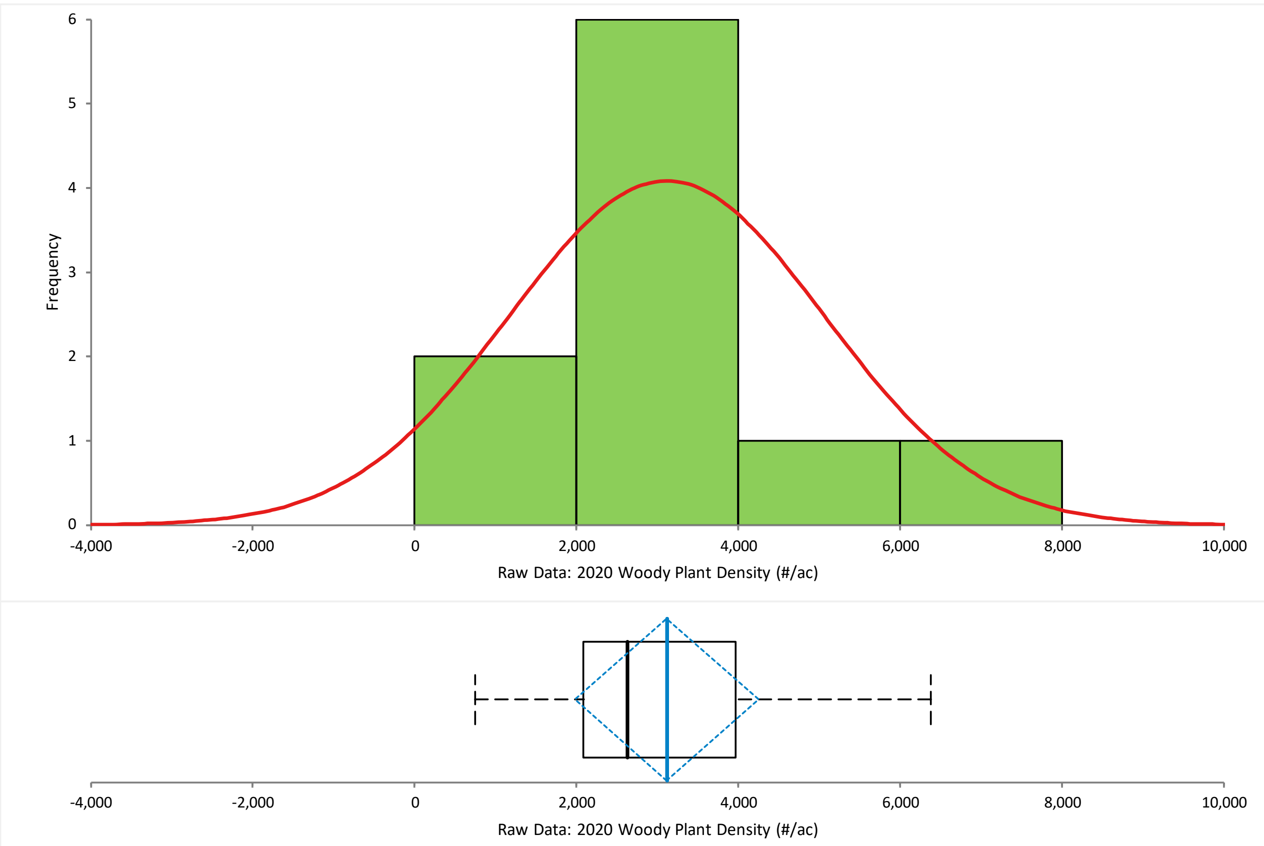
Distribution: Raw Data: 2020 Woody Plant Density

Analyse-it v5.65.7

Table C-2: M-VMU-4 2020 Data for Normal Distribution and Variance Analysis
Filter: No filter

Last updated 11 February 2021 at 14:35 by Ward, Dustin

Descriptives



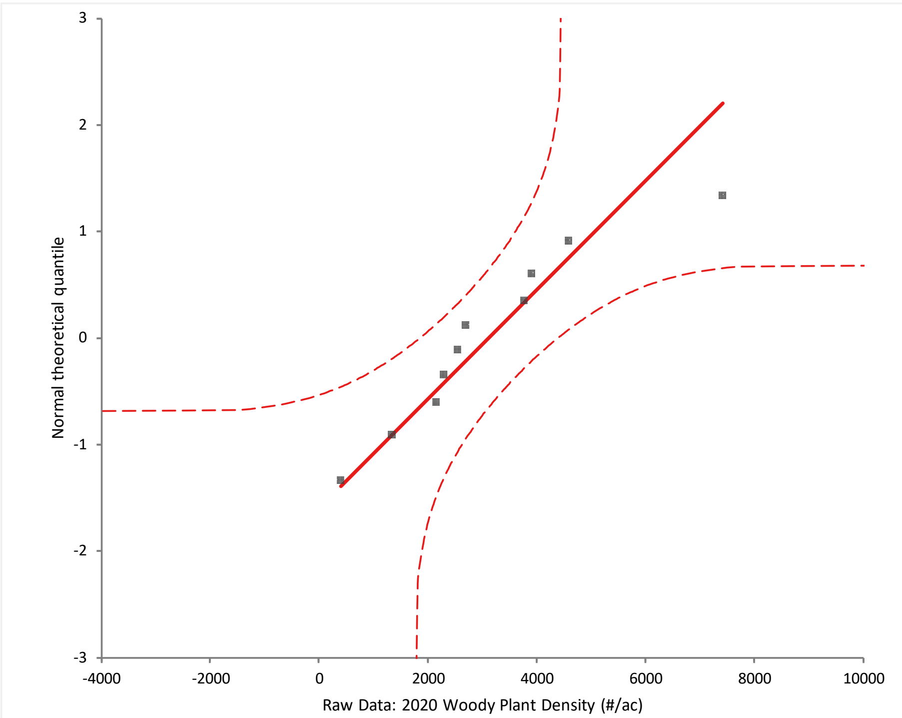
N	10

	Mean	90% CI	Mean SE	SD	Skewness	Kurtosis
Raw Data: 2020 Woody Plant Density (#/ac)	3116.1	1984.4 to 4247.7	617.3	1952.2	1.1	1.87

	1st quartile	Median	3rd quartile
Raw Data: 2020 Woody Plant Density (#/ac)	2090.9	2630.5	3968.2

Figure C-3: Shrub Density (#/ac) by the Belt Transect Method Descriptive Statistics and Normality, 2020

Normality



Shapiro-Wilk test

W statistic	0.93
p-value	0.4645 [1]

H0: F(Y) = N(μ, σ)
The distribution of the population is normal with unspecified mean and standard deviation.
H1: F(Y) ≠ N(μ, σ)
The distribution of the population is not normal.

[1] Do not reject the null hypothesis at the 10% significance level.

golder.com

REPORT

Vegetation Management Unit 4
Vegetation Success Monitoring, 2021

McKinley Mine, New Mexico - Mining and Minerals Division Permit Area

Submitted to:

Chevron Environmental Management and Real Estate Company

Chevron Mining Inc. - McKinley Mine
24 Miles NW HWY 264
Mentmore, NM 87319

Submitted by:

Golder Associates USA Inc.

2440 Louisiana Boulevard NE, Suite 400,
Albuquerque, New Mexico, USA 87110

+1 505 821-3043

133-8105208

February 28, 2022

Table of Contents

TABLES

FIGURES

APPENDICES

1.0 INTRODUCTION

Mining was completed in New Mexico Mining and Minerals Division (MMD) jurisdictional lands at the McKinley Mine in 2007; most of the land is reclaimed, with only the facilities remaining. The lands mined and reclaimed included prelaw, initial-program, and permanent-program lands. Liability release has been completed on all prelaw and initial-program lands, and full bond release on a limited amount of permanent-program land.

Chevron Mining Inc. (CMI) is assessing the vegetation in the remaining permanent-program reclaimed areas in anticipation of future bond and liability releases. CMI understands the importance of returning the mined lands to productive traditional uses in a timely manner. In order to qualify for release, the lands must be in a condition that is as good as or better than the pre-mine conditions, stable, and capable of supporting the designated postmining land use of grazing and wildlife. To make the demonstration for bond and liability release, the reclaimed land must meet the revegetation success standards contained in Permit No. 2016-02. The extended period of responsibility before an application for bond and liability release can be submitted for a given area in the permit is at least ten years. Golder Associates USA Inc. (Golder) was retained to monitor and assess the success of the vegetation relative to these requirements.

1.1 Vegetation Management Unit 3

This report presents results from 2021 quantitative vegetation monitoring conducted in Vegetation Management Unit 4 (M-VMU-4), comprising about 1,240 acres within Area 9 south and parts of Area 9 north (Figure 1). The elevation in this area ranges from about 6,700 to 7,000 feet above mean sea level.

Permanent program reclamation in Area 9 started on lands disturbed after 1986, and reclamation generally was completed by 2009 with the exception of sediment ponds and roads that were reclaimed in 2013. Thus, reclamation age in the majority of M-VMU-4 ranges from approximately 12 to 30+ years. The configuration of the VMUs within the MMD Permit Area, shown on Figure 1 were developed in consultation with MMD. This section provides a general description of the reclamation activities that were implemented. Additional details of the reclamation for specific areas can be obtained through review of McKinley's annual reports.

1.2 Reclamation and Revegetation Procedures

Reclamation methods applied in Area 9 included grading of the spoils to achieve a stable configuration, positive drainage and approximate original contour. Graded spoil monitoring was then conducted to verify that the upper 42 inches of spoil were suitable for plant growth. A minimum of 6 inches of topdressing (topsoil or topsoil substitute) were then applied over suitable spoils.

After topdressing placement, the surface was scarified in preparation for planting. Seeding was done using various implements that drilled and/or broadcast the seed. After the seeding, mulch consisting of either hay or straw was applied at a rate of about 2 tons/acre. The mulch was anchored 3 to 4 inches into the soil with a tractor-drawn straight coulter disc. The seeding was generally performed in the fall, which coincided with logical units for seeding that had been topdressed over the spring and summer. Seed mixes used at McKinley have varied over time but included both warm- and cool-season grasses, introduced and native forbs, and shrubs. The early seed mixes tended to emphasize the use of alfalfa and cool-season grasses. Over time the seed mixes shifted to include more warm-season grasses and a broader variety of native forbs.

1.3 Prevailing Climate Conditions

The amount and distribution of precipitation are important determinants for vegetation establishment and performance at the McKinley Mine. Once vegetation is established, the precipitation dynamics affect the amount of vegetation cover and biomass on a year-to-year basis with grasses and forbs showing the most immediate response. Precipitation has been monitored at the site since 2015, with the South Tipple and Rain 9 gages capturing precipitation in M-VMU-4 (Figure 1).

Total annual precipitation measured at the South Tipple was 15.76 inches, well above the regional average of 11.8 inches at Window Rock (Table 1); the North Bluff gauge, however, recorded 8.67 inches of annual precipitation. Higher than normal rainfall was recorded at the South Tipple in July and September, but it appears the precipitation was unique to the South Tipple area. Rain Gauge 9 located near the center of Area 9 recorded 5.29 inches of precipitation from late April to mid-November (the period this station operates), whereas the South Tipple recorded approximately 11.65 inches of rain for the same period. Mine wide, the precipitation recorded by the rest of the gauges during this time period was in the same range as what was recorded at Rain 9. Table 1 contains a summary of precipitation recorded at all the rain gauges.

Growing season precipitation provides additional context to evaluate vegetation performance in M-VMU-4. The departure of growing season precipitation (April through September) between these gauges and the Window Rock (1937-1999) long-term seasonal mean is illustrated in Figure 2. Growing season precipitation at the South Tipple, in 2021 exceeded the Window Rock long-term seasonal mean by 2.73 inches while the Rain 9 gauge only 2 miles away recorded roughly 2 inches less than Window Rock's normals for the same period. The total difference in precipitation is 4.82 inches during the 2021 growing season, indicating that at least a portion of the reclamation in M-VMU-4 is still experiencing drought conditions. Furthermore, the excessive precipitation reported at the South Tipple came during a handful of high intensity monsoonal events. These rapid bursts of precipitation lead to higher runoff, reduced infiltration, and ultimately less moisture available to the vegetation. Substantive differences in growing season precipitation between the gauges have occurred in 2016, 2018 and 2021 (Figure 2).

1.4 Objectives

The intent of this report is to document the vegetation community attributes in M-VMU-4 and compare them to the Permit vegetation success criteria. Section 2 describes the vegetation monitoring methods that were used in 2021. Section 3 presents the results of the investigation with respect to ground cover, annual production, shrub density, and composition and diversity. Section 4 is a summary of the results for M-VMU-4 with emphasis on vegetation success.

2.0 VEGETATION MONITORING METHODS

Vegetation attributes on M-VMU-4 in Area 9 were quantified using the methods described in Section 6.5 of the Permit. Fieldwork was conducted at the end of the growing season, but prior to the first killing frost, which was between September 14 and 20, 2021.

2.1 Sampling Design

A systematic random sampling procedure employing a transect/quadrat system was used to select sample sites within the reclaimed area. The proposed transect locations were reviewed with MMD in advance of sampling. A 50-square foot grid was imposed over the VMU to delineate vegetation sample plots, and random points created in a geographic information system (GIS) were used to select plots for vegetation sampling. The locations of randomly selected vegetation plots for M-VMU-4 are shown on Figure 3. In the field, the randomly selected transect locations were assessed in numerical order. If the transect location was determined to be unsuitable, the next alternative location was assessed for suitability. Unsuitable transects were those that fell on or would intersect roads, drainage ways, wildlife rock piles, or prairie dog colonies.

Transects originated from the southeastern corner of the vegetation plot. Each transect was 30 meters (m) long in a dog-leg pattern (Figure 4). Four 1-m^2 quadrats were located at pre-determined intervals along the transect for quantitative vegetation measurements. Each quadrat is considered an individual sample where measurements were made of production, total canopy, species canopy and basal cover, surface litter, surface rock fragments, and bare soil as discussed below.

2.2 Vegetation and Ground Cover

Relative and total canopy cover, basal cover, surface litter, rock fragments, and bare soil were estimated for each quadrat. Canopy cover estimates include the foliage and foliage interspaces of all individual plants rooted in the quadrat. Canopy cover is defined as the percentage of quadrat area included in the vertical projection of the canopy. The canopy cover estimates made on a species basis may exceed 100% in individual quadrats where the vegetation has multi-layered canopies. In contrast, the sum of the total canopy cover, surface litter, rock fragments, and bare soil does not exceed 100%.

Basal cover is defined as the proportion of the ground occupied by the crowns of grasses and rooting stems of forbs and shrubs. Basal cover estimates were also made for surface litter, rock fragments, and bare soil. Like the total cover estimates, the basal cover estimates do not exceed 100%. All cover estimates were made in 0.05% increments. Percent area cards were used to increase the accuracy and consistency of the cover estimates. Plant frequency was determined on a species-basis by counting the number of individual plants rooted in each quadrat.

2.3 Annual Forage and Biomass Production

Production was determined by clipping and weighing all annual (current year's growth) above-ground biomass within the vertical confines of a 1-m^2 quadrat. Grasses and forbs were clipped to within 5 centimeters (cm) of the soil surface, and the current year's growth was segregated from the previous year's growth (e.g., gray, weathered grass leaves and dried culms). For this sampling event, plants that were less than 5 cm tall or considered volumetrically insignificant were not collected. Production from shrubs was determined by clipping the current year's growth.

The plant tissue samples of every species collected were placed individually in labeled paper bags. The plant tissue samples were air-dried (> 90 days) until no weight changes were observed with repeated measurements on representative samples. The average tare weight of the empty paper bags was determined to correct the total sample weight to air-dry vegetation weights. The net weight of the air-dried vegetation was converted to a pounds per acre (lbs/ac) basis.

2.4 Shrub Density

Shrub density, or the number of plants per square meter, was determined using the frequency count data from the quadrats and the belt transect method (Bonham 1989). Shrub density was calculated from the quadrat data by dividing the total number of individual plants counted by the number of quadrats measured. The density per square meter was converted to density per acre.

Shrub density was also determined using a belt transect method (Bonham 1989). Shrub density was determined from a 1-meter wide; 30-meter long belt transect situated along the perimeter of the dog-legged transect (Figure 4). Shrubs rooted in the belt transect were counted on a species basis.

2.5 Statistical Analysis and Sample Adequacy

The procedures for financial assurance release as described in Coal Mine Reclamation Program (CMRP) Vegetation Standards (MMD 1999) and the Permit guided this statistical analysis. Statistical tests were performed using both Microsoft® Excel and Analyse-it (version 5.92), a statistical add-in for Excel. The normality of each dataset was first assessed using the Shapiro-Wilk test to determine the appropriate hypothesis test method (i.e., parametric versus nonparametric). Data were considered normal when the test statistic was significant (p-value > 0.10) for alpha (α) = 0.10. Thus, the null hypothesis that the population is normally distributed was accepted if the p--value > 0.10. In cases where the data were not normally distributed, a log transformation was applied to see if it normalized the data.

All hypothesis testing used to demonstrate that the vegetation success standards were met was conducted using a reverse null approach. Because vegetation performance at McKinley is compared to technical standards, the one-sample, one-sided t-test (CMRP Method 3) is used for normally distributed data to evaluate the mean and the one-sample, one-sided sign test (CMRP Method 5) to analyze the median of data that are not normal (MMD 1999; McDonald and Howlin 2013). The one-sided hypothesis tests using the reverse null approach were designed as follows:

Perennial/Biennial Canopy Cover

H_0 : Reclaim < 90% of the Technical Standard (15%)

H_a : Reclaim ≥ 90% of the Technical Standard (15%)

Annual Forage Production

H_0 : Reclaim < 90% of the Technical Standard (350 lbs/ac)

H_a : Reclaim ≥ 90% of the Technical Standard (350 lbs/ac)

Shrub Density

H_0 : Reclaim < 90% of the Technical Standard (150 stems per acre [stems/ac])

H_a : Reclaim ≥ 90% of the Technical Standard (150 stems/ac)

where H_0 is the null hypothesis, that the parameter mean of the reclaimed area is less than 90% of the technical standard, and H_a is the alternative hypothesis, that the parameter mean of the reclaimed area is greater than or equal to 90% of the technical standard. All hypothesis tests were performed with a 90% level of confidence.

Under the reverse null test, the revegetation success standard is met when H_0 is rejected and H_a is accepted. The decision criteria at 90% confidence under the reverse null hypothesis are as follows:

One-sample, one-sided t-test – Method 3 (CMRP)

If $t^* < t_{(1-\alpha;\, n-1)}$, conclude failure to meet the performance standard

If $t^* \geq t_{(1-\alpha;\, n-1)}$, conclude that the performance standard was met

One-sample, one-sided sign test – Method 5 (CMRP)

If $P > 0.10$, conclude failure to meet the performance standard

If $P \leq 0.10$, conclude that the performance standard was met

Statistical hypothesis testing was performed on perennial/biennial cover, annual forage production and shrub density using the one-sample, one-sided t-test and the one-sample, one-sided sign test. The hypotheses testing used the reverse null hypothesis bond release testing procedure as described in CMRP Vegetation Standards (MMD 1999).

Statistical adequacy is not required for vegetation success demonstrations at McKinley under the reverse null approach but is presented on the basis of the canopy cover, production and shrub density data. The number of samples required to characterize a particular vegetation attribute depends on the uniformity of the vegetation and the desired degree of certainty required for the analysis.

The number of samples necessary to meet sample adequacy (N_{min}) was calculated assuming the data were normally distributed using Snedecor and Cochran (1967).

$$N_{min} = \frac{t^2 s^2}{(\overline{x}D)^2}$$

Where N_{min} equals minimum number of samples required, t is the two-tailed t-distribution value based on a 90% level of confidence with n-1 degrees of freedom, s is the standard deviation of the sample data, $\overline{x}$ is the mean, and D is the desired level of accuracy, which is 10 percent of the mean.

In addition to N_{min}, the 90% confidence interval (CI) of the sample mean and the level of confidence that the sample mean is within 10 percent of the true mean are reported.

It is often impractical to achieve sample adequacy in vegetation monitoring studies based on Snedecor and Cochran's equation and a minimum sample number approach is taken. MMD recognizes the practical limitations of achieving statistical adequacy and has provided minimum sample sizes for various quantitative methods (MMD 1999). With normally distributed data where sample adequacy cannot be met because of operational constraints or for other reasons, 40 samples are often considered adequate. The 40 -sample recommendation is based on an estimate of the number of samples needed for a t-test under a normal distribution (Sokal and Rohlf 1981). Schulz et al. (1961) demonstrated that 30 to 40 samples provide a robust estimate for most cover and density measurements with increased numbers of samples only slightly improving the precision of the estimate.

CMI collected 40 samples at the outset of sampling based on the guidance discussed above. The 40 samples came from ten transects each having four quadrats as described in Section 2.1. Each quadrat is considered a unique sampling unit. Additional analysis around sample adequacy was done to see the number of samples that would have been required for adequacy by the Snedecor and Cochran equation. Further analysis for sample adequacy of cover, production and density attributes was also demonstrated using a graphical stabilization of the mean method (Clark 2001).

The emphasis on statistical adequacy assumes that parametric tests of normally distributed data will be conducted to demonstrate compliance with the vegetation success standards. It is important to note that normally distributed data and sample adequacy are not required for hypothesis testing. Nonparametric hypothesis tests are used to analyze data that are not normally distributed. When sample adequacy is not achieved, it is appropriate to use the reverse null approach for hypothesis testing. The reverse null is also generally recommended to evaluate reclamation success whether N_{min} is met or not (MMD 1999). This is because the reverse null is more defensible (compared to the classic approach) where the rejection of the null hypothesis definitively concludes that the reclamation mean is greater the technical standard (McDonald and Howlin 2013).

3.0 RESULTS

The vegetation community in M-VMU-4 is well established and dominated by perennial plants. A representative photograph of the vegetation and topography in M-VMU-4 is shown in Figure 5. The vegetation cover levels in 2021 suggest that the site is capable of meeting the vegetation success standards for the Permit Area.

Vegetation success standards consist of four vegetative parameters: ground cover, productivity, diversity and woody stem stocking (Table 2). The ground cover requirement for live perennial/biennial cover on the reclamation is 15%. The productivity requirement is 350 air-dry lbs/ac perennial/biennial annual production. The woody stem stocking success standard is 150 live woody stems/ac.

Diversity is evaluated against numerical guidelines for different growth forms and photosynthetic pathways of the vegetation. In summary, the diversity guideline required by MMD would be met if at least two shrub or subshrub species with individual relative cover values of 1%; at least two perennial warm-season grass species have individual relative cover levels of at least 1%; at least one perennial cool-season grass species has an individual relative cover level of at least 1%; and at least three perennial or biennial forb species have a combined relative cover of at least 1%. MMD (1999) allows for the use of biennial forbs because they are technically monocarpic (single -flowering) perennials that annually produce a significant number of seed and therefore as a species, they persist in the reclaimed plant community. Relative cover is the average percent cover of a perennial/biennial species divided by the total perennial/biennial cover of the sampling unit.

Diversity is also demonstrated by evidence of colonization or recruitment of native (not-seeded) plants from adjacent undisturbed native areas. Table 3 summarizes the attributes for plants recorded in the quadrats in addition to those encountered or observed but not recorded in the formal quantitative monitoring of M-VMU-4. Recruitment of these native plant species is indicative of ecological succession and the capacity of the site to support a self-sustaining ecosystem.

For Phase III bond release applications, it must be demonstrated that the total annual production and total live cover of biennials and perennials equal or exceeds the approved standards for at least two of the last four years of the responsibility period. Shrub density and revegetation diversity must equal or exceed the approved standards during at least one of the two sampling years of the responsibility period (MMD 1999).

The field data for canopy and basal cover, density, production and shrub density by the belt transect are included in Appendix A. Photographs of the quadrats are included in Appendix B. Appendix C provides the statistical analysis equations, summary data and statistical outputs for perennial/biennial canopy cover, annual forage production, and shrub density by the belt transect method.

3.1 Ground Cover

According to the permit, ground cover is the canopy cover provided by perennial and biennial plant species. Perennial/biennial canopy cover was calculated by subtracting the canopy cover of annual forbs and grasses from the total cover for each quadrat. Noxious weeds are also excluded from perennial/biennial cover.

Average total ground cover in M-VMU-4 is 43.4% comprised of 23.1% total vegetation canopy cover, 6.8% rock, and 13.6% litter on a canopy cover basis (Table 3). On a basal area basis, average ground cover is 30.5% with 3.1% vegetation, 7.4% rock and 20.0% litter. Consistent with the spatial variability in semi-arid rangelands, plant canopy cover in the individual quadrats varied, ranging from 0.0 to 100.0% (Table A-1). Note that cover and production data were corrupted for one quadrat and the total sample number was 39 for M-VMU-4.

The mean perennial/biennial canopy cover was 21.6% (± 5.9% [90% CI]). The calculated minimum sample size needed to meet N_{min} was 307 samples for perennial/biennial canopy cover (Table 4). In 2020 the mean total vegetation canopy cover 40.0% (± 4.2%) and the mean perennial/biennial canopy cover was 41.5% (± 5.2%) (Table 4).

Statistically, perennial/biennial canopy cover data for M-VMU-4 were not normally distributed (Figure C-1). A log transformation of the perennial/biennial canopy cover data also did not result in a normal distribution (Figure C-2). Because N_{min} was not met, the variability of perennial/biennial canopy cover data was evaluated using a stabilization of the mean approach (Clark 2001). Figure 6 illustrates the stabilization of the mean for perennial/biennial canopy cover based on incrementally calculating the mean and 90% CIs for four samples from a single transect sequentially. The analysis suggests that mean perennial/biennial canopy cover was estimated to within the 90% CI of the estimated population mean beginning about the 8^{th} sample, with the 90% CI tightening to no greater than 7.0% after about 32 samples. This analysis suggests that 39 samples samples were more than adequate and collecting additional samples would not improve the precision of the canopy cover estimate.

Hypotheses testing was conducted using a one-sided, one-sample sign test using the reverse null (MMD 1999). The testing found that 17 perennial/biennial cover quadrats did not meet the performance standard (13.5%), resulting in the probability (P) of 0.2611 of observing a z-value less than -0.64 (Table C-3). Therefore, under the reverse null hypothesis we conclude the performance standard is not met for perennial/biennial canopy cover in 2021. This standard was under the same statistical analysis methods in both 2019 and 2020.

3.2 Production

Productivity for vegetation success is assessed for above-ground annual forage production, excluding annuals and noxious weeds in air-dried pounds per acre (lbs/ac). Total annual production for all plant species is reported but not used in determining productivity success for the VMU. The 2021 annual forage production in M-VMU-4 was estimated to be 294 (± 97) lbs/ac with an annual total production of 326 (± 103) lbs/ac (Table 4). With a technical standard of 350 lbs/acre, M-VMU-4 failed to meet this standard for the first time since 2019 as discussed below. Nine perennial grasses contributed 122 lbs/ac of forage and 5 shrubs contributed 164 lbs/ac of browse. Grass productivity is predominantly James' galleta (*Pleuraphis jamesii*), alkali sacaton (*Sporobolus airoides*), and Russian wildrye (*Psathyrostachys juncea*). Four-wing saltbush (*Atriplex canescens*) and Mormon tea (*Ephedra viridis*) provided the bulk of shrub production (Table 3). The combined annual forage production in M-VMU-4 of 294 lbs/acre sits below comparable ecological sites ranging between 430.5 to 794.2 lbs/ac (Parametrix 2012). The annual forage production of M-VMU-4 in 2019 (958 lbs/ac) and 2020 (551 lbs/ac) demonstrate the site's ability to exceed the minimum production values for comparable ecological sites.

The annual forage production data for M-VMU-4 were not normally distributed (Figure C-3) and the log transformation of the annual forage production data failed to produce a normally distributed dataset as well (Figure C-4). The calculated minimum sample size needed to meet N_{min} at the 90% confidence level for annual forage production was estimated to be 367 samples (Table 4). Because N_{min} was not met, the data were evaluated using a stabilization of the mean (Clark 2001). Figure 7 illustrates the stabilization of the estimated mean and 90% CI for annual forage production based on incrementally calculating the mean and 90% CIs for four samples from a single transect sequentially. The analysis suggests that mean annual forage production was highly variable across M-VMU-4 with broad 90% CIs for the entire dataset though the estimated population mean was captured beginning about the 16th sample. The 90% CI tightened to about ± 100 lbs/ac after 36 samples with no meaningful reduction in with the collection of additional data. This analysis suggests that collecting more than 39 samples may have decreased the variability of forage production to a small extent but given the number of low production quadrats and the high variability among samples, the collection of additional data may not have led to conclusion that production met the success target.

Hypotheses testing was conducted using a one-sided, one-sample sign test using the reverse null (MMD 1999). The testing found that 28 production quadrats did not meet 90% of the performance standard (315 lbs/ac) resulting in the probability (P) of 0.0020 of observing a z-value less than 2.88. We conclude the performance standard is not met for annual forage production in 2021 (Table C-4) because number of minus signs exceeds 50% of the total number of observations. For M-VMU-4, the annual forage production standard was met in 2019 and 2020 but in 2021 it was not met in part due to the continued impacts of drought resulting in a lower mean and increased variance.

3.3 Shrub Density

Shrub density ranged from an average of 1.996 (± 924) stems/ac based on the belt transect method to 3,528 (± 1,177) stems/ac for the quadrat method (Table 4). In M-VMU-4, 7 shrub species were encountered in both the belt transects and the quadrats (Tables 3 and A-5). Four-wing saltbush, Mormon tea, and winterfat were the most commonly encountered shrubs under both measurement methods.

The shrub density raw and log transformed data for the belt transect method were not normally distributed (Figure C-5) and the calculated minimum sample size needed to meet N_{min} at the 90% confidence level was estimated to be 924 samples (Table 4). Because N_{min} was not met and called for an unreasonable number of samples, the shrub density belt transect data were evaluated using a stabilization of the mean (Clark 2001). Figure 8 illustrates the stabilization of the mean for shrub density based on individual belt transect data. The corresponding variability around the mean is expressed by the 90% CIs for each successive sample. These data suggest that the mean shrub density was estimated to within the estimated population mean (n=10) after the fourth sample though the 90% CI uncharacteristically widened after the 9th sample. The high variability in shrub density around the mean would likely decrease with the collection of additional data, but because the mean is well above the performance standard it would not change the statistics.

Hypotheses testing was conducted using the one-sample, one-sided sign test using the reverse null (MMD 1999). The testing found no belt transects below the performance standard (135 stems/ac) resulting in the probability (P) of 0.0022 of observing a z-value less than -2.85. Therefore, under the reverse null hypothesis we conclude the performance standard is met for shrub density in 2021 (Table C-5). The shrub density standard for M-VMU-4 was met in 2019 and 2020 using the reverse null approach.

3.4 Composition and Diversity

Diversity is assessed through comparing the relative cover of various life-forms, based on their duration to the perennial/biennial cover of the vegetation management unit. In this context, relative cover is the average percent cover of a perennial/biennial species divided by the mean perennial/biennial cover of the sampling unit. Relative canopy cover of individual species contributing to perennial cover are listed in Table 3.

Collectively, eight perennial grasses dominate the canopy cover in M-VMU-4 with a combined relative canopy cover of almost 63.7%. Russian wildrye and James' galleta are the most prevalent grasses (Table 3). Six cool -season perennial grasses contribute 33.3% relative canopy cover and three warm-season perennial grasses contribute 30.5% relative canopy cover. Five perennial/biennial forbs contribute just over 3.6% relative canopy cover in M-VMU-4. The collective contribution of five shrubs to perennial/biennial canopy cover is 36.3% relative cover, with four-wing saltbush and rubber rabbitbrush being codominant,

Table 5 provides the diversity results for M-VMU-4 for 2019 through 2021 and is summarized below.

- The diversity standard for cool-season grasses is achieved by several species that exceed 1% relative cover including Russian wildrye (17.6%), Indian ricegrass (7.3%), bottlebrush squirreltail (*Elymus elymoides*, 2.96%), smooth brome (*Bromus inermus*, 2.96%), thickspike wheatgrass (*Elymus lanceolatus*, 1.4%) and western wheatgrass (*Pascopyrum smithii*, 1.1%)
- The diversity standard for warm-season grasses requires a minimum of two species with 1% relative cover each. This was met by James' galleta (19.06%) and alkali sacaton (11.38%) in 2021. The warm-season grass diversity standard was also achieved in 2020 but not met in 2019 in M-VMU-4.
- The diversity standard for forbs requires a minimum of three non-annual forb taxa combining to contribute at least 1% relative cover. The combined relative cover of three non-annual forbs is 22.0% (Table 3). These forbs include rattlesnake weed (*Chamaesyce albomarginata*) (3.2%), an unknown composite (0.24%), and redstem stork bill (*Erodium circutarium*, 0.12%). Based on 2021 sampling, the combined relative cover for three non-annual forbs is greater than 1%, meeting the diversity standard for forbs on M-VMU-4 reclamation.
- The diversity standard for shrubs requires two species with a minimum relative cover of 1% for each species. The diversity standard for shrubs is achieved by four-wing saltbush (13.42%) and rubber rabbitbrush (8.89%). Additional sub-dominant shrubs recorded in the quadrats include winterfat (*Krascheninnikovia lanata*, 4.27%), broom snakeweed (*Gutierrezia sarothrae*, 4.15%), and Mormon tea (*Ephedra viridis*, 3.56%).

The recruitment of native plants and establishment of seeded species within M-VMU-4 is indicative of ecological succession and the capacity of the site to support a diverse and self-sustaining ecosystem. Based on the 2021 vegetation monitoring, 89 different plant species were present within the reclamation areas of M-VMU-4 (Table 3). Species encountered included 43 forbs, 24 grasses and 22 shrubs, trees and cacti. Of the 43 forbs, 18 are considered annuals whereas the remaining 25 have variable durations or are purely perennial. Of the 23 grasses, 15 are cool-season perennials, five are warm-season perennials, three are cool-season annuals and one is a warm-season annual. Cacti and trees are rare on the reclamation, while shrubs and subshrubs are more common.

During the 2021 monitoring program, noxious weeds (NMDA 2020) were infrequently encountered on M-VMU-4. No Class C noxious weeds were recorded in the quadrats, but Class B noxious weeds including cheatgrass (*Bromus tectorum*), saltcedar (*Tamarix ramosissima*) and Siberian elm (*Ulmus pumila*) was observed in the reclamation. The contribution of these species to the vegetation community is insignificant with densities much lower than native rangeland beyond the permit boundary. CMI continues to monitor for noxious weeds and actively controls them through husbandry practices that include annual services for weed control. Further, competition from desirable seeded and native species is expected to inhibit any substantial increase of noxious weeds in the reclamation.

4.0 SUMMARY

McKinley Mine's vegetation success standards for the post-mining land uses of grazing and wildlife are based on canopy cover, production, shrub density, and plant diversity (Table 2). The vegetation monitoring results for the past three years indicate that the vegetation community in M-VMU-4 is progressing having met the cover, shrub, and forage production in 2019 and 2020 (Table 6) and the diversity standard in 2020 and 2021. For 2021, M-VMU-4 exceeded the success parameters shrub density and diversity but fell short with annual forage production and perennial/biennial cover (Tables 5 and 6). A summary of the findings from the past three years are:

1. Despite the drought conditions since 2017, the reclamation has been resilient and successful for cover, annual forage production, and shrub density, demonstrating permanence.
2. Below normal growing season precipitation in 2021 resulted in lower cover and production quadrats and increased variability among samples. Even with estimated means above the technical standard, statistical hypothesis testing in 2021 determined the performance standard for cover and production was not achieved.
3. While drought affected the expression of warm-season grasses in 2019 the entire diversity standards were met in 2020 and 2021.
4. Based on the vegetation monitoring results over the past three years, the M-VMU-4 reclamation appears eligible for Phase III bond release. Annual production and total live cover of biennials and perennials has been achieved in two of the last three years and shrub density and diversity have exceeded the approved standards during one of the past two years.

Overall, vegetation performance in M-VMU-4 is encouraging considering below-average precipitation for the past 6 years including a two-year drought in 2017 and 2018, the exceptional drought in 2020, and the spatial variability of moisture in 2021. The continued presence of feral horses, though less evident in 2021, may also negatively affect production, especially when forage is scarce. The performance of the vegetation under these conditions suggests that the reclaimed plant communities are resilient and capable of sustaining themselves under adverse conditions that are characteristic of this region. Based on the Phase III bond release criteria, CMI believes the reclamation in M-VMU-4 is now clearly capable of meeting the post-mining land use and eligible for bond release.

5.0 REFERENCES

Bonham, C.D. 1989. Measurements for Terrestrial Vegetation. John Wiley & Sons. New York, NY.

Clark, D.L. 2001. Stabilization of the mean as a demonstration of sample adequacy. American Society for Surface Mining and Reclamation Annual Meeting. Albuquerque, NM. June 3-7, 2001. ASSMR, Lexington, KY.

Mining and Minerals Division (MMD). 1999. Coal Mine Reclamation Program Vegetation Standards. Santa Fe, NM. April 30.

McDonald, L., and S. Howlin. 2013. Evaluation and comparison of hypothesis testing techniques for bond release application. University of Wyoming, Laramie, WY.

Parametrix. 2012. Revegetation Success Standards Report: McKinley Mine – Response to OSM. Prepared by Jim Nellessen of Parametrix, Albuquerque, New Mexico. April 2012.

New Mexico Department of Agriculture (NMDA). 2020. New Mexico Noxious Weed List Update. New Mexico State University, Las Cruces, NM. June 2020.

Sokal, R.R. and F.J. Rohlf. 1981. Biometry (2nd edit.). W. H. Freeman and Co., San Francisco.

Schulz, A. M., R. P. Gibbens, and L. F. DeBano. 1961. Artificial populations for teaching and testing range techniques. J. Range Management. 14:236-242.

Snedecor, G.W. and W.G. Cochran. 1967. Statistical methods applied to experiments in agriculture and biology. 6th ed. Ames, Iowa: Iowa State University Press.

Tables

Table 1: South Mine Seasonal and Annual Precipitation (2015-2021)

Year	Station	Precipitation (inches)													
		January	February	March	April	May	June	July	August	September	October	November	December	Annual Total	Growing Season Total
2015	South Tipple	2.05	1.59	0.11	0.52	1.64	1.11	2.37	1.62	0.30	1.36	1.31	0.76	**14.74**	*7.56*
	Rain 9				0.50	1.38	1.22	2.88	1.25	0.22	1.13	0.99			*7.45*
	Rain 10				0.42	1.32	1.11	2.59	1.39	0.30	1.10	0.78			*7.13*
	Rain 11				0.48	1.88	1.02	2.80	1.69	0.26	0.97	1.08			*8.13*
2016	South Tipple	0.62	0.22	0.05	1.31	0.80	0.07	1.37	1.74	1.75	0.40	1.57	1.84	**11.74**	*7.04*
	Rain 9				0.22	0.62	0.45	1.24	0.50	1.05	1.05	0.00			*4.08*
	Rain 10				0.13	0.55	0.20	2.75	0.38	0.99	0.14	0.02			*5.00*
	Rain 11				0.28	0.77	0.64	1.61	0.42	1.09	0.09	0.04			*4.81*
2017	South Tipple	1.25	1.64	0.48	0.35	0.77	0.42	2.48	0.90	1.34	0.15	0.09	0.02	**9.89**	*6.26*
	Rain 9				1.20	1.02	0.01	0.82	1.40	1.64	0.37	0.91			*6.09*
	Rain 10				1.00	0.67	0.08	0.94	1.63	1.36	0.34	0.81			*5.68*
	Rain 11				1.23	1.16	0.05	0.86	2.00	1.85	0.34	0.49			*7.15*
2018	South Tipple	0.35	0.79	0.54	0.09	0.29	0.51	2.61	1.34	1.10	1.65	0.19	0.29	**9.75**	*5.94*
	Rain 9				0.07	0.27	0.25	2.16	0.74	0.67	1.31	0.00			*4.16*
	Rain 10				0.08	0.20	0.27	3.05	1.15	0.92	1.51	0.00			*5.67*
	Rain 11				0.09	0.29	0.26	1.92	1.00	0.89	1.45	0.00			*4.45*
2019	South Tipple	1.30	1.81	1.23	0.44	1.77	0.33	0.22	0.05	1.59	0.09	1.14	0.85	**10.82**	*4.40*
	Rain 9				0.16	1.36	0.24	0.46	0.37	1.84	0.05	0.07			*4.43*
	Rain 10				0.20	1.49	0.37	0.19	0.27	1.34	0.03	0.05			*3.86*
	Rain 11				0.20	1.50	0.19	0.44	0.20	1.72	0.06	0.08			*4.25*
2020	South Tipple	0.98	1.44	1.35	0.17	0.01	0.04	1.13	0.24	0.15	0.26	0.40	0.27	**6.44**	*1.74*
	Rain 9				0.16	0.02	0.11	0.60	0.06	0.14	0.08	0.45			*1.09*
	Rain 10				0.11	0.02	0.13	0.79	0.14	0.14	0.16	0.09			*1.33*
	Rain 11				0.22	0.00	0.05	0.63	0.69	0.20	0.30	0.41			*1.79*
2021	South Tipple	1.11	0.34	0.40	0.07	0.08	0.37	5.45	1.24	2.12	1.77	0.55	2.26	**15.76**	*9.33*
	No. Bluff	1.13	0.21	0.46	0.04	0.04	0.20	2.17	1.31	1.13	0.86	0.20	0.92	**8.67**	*4.89*
	Rain 9				0.00	0.10	0.27	1.81	1.22	1.11	0.78	0.00			*4.51*
	Rain 10				0.01	0.06	0.24	2.48	1.80	0.96	0.80	0.00			*5.55*
	Rain 11				0.00	0.07	0.18	2.10	1.31	1.43	0.98	0.00			*5.09*
Window Rock, Long-term normals		0.72	0.68	0.88	0.61	0.49	0.47	1.75	2.05	1.23	1.14	0.83	0.95	**11.80**	*6.60*

Notes:
Long-term averages are from Window Rock, Arizona Station (029410), 1937 to 1999 (Western Regional Climate Center, 2020).
Growing season total precipitation is between April and September

Table 2: Revegetation Success Standards for the Mining and Minerals Division Permit Area

Vegetative Parameter	Success Standard
Ground Cover	15% live perennial/biennial cover
Productivity	350 air-dry pounds per acre perennial/biennial annual production
Diversity	A minimum of 2 shrub or subshrub taxa contributing at least 1% relative cover each.
	A minimum of 2 perennial warm-season grass taxa contributing at least 1% relative cover each.
	A minimum of 1 perennial cool-season grass taxa contributing at least 1% relative cover.
	A minimum of 3 perennial/biennial forb taxa combining to contribute at least 1% relative cover.
Woody Stem Stocking	150 live woody stems per acre

Note:

Diversity criteria assessed for individual perennial/biennial species relative cover as agreed upon by MMD and CMI in June 2019.

Table 3: Vegetation Cover, Density, and Production by Species, M-VMU-4, 2020

Scientific Name	Common Name	Code	Mean Vegetation Cover (%)			Mean Density (#/m^2)	Mean Annual Production (lbs/ac)
			Canopy	Basal	Relative Canopy[a]		
Cool-Season Grasses (17)							
Annuals (3)							
Bromus arvensis	Field brome	BRAR5	--	--	--	--	--
Bromus tectorum	Cheatgrass	BRTE	--	--	--	--	--
Hordeum vulgare	Common barley	HOVU	--	--	--	--	--
Perennials (14)							
Achnatherum hymenoides	Indian ricegrass	ACHY	1.57	0.18	7.26	0.59	7
Agropyron cristatum	Crested wheatgrass	AGCR	--	--	--	--	--
Bromus inermis	Smooth brome	BRIN2	0.64	<0.05	2.96	--	6
Elymus elymoides	Bottlebrush squirreltail	ELEL	0.64	<0.05	2.96	0.31	4
Elymus glaucus	Blue wildrye	ELGL	--	--	--	--	--
Elymus lanceolatus ssp. lanceolatus	Thickspike wheatgrass	ELLAL	--	--	--	--	--
Elymus lanceolatus	Thickspike wheatgrass	ELLA3	0.31	<0.05	1.43	0.23	<1
Elymus trachycaulus	Slender wheatgrass	ELTR7	--	--	--	--	--
Hesperostipa comata	Needle and thread	HECO26	--	--	--	--	--
Hordeum jubatum	Foxtail barley	HOJU	--	--	--	--	--
Leymus ambiguus	Colorado wildrye	LEAM	--	--	--	--	--
Pascopyrum smithii	Western wheatgrass	PASM	0.23	<0.05	1.07	0.10	6
Psathyrostachys juncea	Russian wildrye	PSJU3	3.81	0.40	17.64	0.97	21
Thinopyrum intermedium	Intermediate wheatgrass	THIN6	--	--	--	--	--
Thinopyrum ponticum	Tall wheatgrass	THPO7	--	--	--	--	--
Warm-Season Grasses (7)							
Munroa squarrosa	False buffalograss	MUSQ3	0.08	<0.05	0.39	0.18	<1
Perennials (7)							
Aristida purpurea	Purple threeawn	ARPU	--	--	--	--	--
Bouteloua curtipendula	Sideoats grama	BOCU	--	--	--	--	--
Bouteloua gracilis	Blue grama	BOGR2	--	--	--	--	--
Pleuraphis jamesii	James' galleta	PLJA	4.12	0.81	19.06	3.00	52
Sporobolus airoides	Alkali sacaton	SPAI	2.46	0.38	11.38	0.79	24
Forbs (42)							
Annuals (16)							
Ambrosia acanthicarpa	Flatspine bur ragweed	ACAM	0.08	<0.05	<0.01	0.13	--
Alyssum desertorum	Desert madwort	ALDE	--	--	--	--	--
Alyssum simplex	Alyssum	ALSI8	--	--	--	--	--
Chenopodium album	Lambsquarters	CHAL7	--	--	--	--	--
Chenopodium incanum	Mealy goosefoot	CHIN2	--	--	--	--	--
Chenopodium leptophyllum	Narrowleaf goosefoot	CHLE4	--	--	--	--	--
Cordylanthus wrightii	Wright's bird's beak	COWR2	--	--	--	--	--
Eriogonum cernuum	Nodding buckwheat	ERCE2	--	--	--	--	--
Eriogonum divaricatum	Divergent buckwheat	ERDI5	--	--	--	--	--
Helianthus annuus	Common sunflower	HEAN3	--	--	--	--	--
Kochia scoparia	Kochia	KOSC	--	--	--	--	--
Malacothrix fendleri	Fendler's desertdandelion	MAFE	--	--	--	--	--
Polygonum erectum	Erect knotweed	POER2	--	--	--	--	--
Portulaca oleracea	Little hogweed	POOL	<0.05	<0.05	<0.01	0.13	<1
Salsola tragus	Russian thistle	SATR	1.33	0.06	<0.01	0.23	32
Verbesena encelioides	Cowpen daisy	VEEN	<0.05	<0.05	<0.01	0.08	<1
Unknown Annual Forb	Unknown annual forb	UNKAF	--	--	--	--	--
Xanthium strumarium	Rough cocklebur	XAST	--	--	--	--	--
Perennials/Biennials (26)							
Achillea millefolium	Common yarrow	ACMI2	--	--	--	--	--
Asteraceae family	Unknown composite forb	ASTER	0.05	<0.05	0.24	0.18	<1
Chamaesyce albomarginata	Rattlesnake weed	CHAL11	0.69	<0.05	3.20	4.74	7
Chaetopappa ericoides	Rose heath	CHER	--	--	--	--	--
Conyza canadensis	Horseweed	COCA	--	--	--	--	--
Descurainia sophia	Flixweed	DESO	--	--	--	--	--
Erodium cicutarium	Redstem stork's bill	ERCI6	<0.05	<0.05	0.12	0.05	<1
Eriogunum species	Unknown buckwheat species	ERIOG	<0.05	<0.05	0.06	<0.0	<1
Lappula occidentalis	Flatspine stickseed	LAOC3	<0.05	<0.05	0.07	0.28	<1
Machaeranthera canescens	Purple aster	MACA	--	--	--	--	--
Machaeranthera tanacetifolia	Tanseyleaf tansyaster	MATA	--	--	--	--	--
Mentzelia species	Unknown blazingstar species	MENTZ	--	--	--	--	--
Melilotus officinalis	Yellow sweetclover	MEOF	--	--	--	--	--
Medicago sativa	Alfalfa	MESA	--	--	--	--	--
Mirabilis multiflora	Colorado four o'clock	MIMU	--	--	--	--	--
Penstemon palmeri	Palmer's penstemon	PEPA8	--	--	--	--	--
Polygonum aviculare	Prostrate knotweed	POAV	--	--	--	--	--
Ratibida columnifera	Upright prairie coneflower	RACO3	--	--	--	--	--
Rumex crispus	Curly dock	RUCR	--	--	--	--	--
Sisymbrium altissimum	Tall tumblemustard	SIAL2	--	--	--	--	--
Sphaeralcea coccinea	Scarlet globemallow	SPCO	--	--	--	--	--
Sphaeralcea emoryi	Emory's globemallow	SPEM	--	--	--	--	--
Sphaeralcea grossulariifolia	Gooseberryleaf globemallow	SPGR2	--	--	--	--	--
Sphaeralcea incana	Gray globemallow	SPIN2	--	--	--	--	--
Tragopogon dubius	Yellow salsify	TRDU	--	--	--	--	--
Shrubs, Trees and Cacti (25)							
Perennials (25)							
Artemisia frigida	Prairie sagewort	ARFR4	--	--	--	--	--
Artemisia ludoviciana	White sagebrush	ARLU	--	--	--	--	--
Artemisia tridentata	Big sagebrush	ARTR2	0.38	<0.05	1.78	0.05	6
Atriplex canescens	Four-wing saltbush	ATCA	2.90	0.18	13.42	0.33	58
Atriplex confertifolia	Shadscale saltbush	ATCO	--	--	--	--	--
Atriplex corrugata	Mat saltbush	ATCO4	--	--	--	--	--
Atriplex gardneri	Gardner's saltbush	ATGA	--	--	--	--	--
Atriplex obovata	Mound saltbush	ATOB	--	--	--	--	--
Chrysothamnus viscidiflorus	Yellow rabbitbrush	CHVI	--	--	--	--	--
Ephedra trifurca	Longleaf jointfir	EPTR	--	--	--	--	--
Ephedra viridis	Mormon tea	EPVI	0.77	0.05	3.56	0.10	43
Ericameria nauseosa	Rubber rabbitbrush	ERNA	1.92	0.64	8.89	0.05	17
Fallugia paradoxa	Apache plume	FAPA	--	--	--	--	--
Gutierrezia sarothrae	Broom snakeweed	GUSA	0.90	0.13	4.15	0.05	19
Heterotheca villosa	Hairy false goldenaster	HEVI	--	--	--	--	--
Krascheninnikovia lanata	Winterfat	KRLA	0.92	0.09	4.27	0.26	18
Opuntia polyacantha	Plains pricklypear	OPPO	--	--	--	--	--
Pinus edulis	Piñon pine	PIED	--	--	--	--	--
Purshia mexicana	Mexican cliffrose	PUME	--	--	--	--	--
Purshia tridentata	Antelope bitterbrush	PUTR2	--	--	--	--	--
Sarcobatus vermiculatus	Greasewood	SAVE4	<0.05	<0.05	0.18	<0.0	2
Ulmus pumila	Siberian elm	ULPU	--	--	--	--	--
Cover Components							
Perennial/Biennial Vegetation Cover			21.6	1.7			
Total Vegetation Cover			23.1	3.1			
Rock			6.8	7.4			
Litter			13.6	20.0			
Bare Soil			56.8	69.5			

Notes:

[a] = relative cover is the average percent cover of a perennial/biennial species divided by the total perennial/biennial cover of the sampling unit

-- = this parameter is not calculated for this attribute

#/ac = number of plants per acre

lbs/ac = air-dry forage pounds per acre

obs = observed on vegetation management unit during monitoring, but not recorded in the quadrats

Ps Pathway or growing season for the grasses is from Allred (2005)

Duration for plants is from the USDA Plants Database

Table 4: Summary Statistics for M-VMU-4

	2019	2020	2021	Technical Standard
Total Vegetation Canopy Cover (%)				
Mean	39.6	40.0	23.1	None
Standard Deviation	23.4	16.2	22.9	
90% Confidence Interval	6.1	4.2	6.0	
Nmin[1]	99	46	280	
Probability within true mean[2]	0.64	0.60	0.27	
Perennial/Biennial Canopy Cover (%)				
Mean	40.9	41.5	21.6	15.0
Standard Deviation	29.0	19.9	22.5	
90% Confidence Interval	7.5	5.2	5.9	
Nmin[1]	142	66	307	
Probability within true mean[2]	0.67	0.62	0.26	
Basal Cover (%)				
Mean	2.2	4.1	3.1	None
Standard Deviation	1.9	3.2	20.9	
90% Confidence Interval	0.5	0.8	1.2	
Nmin[1]	198	170	614	
Probability within true mean[2]	0.70	0.69	0.18	
Annual Forage Production (lbs/ac)				
Mean	958	551	294	350
Standard Deviation	736	331	367	
90% Confidence Interval	191	86	97	
Nmin[1]	167	102	443	
Probability within true mean[2]	0.69	0.65	0.23	
Annual Total Production (lbs/ac)				
Mean	1,000	555	326	None
Standard Deviation	764	326	392	
90% Confidence Interval	199	85	103	
Nmin[1]	166	98	410	
Probability within true mean[2]	0.68	0.64	0.23	
Shrub Density (stems/acre) from Quadrats				
Mean	6,778	4,350	3,528	150
Standard Deviation	11,238	5,052	4,470	
90% Confidence Interval	2,923	1,314	1,177	
Nmin[1]	780	383	456	
Probability within true mean[2]	0.85	0.77	0.22	
Shrub Density (stems/acre) from Belt Transect				
Mean	3,723	3,116	1,996	150
Standard Deviation	1,520	1,952	1,776	
90% Confidence Interval	791	1,015	924	
Nmin[1]	56	132	266	
Probability within true mean[2]	0.55	0.58	0.39	

Notes:
1 Minimum number of samples required to obtain 90 percent probability that the sample mean is within 10 percent of the population mean
2 Probability the true value of the mean is within 10 percent of the mean for the sample size

Table 5: M-VMU-4 Results for Diversity, 2019 to 2021

Parameter[1]	Standard (Relative %)	2019		2020		2021	
		Result	Species	Result	Species	Result	Species
Subshrub or shrubs			**(6 spp.)**		**(9 spp.)**		**(7 spp.)**
Shrub 1	≥ 1.0%	26.56%	Four-wing saltbush	11.99%	Four-wing saltbush	13.42%	Four-wing saltbush
Shrub 2	≥ 1.0%	2.73%	Winterfat	3.45%	Winterfat	8.89%	Rubber rabbitbrush
Shrub 3 (bonus)	--	1.22%	Yellow rabbitbrush	0.80%	Broom snakeweed	4.27%	Winterfat
Perennial warm-season grasses			**(3 spp.)**		**(3 spp.)**		**(2 spp.)**
Grass 1	≥ 1.0%	21.09%	James' galleta	12.70%	James' galleta	19.06%	James' galleta
Grass 2	≥ 1.0%	0.48%	Alkali sacaton	1.10%	Alkali sacaton	11.38%	Alkali sacaton
Grass 3 (bonus)	--	0.19%	Blue grama	0.65%	Blue grama	--	--
Perennial cool-season grasses			**(6 spp.)**		**(9 spp.)**		**(6 spp.)**
Grass 1	≥ 1.0%	21.31%	Colorado wildrye	39.63%	Colorado wildrye	17.60%	Russian wildrye
Grass 2 (bonus)	--	13.94%	Western wheatgrass	6.34%	Thickspike wheatgrass	7.30%	Indian ricegrass
Perennial/biennial forbs		**11.34%**	**(7 spp.)**	**2.21%**	**(5 spp.)**	**3.55%**	**(5 spp.)**
Forb 1	**≥ 1.0% (combined)**	8.73%	Flatspine stickseed	0.96%	Gray globemallow	3.20%	Rattlesnake weed
Forb 2		1.91%	Flixweed	0.72%	Palmer's penstemon	0.24%	Unknown composite
Forb 3		0.55%	Blazingstar species	0.20%	Rose heath	0.12%	Redstem stork's bill
Forb 4 (bonus)		0.06%	pright prairie coneflowe	0.17%	Scarlett globemallow	--	--

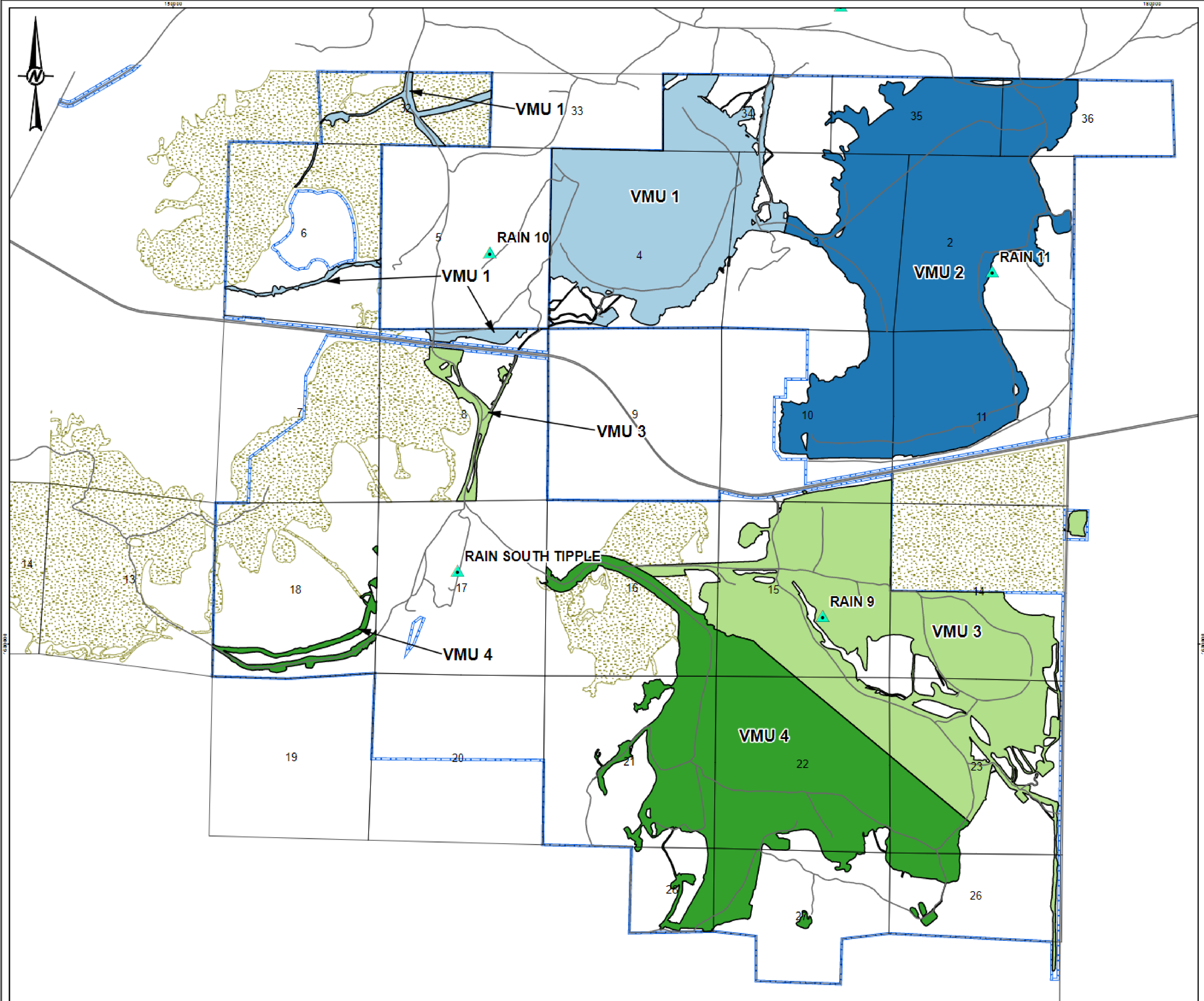
Table 6: M-VMU-4 Statistical Analysis Results for Cover, Production, and Woody Plant Density, 2019 to 2021

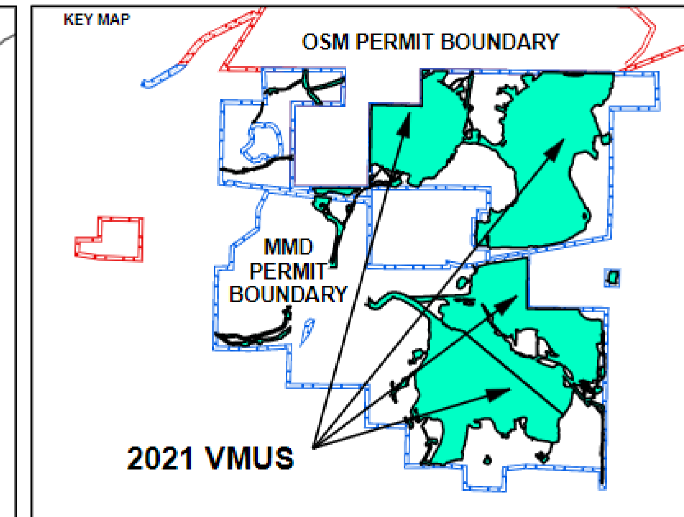
Vegetation Metric	Success Standard	Results		
		2019	2020	2021
Perennial/Biennial Cover	≥ 15%	40.9	41.5%	21.6%
Annual Forage Production	≥ 350 lb/ac	958	551	294
Woody Plant Density	≥ 150 stems/ac	3,723	3,116	1,996

Notes:

Hypothesis testing found the success standard was not met

Figures





LEGEND

- Rain Gauges
- Two-tracks, Roads and Highways
- MMD Permit Boundary
- PLSS - Sections
- Liability Release
- MMD VMU 1 (~ 839 acres)
- MMD VMU 2 (~ 1,518 acres)
- MMD VMU 3 (~ 1,284 acres)
- MMD VMU 4 (~ 1,238 acres)

0 3,000 6,000
1 inch = 3,000 feet Feet

NOTE(S)
1. VMU = VEGETATION MANAGEMENT UNIT FOR VEGETATION SAMPLING PLAN

REFERENCE(S)
COORDINATE SYSTEM: NAD 1927 STATEPLANE NEW MEXICO WEST FIPS 3003
PROJECTION: TRANSVERSE MERCATOR
DATUM: NORTH AMERICAN 1927

CLIENT
CHEVRON MINING, INC. - MCKINLEY MINE
24 MILES, NW HWY 264
MENTMORE, NM 87319

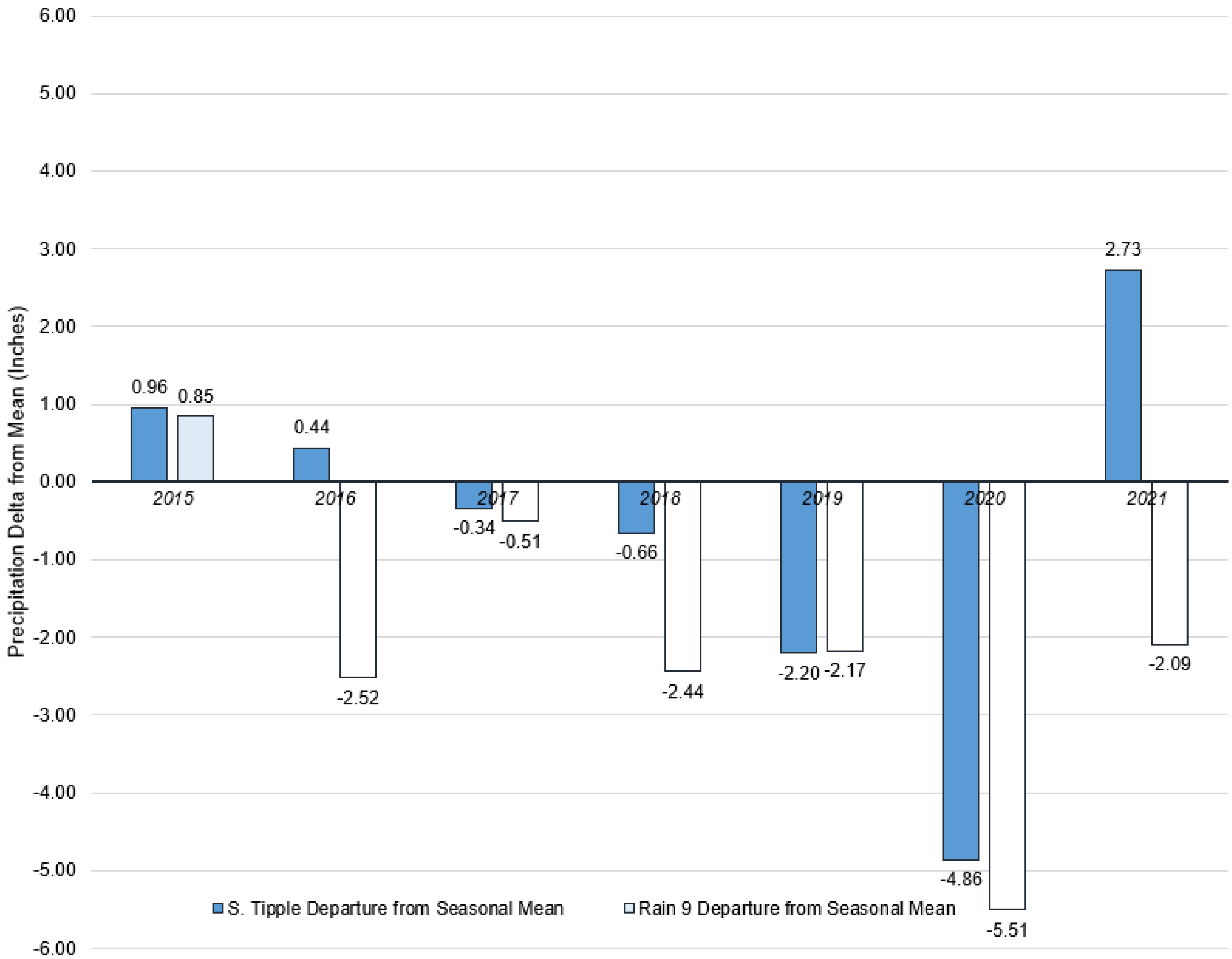
PROJECT
MCKINLEY MINE - MMD PERMIT PHASE III BOND RELEASE, 2021 VEGETATION MONITORING

TITLE
2021 VEGETATION MANAGEMENT (2021) OVERVIEW

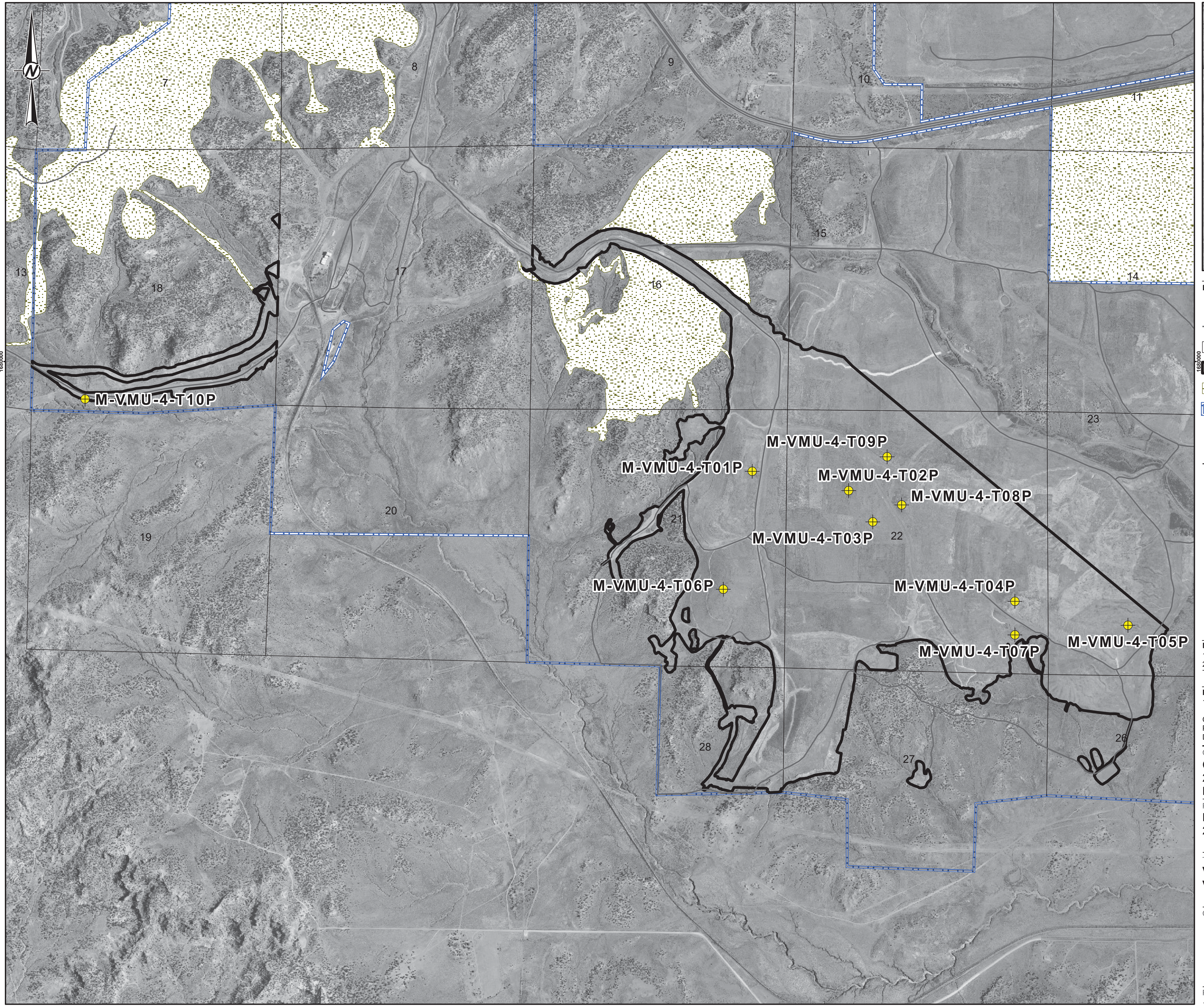
CONSULTANT	YYYY-MM-DD	2022-02-28
GOLDER MEMBER OF WSP	Designed	GFD
	Prepared	GFD
	Reviewed	CD
	Approved	KK

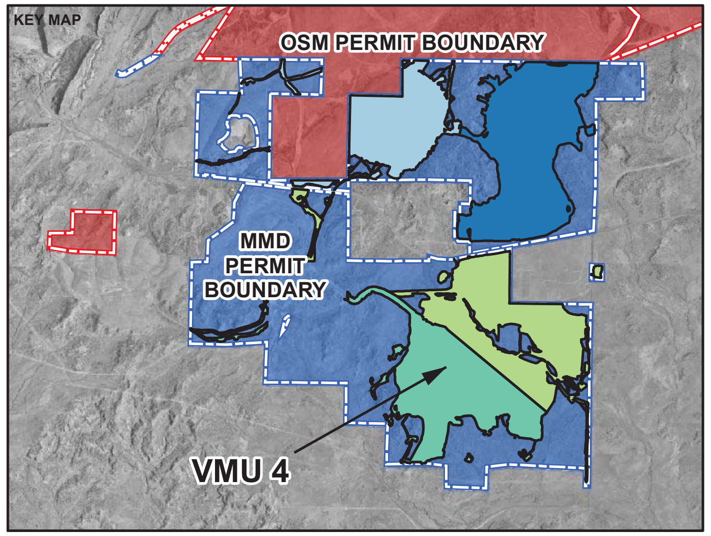
PROJECT NO.	CONTROL	REV.	FIGURE
1338105208	A001	1	1

Figure 2: Departure of Growing Season Precipitation from Long-Term Seasonal Mean at Window Rock; S. Tipple and Rain 9 Gauges



Notes:
Long-term averages are from Window Rock, Arizona Station (029410) for 1937 to 1999 (Western Regional Climate Center, 2020).
Growing season total precipitation is the sum of monthly totals between April and September
Source data is in Table 1





LEGEND

- Primary Transect
- Two-tracks, Roads and Highways
- PLSS - Sections
- MMD VMU 4 (~ 1,238 acres)
- Liability Release
- MMD Permit Boundary

TRANSECT LABEL EXPLANATION:

M-VMU-1-T1P

- MMD Permit Area
- Vegetation Management Unit (VMU-#)
- Transect Number
- Primary (P) or Alternate (A)

0 2,000 4,000

1 inch = 2,000 feet Feet

NOTE(S)

1. KEY MAP SCALE IS DIFFERENT FROM OVERVIEW OF VMUS
2. TRANSECT LOCATIONS WERE CREATED IN ACCORDANCE WITH METHODS OUTLINED IN THE PERMIT

REFERENCE(S)

1. ORTHO SOURCE: CHEVRON, 2013

COORDINATE SYSTEM: NAD 1927 STATEPLANE NEW MEXICO WEST FIPS 3003
PROJECTION: TRANSVERSE MERCATOR
DATUM: NORTH AMERICAN 1927

CLIENT

CHEVRON MINING, INC. - MCKINLEY MINE
24 MILES, NW HWY 264
MENTMORE, NM 87319

PROJECT

MCKINLEY MINE - MMD PERMIT PHASE III BOND RELEASE, 2021 VEGETATION MONITORING

TITLE

VEGETATION MONITORING TRANSECTS, 2021
VEGETATION MANAGEMENT UNIT 4

CONSULTANT

GOLDER
MEMBER OF WSP

YYYY-MM-DD	2022-02-28
DESIGNED	GFD
PREPARED	GFD
REVIEWED	CD
APPROVED	KK

PROJECT NO.	CONTROL	REV.	FIGURE
1338105208	A005	1	3

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

Figure 4: Vegetation Plot, Transect, and Quadrat Layout

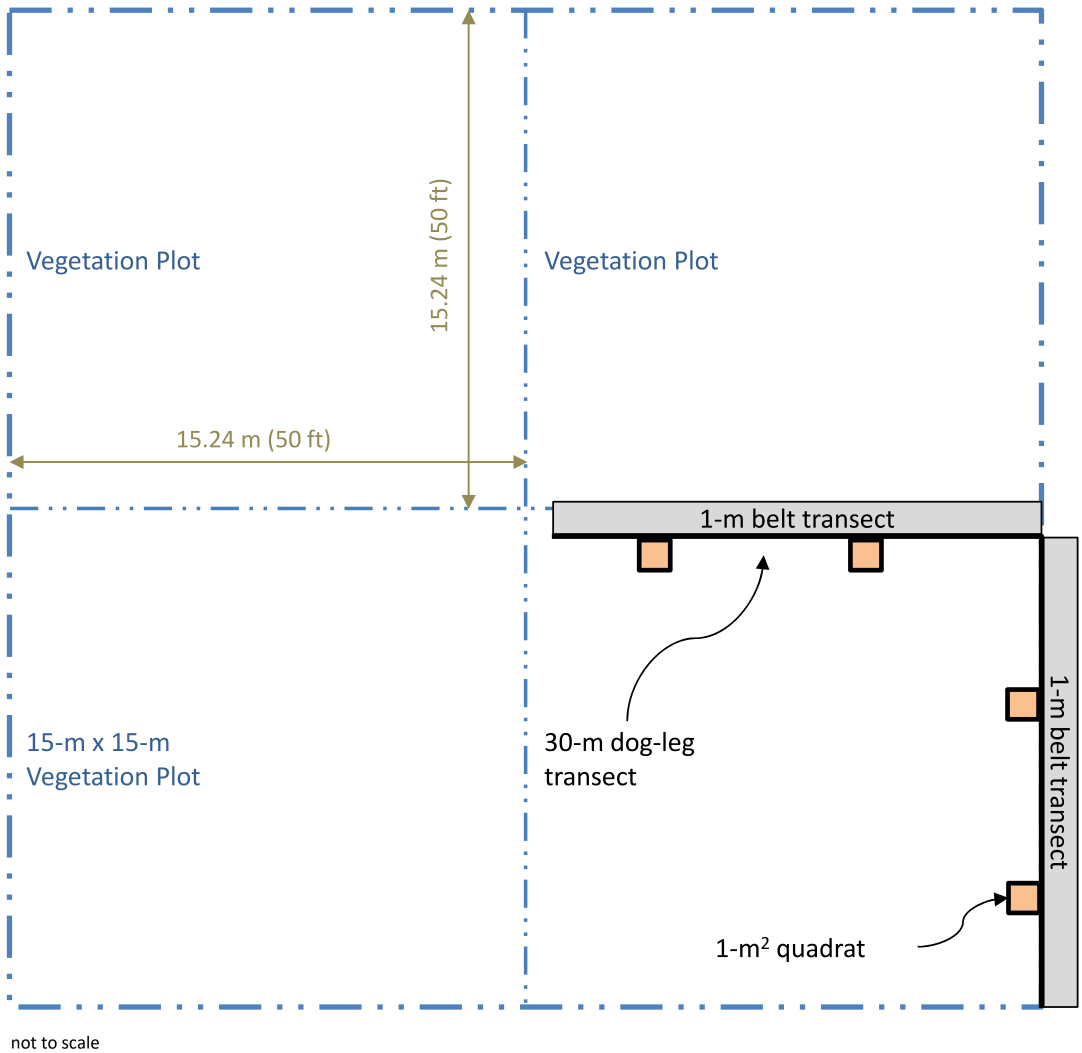


Figure 5: Typical Grass-Shrubland Vegetation in M-VMU-1, September 2021

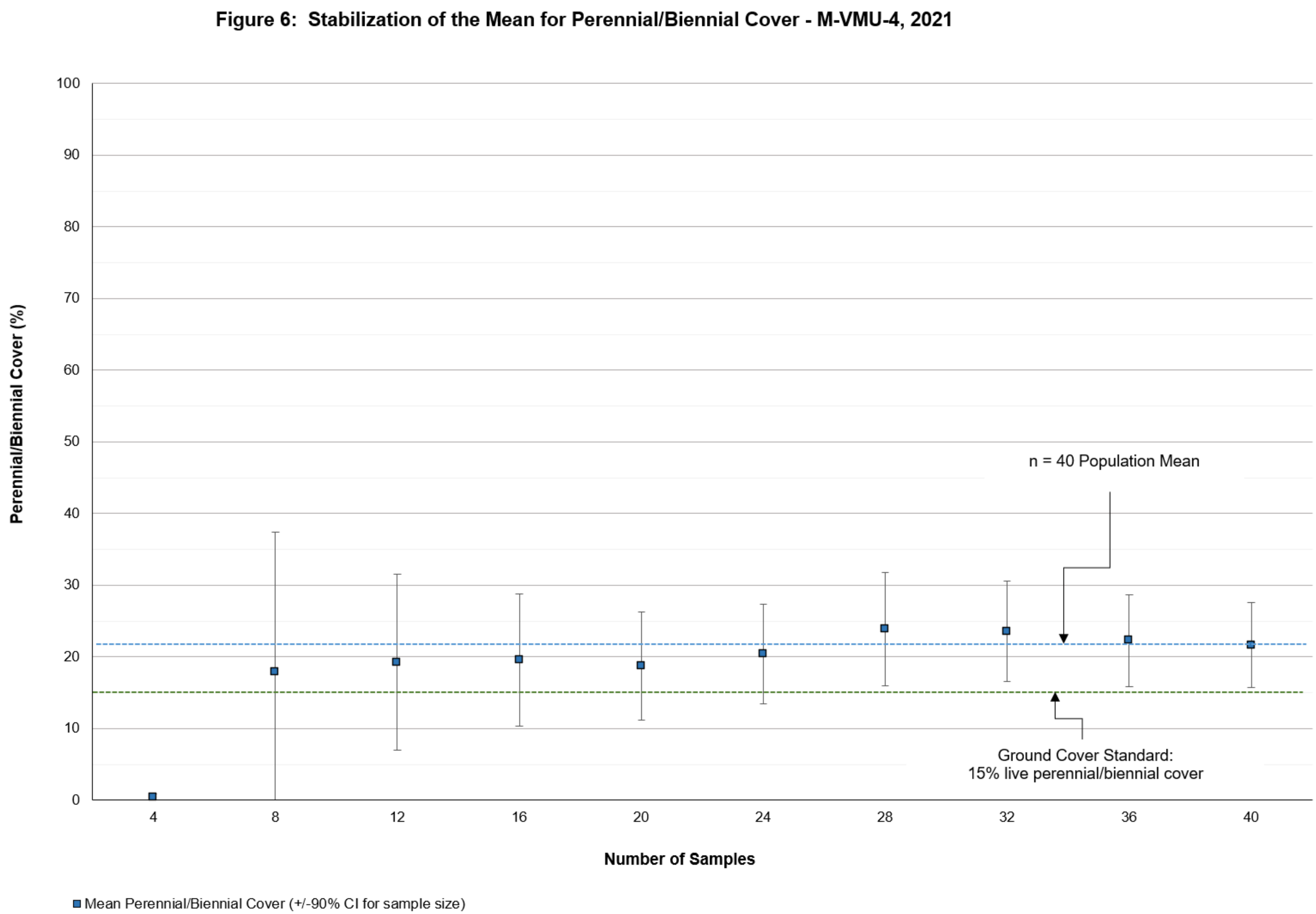


Figure 6: Stabilization of the Mean for Perennial/Biennial Cover - M-VMU-4, 2021
Perennial/Biennial Cover (%)
100
90
80
70
60
50
40
30
20
10
0
4
8
12
16
20
24
28
32
36
40
Number of Samples
n = 40 Population Mean
Ground Cover Standard:
15% live perennial/biennial cover
Mean Perennial/Biennial Cover (+/-90% CI for sample size)

Figure 7: Stabilization of the Mean for Annual Forage Production - M-VMU-4, 2021

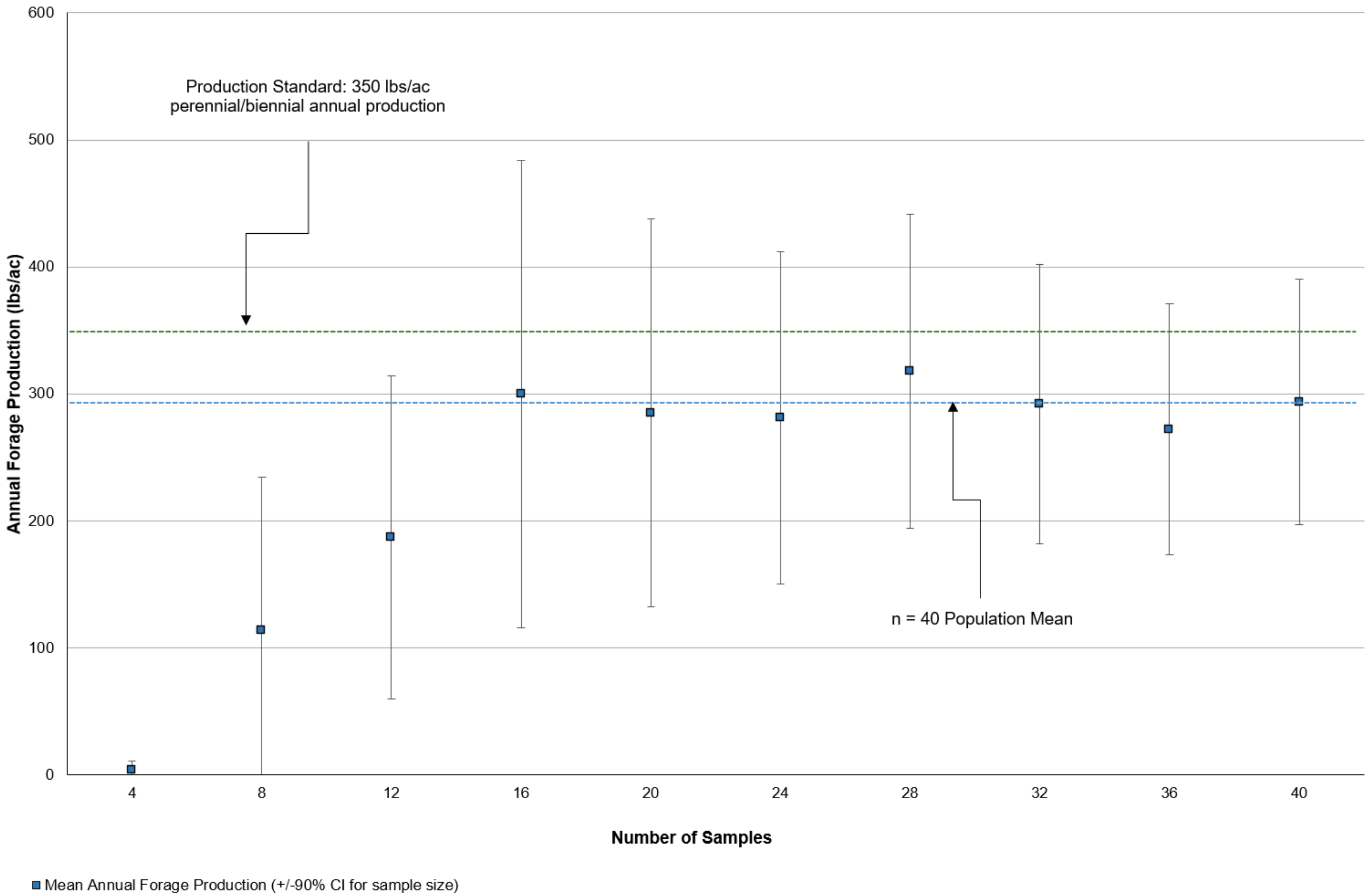
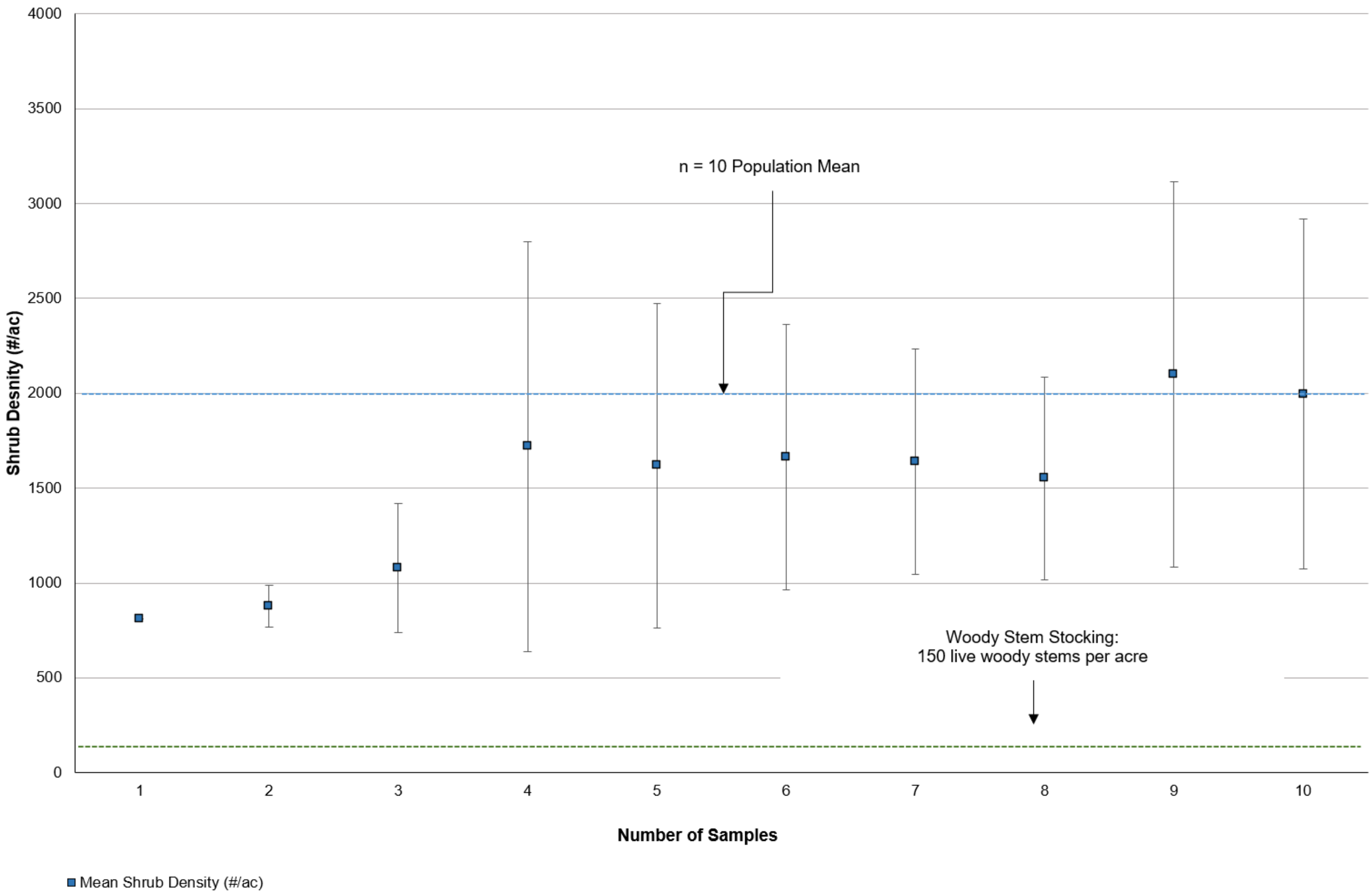


Figure 8: Stabilization of the Mean for Shrub Density - M-VMU-4, 2021



APPENDIX A

Vegetation Data Summary

Table A-1: M-VMU-4 Canopy Cover Data, 2021

Transect	M-VMU-4-T01P				M-VMU-4-T02P				M-VMU-4-T03P				M-VMU-4-T04P				M-VMU-4-T05P				M-VMU-4-T06P				M-VMU-4-T07P				M-VMU-4-T08P				M-VMU-4-T09P				M-VMU-4-T10P			
Quadrat	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
Grasses																																								
Perennials																																								
ACHY	--	--		--	--	--	--	--	--	--	--	--	--	--	--	--	0.3	3.0	8.0	--	--	--	--	--	--	--	--	--	0.5	25.0	12.0	12.0	--	--	--	--	0.5	--	--	--
ELLA3	--	--		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	12.0	--	--	--	--	--	--	--	--	--	--	--	--	--	0.1	--	--	--	--	--	--	--
PASM	--	--		--	--	--	--	--	--	--	--	--	--	--	--	--	4.0	--	--	--	--	--	--	--	5.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
PLJA	--	--		--	--	6.0	3.0	--	4.5	5.0	--	3.0	7.5	8.5	15.0	6.0	0.0	--	--	--	--	5.0	1.0	18.0	--	30.0	--	--	--	13.0	--	0.0	1.3	--	25.0	--	--	9.0	--	--
PSJU3	--	--		--	--	--	18.0	--	4.0	9.0	28.0	12.0	3.0	--	--	--	--	--	--	--	10.8	4.0	38.0	15.0	--	--	--	--	--	--	--	7.0	--	--	--	--	--	--	--	--
SPAI	--	--		--	--	--	--	85.0	6.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ELEL	--	--		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.0	--	--	25.0	--	--	--	--	--	--	--	--	--	--	--	--
BRIN2	--	--		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	25.0	--	--
MUSQ3	--	--		--	--	0.3	--	3.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Forbs																																								
Annual																																								
POOL	--	--		--	--	--	--	0.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.5	--	--
SATR	--	--		--	--	--	--	0.0	--	--	--	--	--	--	--	--	--	--	--	0.1	--	--	--	--	0.1	--	--	--	--	--	1.0	--	--	--	--	--	--	--	0.5	50.0
ACAM	--	--		--	--	--	--	3.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
VEEN	--	--		--	--	--	--	0.0	0.1	--	--	--	--	--	--	--	--	0.1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Perennials																																								
ERCI6	--	--		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.0	--
LAOC3	--	--		--	--	0.3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.3	--	--	--	--	--	--	--	--	--	--
CHAL11	--	--		--	--	7.0	3.0	--	--	--	--	--	--	--	--	--	--	2.5	--	1.0	--	--	--	--	--	--	--	--	--	2.0	0.5	6.0	--	--	--	--	--	--	5.0	--
ERIOG	--	--		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.5	--	--	--	--
ASTER	--	--		--	--	--	--	2.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Shrubs, Trees and Cacti																																								
Perennials																																								
ARTR2	--	--		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	15.0	--	--	--
ATCA	--	1.0		--	--	0.2	--	--	--	--	--	9.0	--	--	12.0	--	28.0	--	2.0	2.0	--	--	--	30.0	--	--	--	--	--	--	--	--	--	--	--	1.0	--	25.0	3.0	--
ERNA	--	--		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	75.0	--	--	--	--	--	--	--	--	--	--	--	--
KRLA	--	--		--	--	--	--	--	6.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	8.0	--	2.0	7.5	12.0	--	--	--	--	--
EPVI	--	--		--	--	--	--	--	--	--	--	--	--	--	--	30.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
GUSA	--	--		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	35.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SAVE4	--	--		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.5	--	--	--
Cover Components																																								
Perennial/Biennial Vegetation Cover	0.0	1.0		0.0	0.0	13.8	24.0	90.0	21.0	14.0	28.0	24.0	10.5	8.5	27.0	36.0	32.3	5.5	22.0	3.0	10.8	9.0	39.0	63.0	45.0	30.0	0.0	100.0	0.5	40.3	20.5	25.0	3.4	7.5	37.0	1.5	17.0	59.0	9.0	0.0
Total Vegetation Cover	--	1.0		--	--	13.8	24.0	89.0	21.0	14.0	28.0	24.0	10.5	8.5	27.0	36.0	32.0	5.5	22.0	3.1	10.8	9.0	38.0	55.0	45.0	30.0	--	100.0	0.5	40.0	21.5	25.0	3.4	7.5	37.0	1.5	17.0	40.0	9.0	50.0
Rock	29.0	19.0		1.5	40.0	2.0	3.0	--	0.3	0.8	5.0	2.0	3.0	5.0	15.0	12.0	15.0	1.5	12.0	5.0	3.0	0.8	0.5	0.5	--	3.0	12.0	--	7.0	0.3	1.0	0.5	1.5	9.0	5.0	33.0	13.0	3.0	0.5	0.0
Litter	31.0	65.0		75.0	3.0	4.0	18.0	11.0	19.0	16.0	2.0	7.0	8.0	13.0	3.0	2.0	11.0	18.0	3.0	3.0	25.0	13.0	12.0	4.0	3.0	15.0	2.0	--	1.5	18.0	5.0	15.0	25.0	3.5	1.0	0.5	12.0	30.0	20.0	12.0
Base Soil	40.0	15.0		23.5	57.0	80.2	55.0	0.0	59.8	69.3	65.0	67.0	78.5	73.5	55.0	50.0	42.0	75.0	63.0	88.9	61.3	77.3	49.5	40.5	52.0	52.0	86.0	8.0	91.0	41.8	72.5	59.5	70.2	80.0	57.0	65.0	58.0	27.0	70.5	38.0

Notes:
Species codes defined in Table 3

Table A-2: M-VMU-3 Basal Cover Data, 2020

Transect	M-VMU-4-T01P				M-VMU-4-T02P				M-VMU-4-T03P				M-VMU-4-T04P				M-VMU-4-T05P			
Quadrat	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
Grasses																				
Perennials																				
ACHY	--	--		--	--	--	--	--	--	--	--	--	--	--	--	--	0.10	1.50	0.10	--
ELLA3	--	--		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.00	--
PASM	--	--		--	--	--	--	--	--	--	--	--	--	--	--	--	0.50	--	--	--
PLJA	--	--		--	--	0.65	0.10	--	2.00	2.50	--	0.50	4.00	5.00	1.00	0.50	--	--	--	--
PSJU3	--	--		--	--	--	1.00	--	1.50	4.00	1.00	0.50	2.00	--	--	--	--	--	--	--
SPAI	--	--		--	--	--	--	12.00	2.50	--	--	--	--	--	--	--	--	--	--	--
ELEL	--	--		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BRIN2	--	--		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MUSQ3	--	--		--	--	0.10	--	< 0.3	--	--	--	--	--	--	--	--	--	--	--	--
Forbs																				
Annual																				
POOL	--	--		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SATR	--	--		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.3
ACAM	--	--		--	--	--	--	< 0.3	--	--	--	--	--	--	--	--	--	--	--	--
VEEN	--	--		--	--	--	--	--	< 0.3	--	--	--	--	--	--	--	--	< 0.3	--	--
Perennials																				
ERCI6	--	--		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
LAOC3	--	--		--	--	0.10	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CHAL11	--	--		--	--	0.05	< 0.3	--	--	--	--	--	--	--	--	--	< 0.3	0.1	--	< 0.3
ERIOG	--	--		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ASTER	--	--		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Shrubs, Trees and Cacti																				
Perennials																				
ARTR2	--	--		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ATCA	--	0.2		--	--	< 0.3	--	--	--	--	--	1.0	0.0	0.0	2.0	--	0.4	--	0.1	0.1
ERNA	--	--		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
KRLA	--	--		--	--	--	--	--	0.4	--	--	--	--	--	--	--	--	--	--	--
EPVI	--	--		--	--	--	--	--	--	--	--	--	--	--	--	2.0	--	--	--	--
GUSA	--	--		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SAVE4	--	--		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cover Components																				
Perennial/Biennial Vegetation Cover	--	0.2		--	--	0.9	1.1	12.1	6.4	6.5	1.0	2.0	6.0	5.0	3.0	2.5	1.0	1.6	1.2	0.1
Total Vegetation Cover	--	0.2		--	--	0.9	1.1	12.1	6.4	6.5	1.0	2.0	6.0	5.0	3.0	2.5	1.0	1.6	1.2	0.2
Rock	29.0	23.0		2.0	40.0	2.5	4.0	0.0	0.3	0.9	5.0	2.0	2.0	5.0	19.0	18.0	17.0	2.0	13.0	5.0
Litter	31.0	50.0		70.0	3.0	5.0	25.0	87.9	15.0	13.0	2.0	12.0	8.0	6.0	15.0	5.0	14.0	19.0	8.0	12.0
Base Soil	40.0	26.9		28.0	57.0	91.6	69.9	0.0	78.4	79.7	92.0	84.0	84.0	84.0	63.0	74.5	68.1	77.4	77.8	82.8

Transect	M-VMU-4-T06P				M-VMU-4-T07P				M-VMU-4-T08P				M-VMU-4-T09P				M-VMU-4-T10P			
Quadrat	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
Grasses																				
Perennials																				
ACHY	--	--	--	--	--	--	--	--	0.20	4.00	0.50	0.50	--	--	--	--	< 0.3	--	--	--
ELLA3	--	--	--	--	--	--	--	--	--	--	--	--	< 0.3	--	--	--	--	--	--	--
PASM	--	--	--	--	1.00	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
PLJA	--	1.00	0.50	2.50	--	8.00	--	--	--	1.00	0.00	0.00	0.25	--	0.50	--	--	1.50	--	--
PSJU3	2.50	0.75	1.00	1.00	--	--	--	--	--	--	--	0.50	--	--	--	--	--	--	--	--
SPAI	--	--	--	--	0.25	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ELEL	--	--	--	--	--	--	0.50	--	--	--	--	--	--	--	--	--	--	--	--	--
BRIN2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.00	--	--
MUSQ3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Forbs																				
Annual																				
POOL	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.3	--	--
SATR	--	--	--	--	< 0.3	--	--	--	--	--	< 0.3	--	--	--	--	--	--	< 0.3	0.1	2.0
ACAM	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
VEEN	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Perennials																				
ERCI6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.50	--
LAOC3	--	--	--	--	--	--	--	--	< 0.3	--	--	--	--	--	--	--	--	--	--	--
CHAL11	--	--	--	--	--	--	--	--	--	< 0.3	< 0.3	< 0.3	--	--	--	--	--	--	0.25	--
ERIOG	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.1	--	--	--	--
ASTER	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Shrubs, Trees and Cacti																				
Perennials																				
ARTR2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.5	--	--	--
ATCA	--	--	--	1.0	--	--	--	--	--	--	--	--	--	--	--	0.1	--	1.8	0.5	--
ERNA	--	--	--	--	--	--	25.0	--	--	--	--	--	--	--	--	--	--	--	--	--
KRLA	--	--	--	--	--	--	--	--	--	--	1.0	--	0.3	1.1	0.8	--	--	--	--	--
EPVI	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
GUSA	--	--	--	--	5.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SAVE4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.3	--	--	--
Cover Components																				
Perennial/Biennial Vegetation Cover	2.5	1.8	1.5	4.5	6.3	8.0	25.5	--	0.2	5.1	1.5	1.0	0.5	1.1	1.3	0.2	1.8	4.3	1.3	--
Total Vegetation Cover	2.5	1.8	1.5	4.5	6.3	8.0	0.0	25.5	0.2	5.1	1.6	1.0	0.5	1.1	1.3	0.2	1.8	4.3	1.4	2.0
Rock	4.0	0.8	0.8	1.0	--	3.5	12.0	--	7.0	0.3	1.0	0.5	2.0	9.0	6.0	33.0	12.0	3.0	1.0	0.5
Litter	25.0	6.0	25.0	25.0	6.0	18.0	2.0	50.0	1.0	8.0	18.0	25.0	30.0	3.5	20.0	0.5	7.5	35.0	50.0	25.0
Base Soil	68.5	91.5	72.8	69.5	87.8	70.5	86.0	24.5	91.8	86.7	79.4	73.5	67.5	86.4	72.8	66.3	78.8	57.7	47.7	72.5

Table A-3: M-VMU-3 Frequency Data (counts), 2020

Transect	M-VMU-4-T01P				M-VMU-4-T02P				M-VMU-4-T03P				M-VMU-4-T04P				M-VMU-4-T05P				M-VMU-4-T06P				M-VMU-4-T07P				M-VMU-4-T08P				M-VMU-4-T09P				M-VMU-4-T10P			
Quadrat	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
Grasses																																								
Perennials																																								
ACHY	--	--		--	--	--	--	--	--	--	--	--	--	--	--	--	1.0	4.0	1.0	--	--	--	--	--	--	--	--	--	1.0	8.0	1.0	6.0	--	--	--	--	1.0	--	--	--
ELLA3	--	--		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	8.0	--	--	--	--	--	--	--	--	--	--	--	--	--	1.0	--	--	--	--	--	--	--
PASM	--	--		--	--	--	--	--	--	--	--	--	--	--	--	--	3.0	--	--	--	--	--	--	--	1.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
PLJA	--	--		--	--	9.0	9.0	--	12.0	18.0	--	4.0	2.0	5.0	7.0	5.0	--	--	--	--	--	9.0	1.0	5.0	--	8.0	--	--	--	5.0	--	--	3.0	--	12.0	--	--	3.0	--	--
PSJU3	--	--		--	--	--	5.0	--	2.0	5.0	7.0	5.0	1.0	--	--	--	--	--	--	--	2.0	4.0	3.0	3.0	--	--	--	--	--	--	--	1.0	--	--	--	--	--	--	--	--
SPAI	--	--		--	--	--	--	9.0	4.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	18.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ELEL	--	--		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	12.0	--	--	--	--	--	--	--	--	--	--	--	--	--
BRIN2	--	--		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	58.0	--	--
MUSQ3	--	--		--	--	6.0	--	1.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Forbs																																								
Annual																																								
POOL	--	--		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5.0	--	--
SATR	--	--		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.0	--	--	--	--	1.0	--	--	--	--	--	1.0	--	--	--	--	--	--	3.0	1.0	2.0
ACAM	--	--		--	--	--	--	5.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
VEEN	--	--		--	--	--	--	--	1.0	--	--	--	--	--	--	--	--	2.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Perennials																																								
ERCI6	--	--		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2.0	--
LAOC3	--	--		--	--	6.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5.0	--	--	--	--	--	--	--	--	--	--
CHAL11	--	--		--	--	20.0	7.0	--	--	--	--	--	--	--	--	--	2.0	118.0	--	10.0	--	--	--	--	--	--	--	--	--	19.0	3.0	2.0	--	--	--	--	--	--	4.0	--
ERIOG	--	--		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.0	--	--	--	--
ASTER	--	--		--	--	--	--	7.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Shrubs, Trees and Cacti																																								
Perennials																																								
ARTR2	--	--		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2.0	--	--	--
ATCA	--	1.0		--	--	1.0	--	--	--	--	--	1.0	--	--	1.0	--	1.0	--	1.0	2.0	--	--	--	1.0	--	--	--	--	--	--	--	--	--	--	--	2.0	--	1.0	1.0	--
ERNA	--	--		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2.0	--	--	--	--	--	--	--	--	--	--	--	--	--
KRLA	--	--		--	--	--	--	--	2.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.0	--	1.0	4.0	2.0	--	--	--	--	--
EPVI	--	--		--	--	--	--	--	--	--	--	--	--	--	--	4.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
GUSA	--	--		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SAVE4	--	--		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.0	--	--	--

GOLDER
MEMBER OF WSP

Table A-4: M-VMU-4 Aboveground Annual Production Data, 2021

Transect	M-VMU-4-T01P				M-VMU-4-T02P				M-VMU-4-T03P				M-VMU-4-T04P				M-VMU-4-T05P				M-VMU-4-T06P				M-VMU-4-T07P				M-VMU-4-T08P				M-VMU-4-T09P				M-VMU-4-T10P			
Quadrat	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Grasses (g/m²)																																								
Forage																																								
ACHY	--	--		--	--	--	--	--	--	--	--	--	--	--	--	--	1.2	6.9	4.0	--	--	--	--	--	--	--	--	--	1.2	3.6	5.7	7.5	--	--	--	--	--	--	--	--
ELEL	--	--		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	19.6	--	--	--	--	--	--	--	--	--	--	--	--
ELLA3	--	--		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2.8	--	--	--	--	--	--	--	--	--	--	--	--	--	1.0	--	--	--	--	--	--	--
PASM	--	--		--	--	--	--	--	--	--	--	--	--	--	--	--	11.2	--	--	--	--	--	--	--	13.2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
PLJA	--	--		--	--	6.4	9.0	--	24.6	9.6	--	4.3	8.9	23.9	13.4	3.5	--	--	--	--	--	8.7	1.5	9.0	--	42.6	--	--	--	5.5	--	--	2.5	--	14.1	--	--	40.1	--	--
PSJU3	--	--		--	--	--	6.6	--	6.5	13.6	4.3	4.6	3.0	--	--	--	--	--	--	--	11.2	12.5	9.4	19.2	--	--	--	--	--	--	--	1.5	--	--	--	--	--	--	--	--
SPAI	--	--		--	--	--	--	64.8	34.2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BRIN2	--	--		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	28.4	--	--
MUSQ3	--	--		--	--	1.0	--	0.6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Forbs (g/m²)																																								
Non-forage																																								
AMCA	--	--		--	--	--	--	1.3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
POOL	--	--		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.7	--	--
SATR	--	--		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.7	--	--	--	--	0.7	--	--	--	--	--	0.7	--	--	--	--	--	--	0.1	0.8	135.9
VEEN	--	--		--	--	--	--	--	0.1	--	--	--	--	--	--	--	--	0.8	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ERCI6	--	--		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.0	--
LAOC3	--	--		--	--	1.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.4	--	--	--	--	--	--	--	--	--	--
Forage																																								
CHAL11	--	--		--	--	1.7	7.7	--	--	--	--	--	--	--	--	--	--	5.2	--	2.0	--	--	--	--	--	--	--	--	--	3.4	1.0	0.8	--	--	--	--	--	--	10.2	--
ERIOG	--	--		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.6	--	--	--	--
ASTER	--	--		--	--	--	--	1.2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Shrubs, Trees and Cacti (g/m²)																																								
Forage																																								
ATCA	--	1.8		--	--	0.9	--	--	--	--	--	20.1	--	--	46.5	--	61.0	--	3.5	3.4	--	--	--	46.7	--	--	--	--	--	--	--	--	--	--	0.0	0.9	0.0	44.8	23.3	--
EPVI	--	--		--	--	--	--	--	--	--	--	--	--	--	--	187.1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ERNA	--	--		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	75.5	--	--	--	--	--	--	--	--	--	--	--	--
GUSA	--	--		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	83.2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
KRLA	--	--		--	--	--	--	--	27.9	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	19.7	--	8.3	20.0	3.4	--	--	--	--	--
SAVE4	--	--		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	10.1	--	--	--
ARTR2	--	--		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	28.0	--	--	--
Total Air-dry Aboveground Annual Production (g/m²)																																								
Non-forage	--	--		--	--	1	--	1	--	--	--	--	--	--	--	--	--	1	--	1	--	--	--	--	1	--	--	--	--	--	1	--	--	--	--	--	--	1	2	136
Forage	--	2		--	--	10	23	67	93	23	4	29	12	24	60	191	73	12	10	5	11	21	11	75	103	43	0	95	1	12	26	10	12	20	18	1	38	113	34	--
Total Production	--	2		--	--	11	23	68	93	23	4	29	12	24	60	191	73	13	10	6	11	21	11	75	103	43	0	95	1	13	27	10	12	20	18	1	38	114	35	136
Total Air-dry Aboveground Annual Production (lbs/ac)																																								
Non-forage	--	--	--	--	--	9	--	11	1	--	--	--	--	--	--	--	--	7	--	6	--	--	--	--	6	--	--	--	--	4	7	--	--	--	--	--	--	7	16	1213
Forage	--	16	--	--	--	89	208	595	832	207	38	259	107	213	535	1700	655	108	92	49	100	189	97	668	916	380	--	849	10	111	236	88	106	179	156	13	339	1010	299	--
Total Production	--	16	--	--	--	98	208	606	833	207	38	259	107	213	535	1700	655	115	92	55	100	189	97	668	922	380	--	849	10	115	242	88	106	179	156	13	339	1017	315	1213

Notes:
g/m^2 = grams per square meter
lbs/ac = pounds per acre
1 gram per square meter (g/m^2) is equal to 8.922 pounds per acre (lbs/ac)
Species codes defined in Table 3
Non-forage and forage determinations are based on the permit (e.g. plants of perennial and/or biennial duration are forage and plants of annual duration are non-forage; noxious weeds are non-forage)

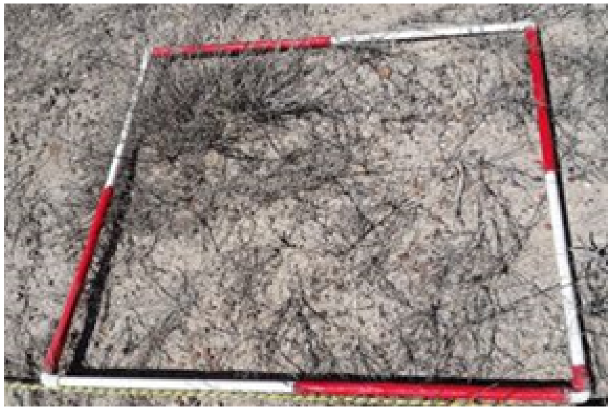
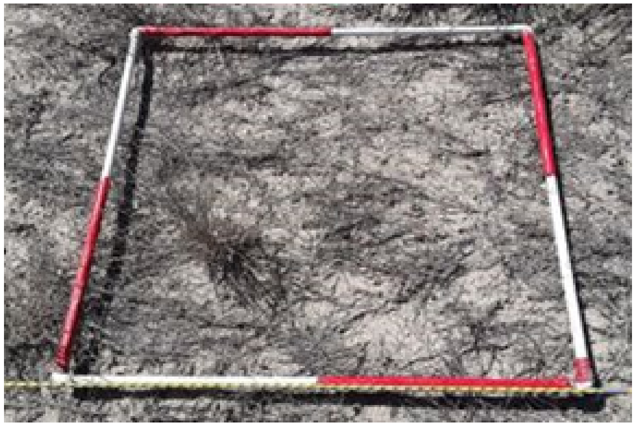
Table A-5: M-VMU-4 Shrub Belt Transect Data, 2021

Transect	M-VMU-3-T01P	M-VMU-3-T02P	M-VMU-3-T03P	M-VMU-3-T04P	M-VMU-3-T05P	M-VMU-3-T06P	M-VMU-3-T07P	M-VMU-3-T08P	M-VMU-3-T09P	M-VMU-3-T10P
Shrubs, Trees and Cacti										
ATCA	13	0	12	6	27	22	3	6	3	11
ATCO	0	0	0	0	0	0	0	2	0	0
ATCO4	0	0	0	1	0	0	3	0	3	0
EPVI	0	1	0	0	0	0	0	12	0	0
KRLA	7	31	2	0	0	0	0	0	0	0
PUTR2	0	0	0	0	3	0	0	5	0	0
PUME	0	0	0	0	0	0	0	2	0	0

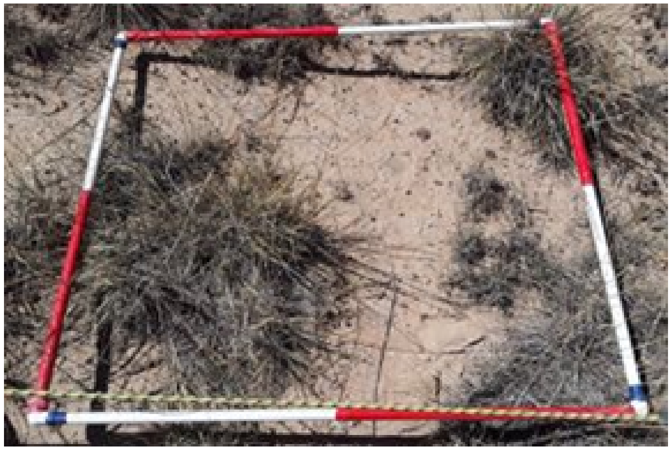
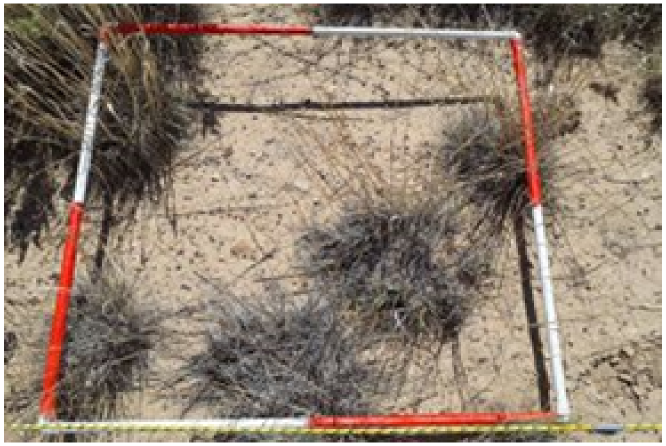
Code	Scientific Name	Common Name
ATCA	*Atriplex canescens*	Four-wing saltbush
ATCO	*Atriplex confertifolia*	Shadscale saltbush
ATCO4	*Atriplex corrugata*	Mat saltbush
EPVI	*Ephedra viridis*	Mormon tea
KRLA	*Krascheninnikovia lanata*	Winterfat
PUTR2	*Purshia tridentata*	Antelope bitterbrush
PUME	*Purshia mexicana*	Mexican cliffrose

APPENDIX B

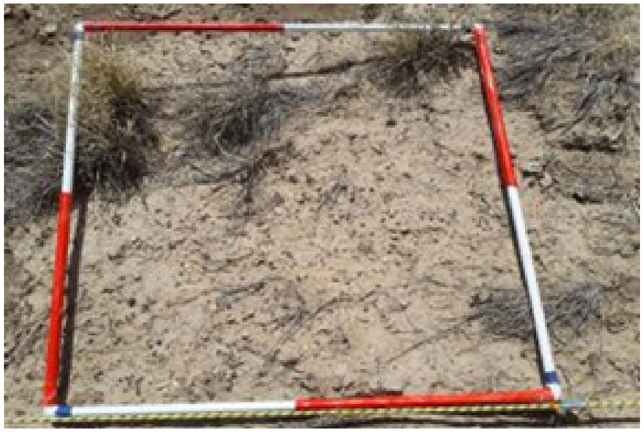
Quadrat Photographs

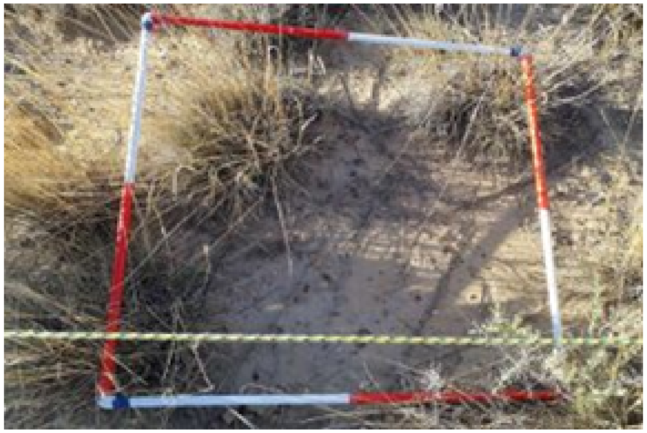
M-VMU-4-T01P	
	
Q1	Q2
	
Q3	Q4

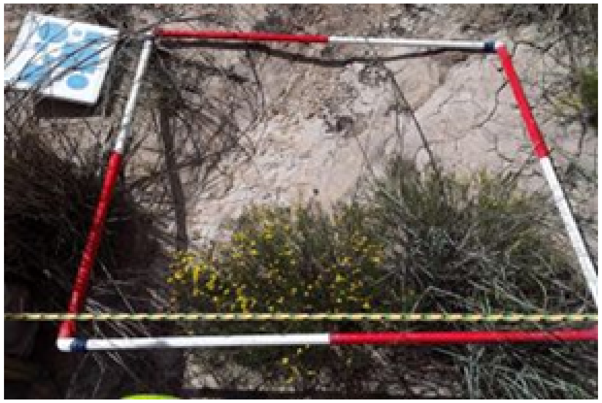
M-VMU-4-T02P	
	
Q1	Q2
	
Q3	Q4

<table>
<tr><th colspan="2">M-VMU-4-T03P</th></tr>
<tr><td></td><td></td></tr>
<tr><td>Q1</td><td>Q2</td></tr>
<tr><td></td><td></td></tr>
<tr><td>Q3</td><td>Q4</td></tr>
</table>

M-VMU-4-T04P	
	
Q1	Q2
	
Q3	Q4

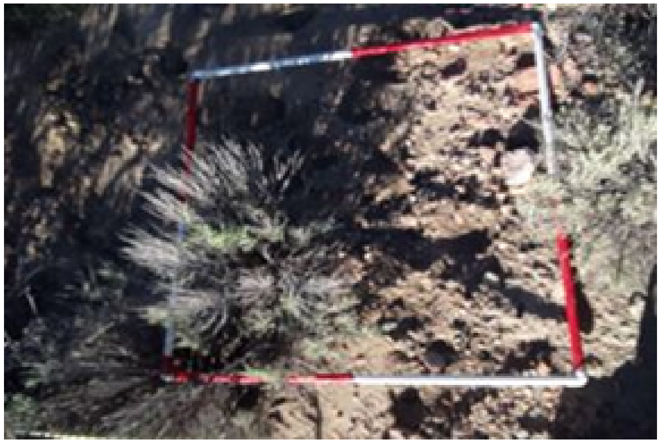
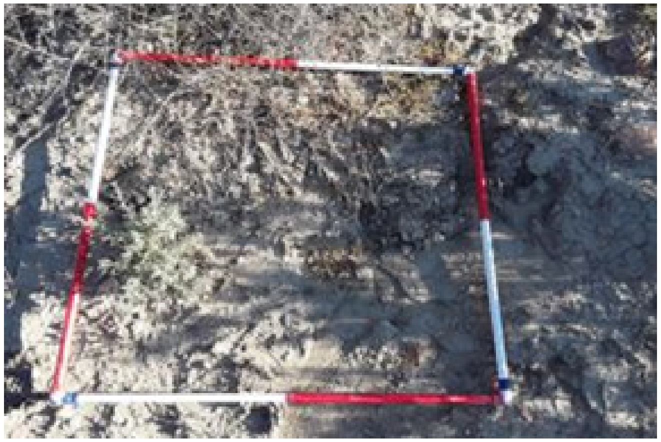
M-VMU-4-T05P	
	
Q1	Q2
	
Q3	Q4

M-VMU-4-T06P	
	
Q1	Q2
	
Q3	Q4

M-VMU-4-T07P	
	
Q1	Q2
	
Q3	Q4

M-VMU-4-T08P	
	
Q1	Q2
	
Q3	Q4

M-VMU-4-T09P	
	
Q1	Q2
	
Q3	Q4

M-VMU-4-T10P	
	
Q1	Q2
	
Q3	Q4

APPENDIX C

Vegetation Statistical Analysis

Figure C-1: Distribution: Raw Data: 2021 Perennial / Biennial Cover

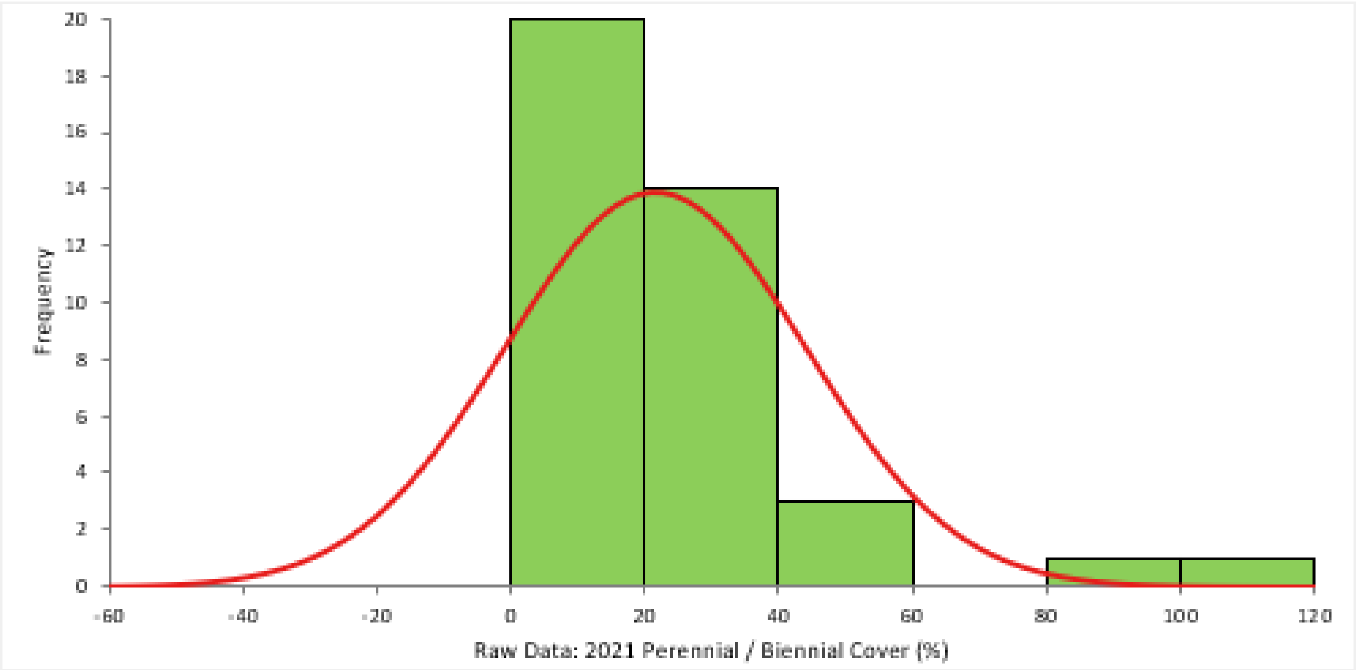
Analyse-it v5.68

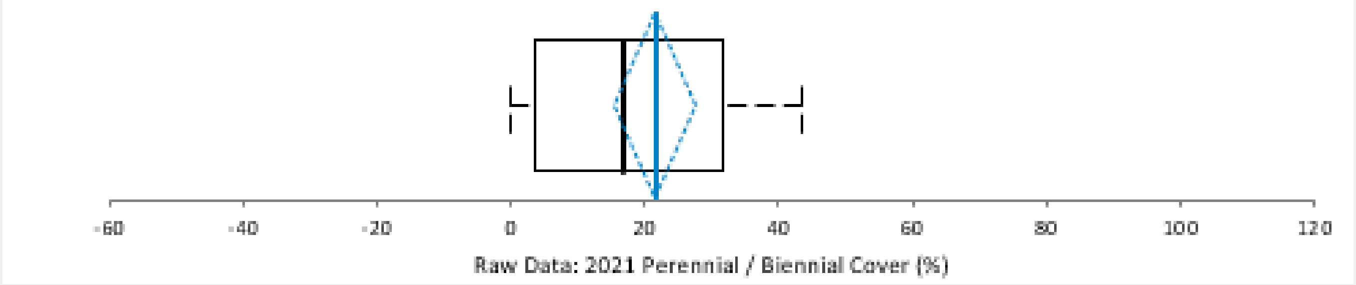
Table C-2: M-VMU-4 2021 Data for Normal Distribution and Variance Analysis

Filter: No filter

Last updated 24 February 2022 at 15:57 by Buchanan, Nicholas

Descriptives



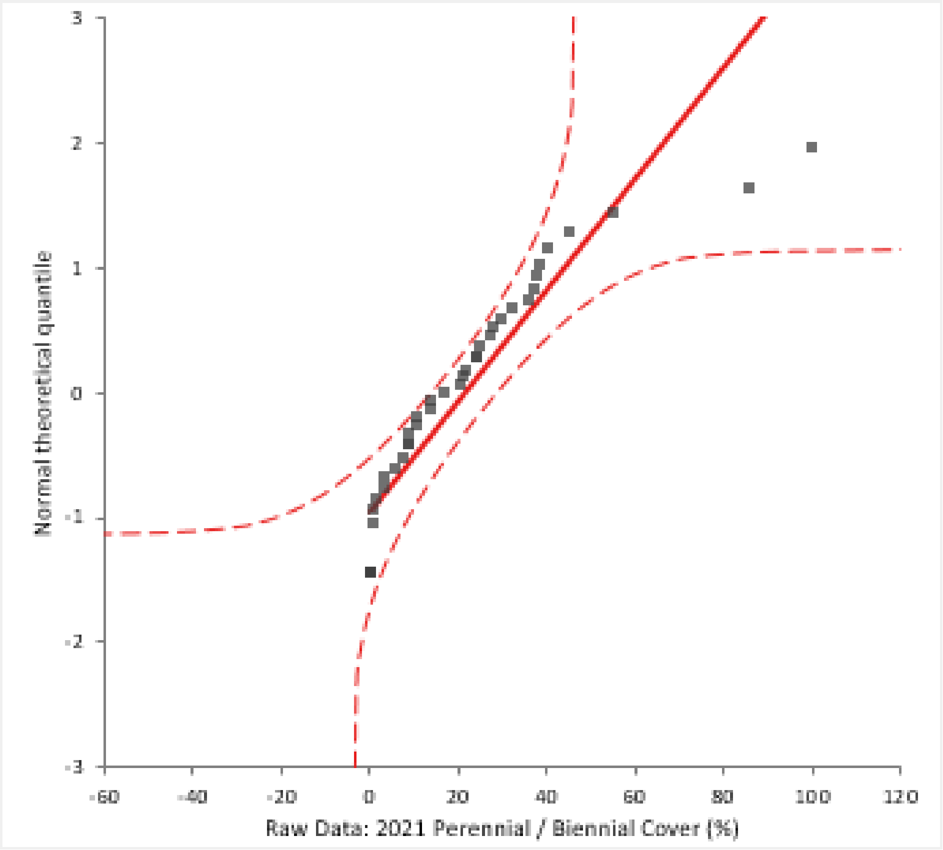


N	39

	Mean	90% CI	Mean SE	SD	Skewness	Kurtosis
Raw Data: 2021 Perennial / Biennial Cover (%)	21.62	15.55 to 27.69	3.599	22.47	1.7	3.87

	1st quartile	Median	3rd quartile
Raw Data: 2021 Perennial / Biennial Cover (%)	3.70	17.00	31.67

Normality



Shapiro-Wilk test

W statistic	0.83
p-value	<0.0001[1]

H0: F(Y) = N(μ, σ)
The distribution of the population is normal with unspecified mean and standard deviation.
H1: F(Y) ≠ N(μ, σ)
The distribution of the population is not normal.

[1] Reject the null hypothesis in favour of the alternative hypothesis at the 10% significance level.

Figure C-2: Distribution: Transformed Data: Log P/B Cover

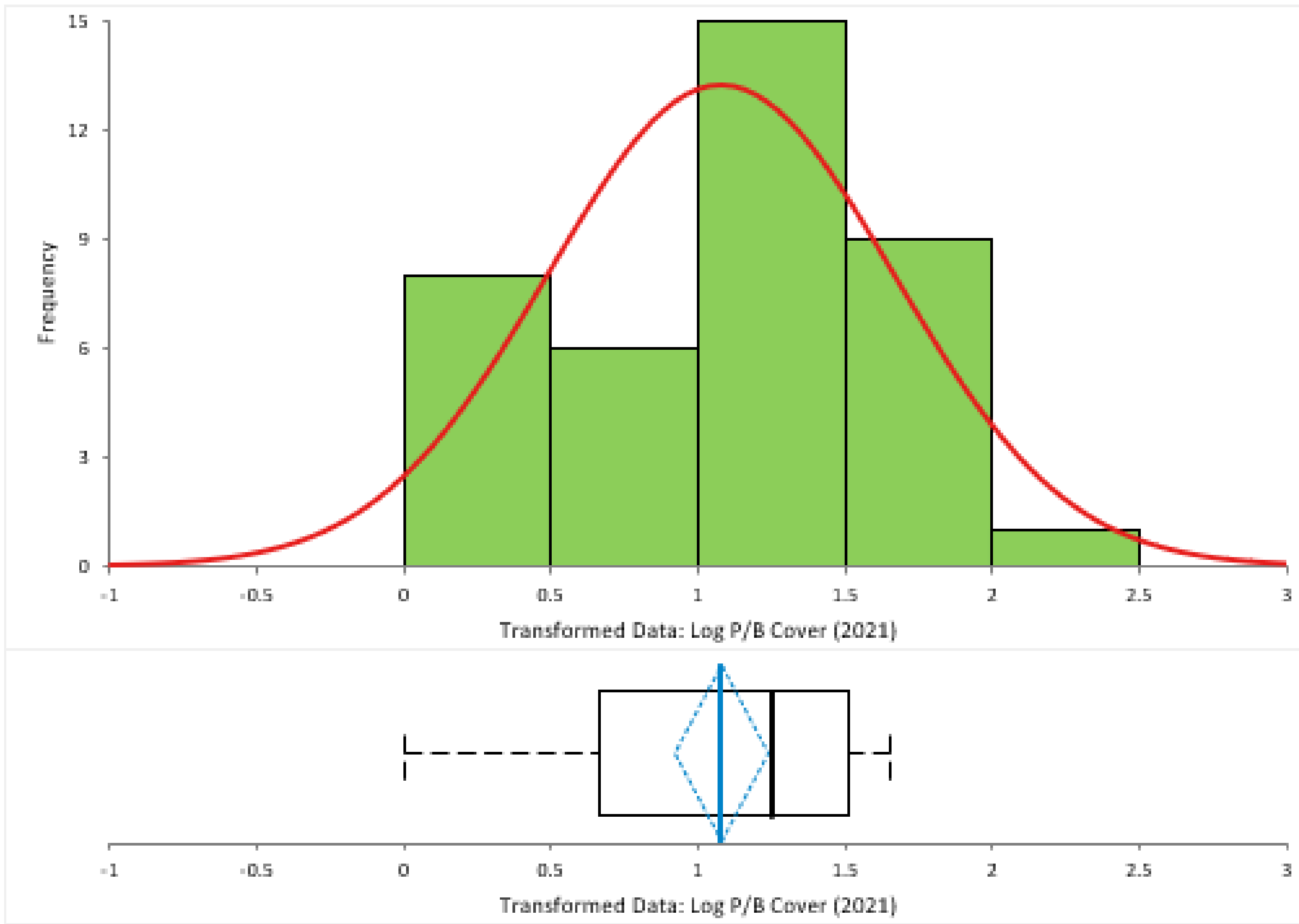
Analyse-it v5.68

Table C-2: M-VMU-4 2021 Data for Normal Distribution and Variance Analysis

Filter: No filter

Last updated 24 February 2022 at 15:57 by Buchanan, Nicholas

Descriptives

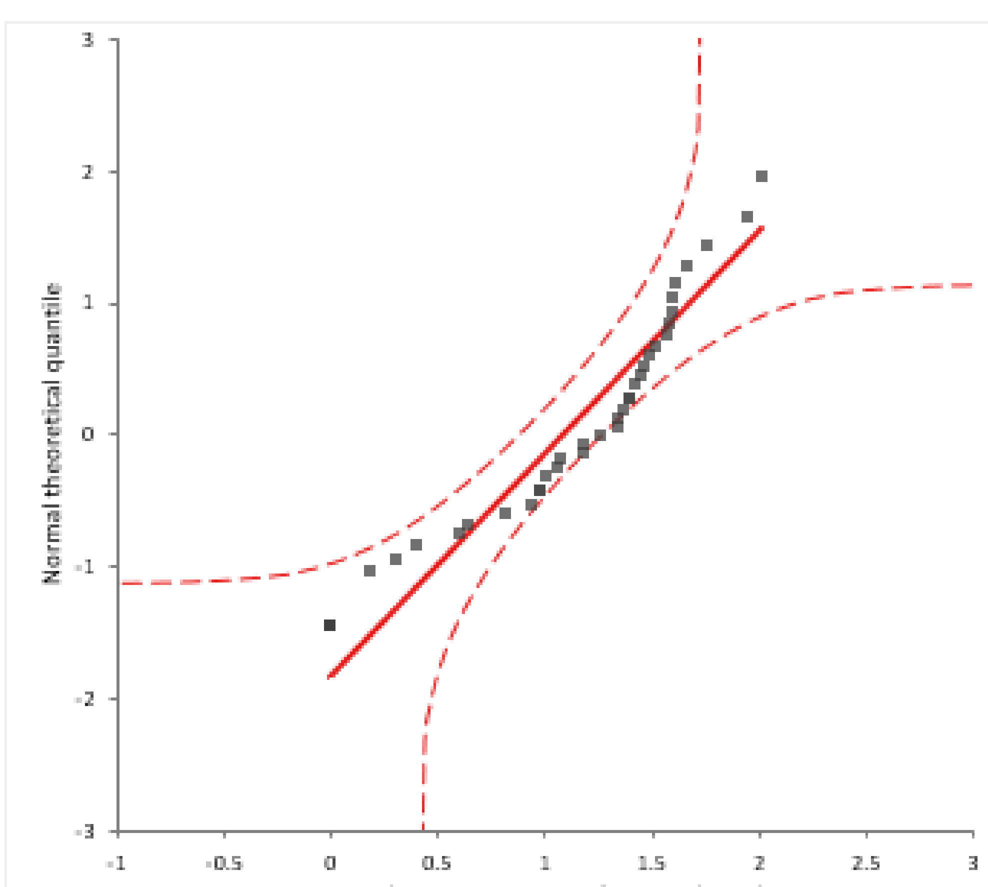


N	39

	Mean	90% CI	Mean SE	SD	Skewness	Kurtosis
Transformed Data: Log P/B Cover (2021)	1.077	0.918 to 1.236	0.0942	0.589	-0.7	-0.64

	1st quartile	Median	3rd quartile
Transformed Data: Log P/B Cover (2021)	0.667	1.255	1.514

Normality



Shapiro-Wilk test

W statistic	0.91
p-value	0.0031

H0: F(Y) = N(μ, σ)
The distribution of the population is normal with unspecified mean and standard deviation.
H1: F(Y) ≠ N(μ, σ)
The distribution of the population is not normal.

[1] Reject the null hypothesis in favour of the alternative hypothesis at the 10% significance level.

Figure C-3: Distribution: Raw Data: 2021 Annual Forage Production

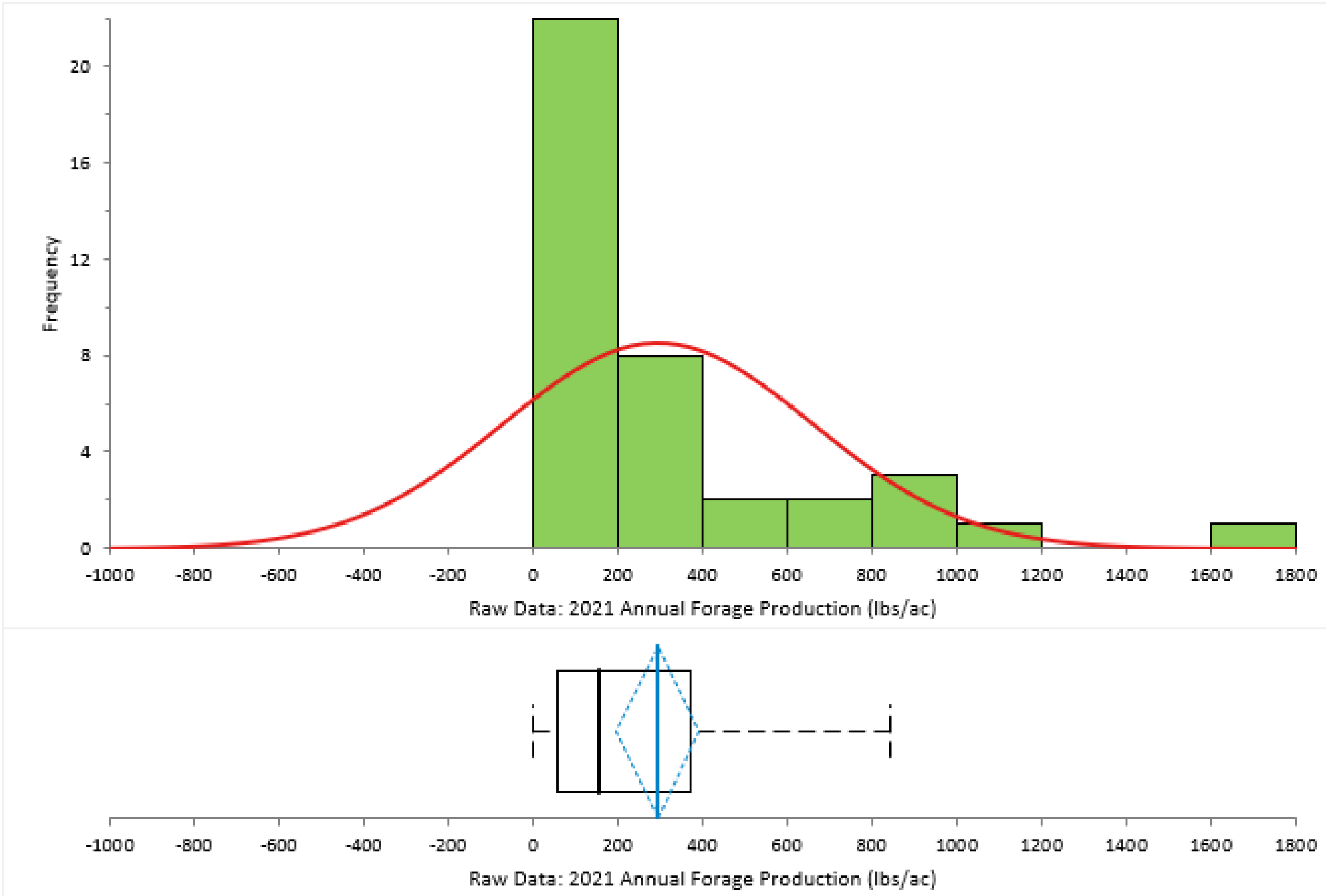
Analyse-it v5.68

Table C-2: M-VMU-4 2021 Data for Normal Distribution and Variance Analysis

Filter: No filter

Last updated 24 February 2022 at 15:57 by Buchanan, Nicholas

Descriptives

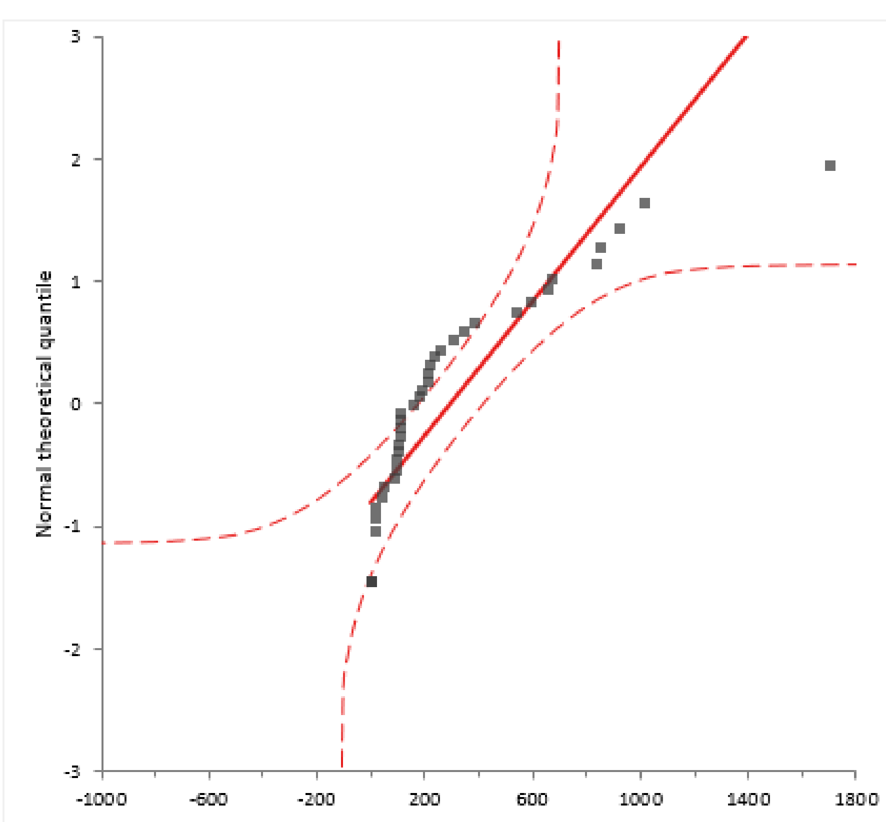


N	39

	Mean	90% CI	Mean SE	SD	Skewness	Kurtosis
Raw Data: 2021 Annual Forage Production (lbs/ac)	2.935305E+02	1.945691E+02 to 3.924919E+02	58.697560467	3.665661E+02	2.0	4.66

	1st quartile	Median	3rd quartile
Raw Data: 2021 Annual Forage Production (lbs/ac)	55.223116730	1.564531E+02	3.730720E+02

Normality



Shapiro-Wilk test

W statistic	0.76
p-value	<0.0001[1]

H0: F(Y) = N(μ, σ)
The distribution of the population is normal with unspecified mean and standard deviation.
H1: F(Y) ≠ N(μ, σ)
The distribution of the population is not normal.
[1] Reject the null hypothesis in favour of the alternative hypothesis at the 10% significance level.

Figure C-4: Distribution: Transformed Data: Log AFP

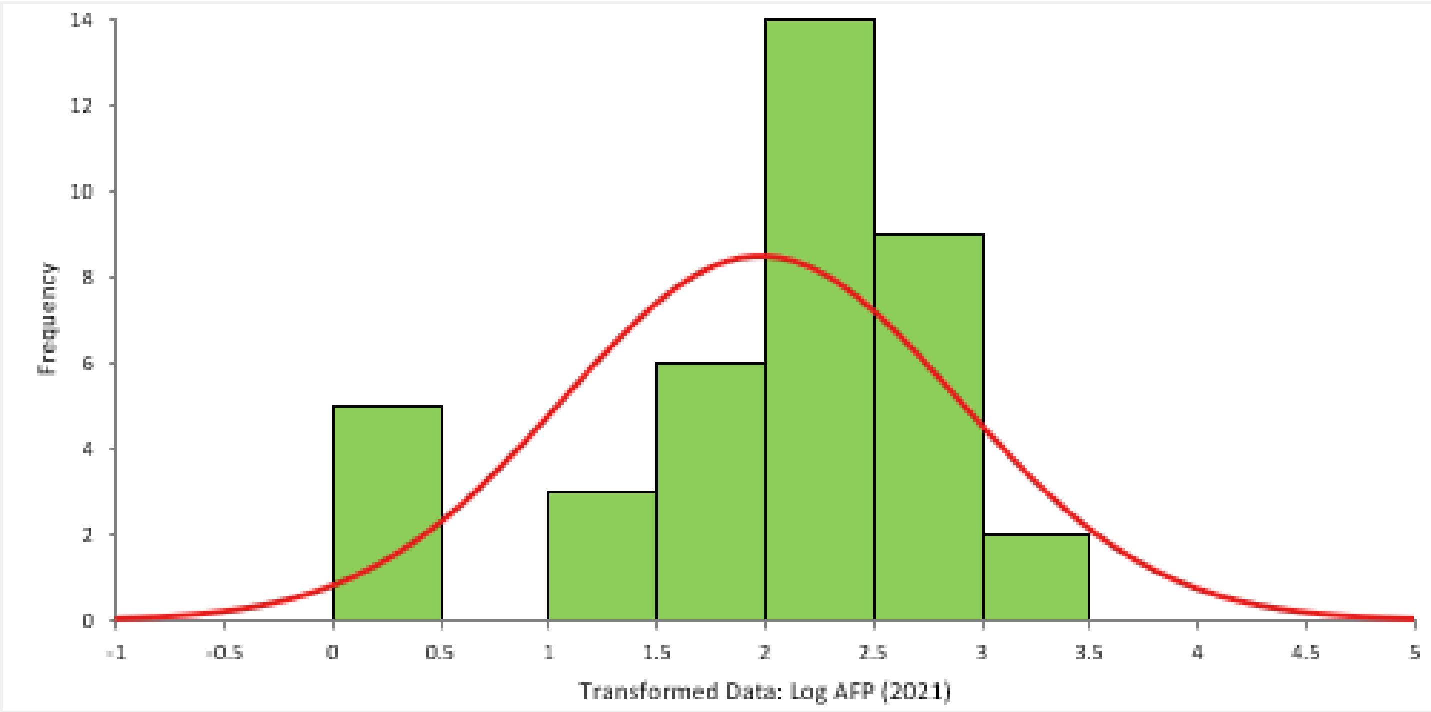
Analyse-it v5.68

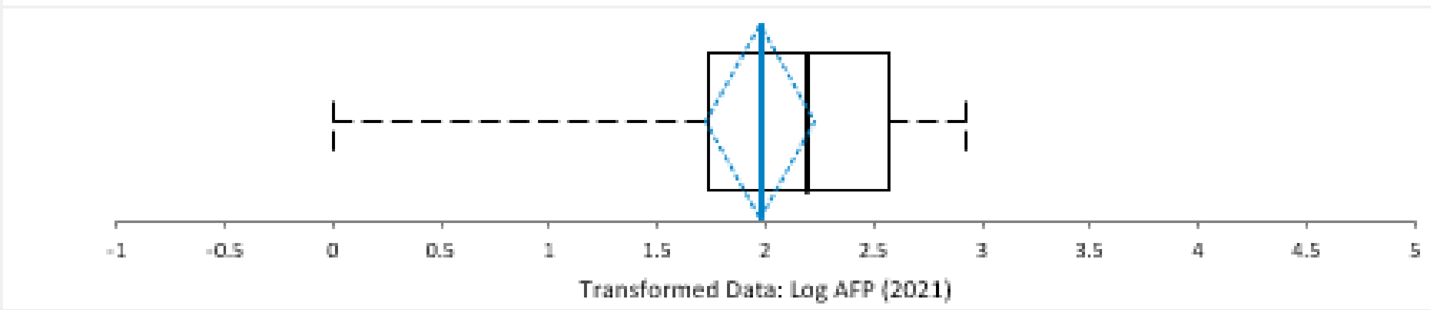
Table C-2: M-VMU-4 2021 Data for Normal Distribution and Variance Analysis

Filter: No filter

Last updated 24 February 2022 at 15:58 by Buchanan, Nicholas

Descriptives



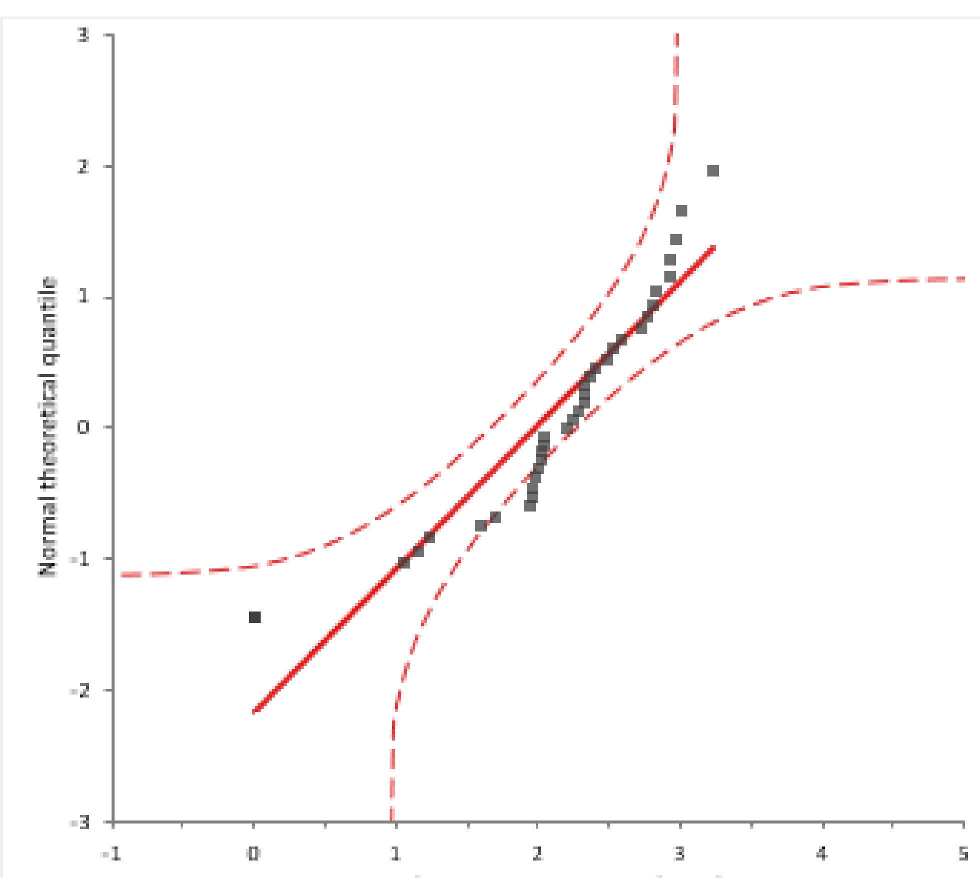


N	39

	Mean	90% CI	Mean SE	SD	Skewness	Kurtosis
Transformed Data: Log AFP (2021)	1.975	1.728 to 2.221	0.1464	0.914	-1.1	0.54

	1st quartile	Median	3rd quartile
Transformed Data: Log AFP (2021)	1.739	2.197	2.573

Normality



Shapiro-Wilk test

W statistic	0.85
p-value	0.0001[1]

H0: F(Y) = N(μ, σ)
The distribution of the population is normal with unspecified mean and standard deviation.
H1: F(Y) ≠ N(μ, σ)
The distribution of the population is not normal.

[1] Reject the null hypothesis in favour of the alternative hypothesis at the 10% significance level.

Figure C-5:Distribution: Raw Data: 2021 Woody Plant Density

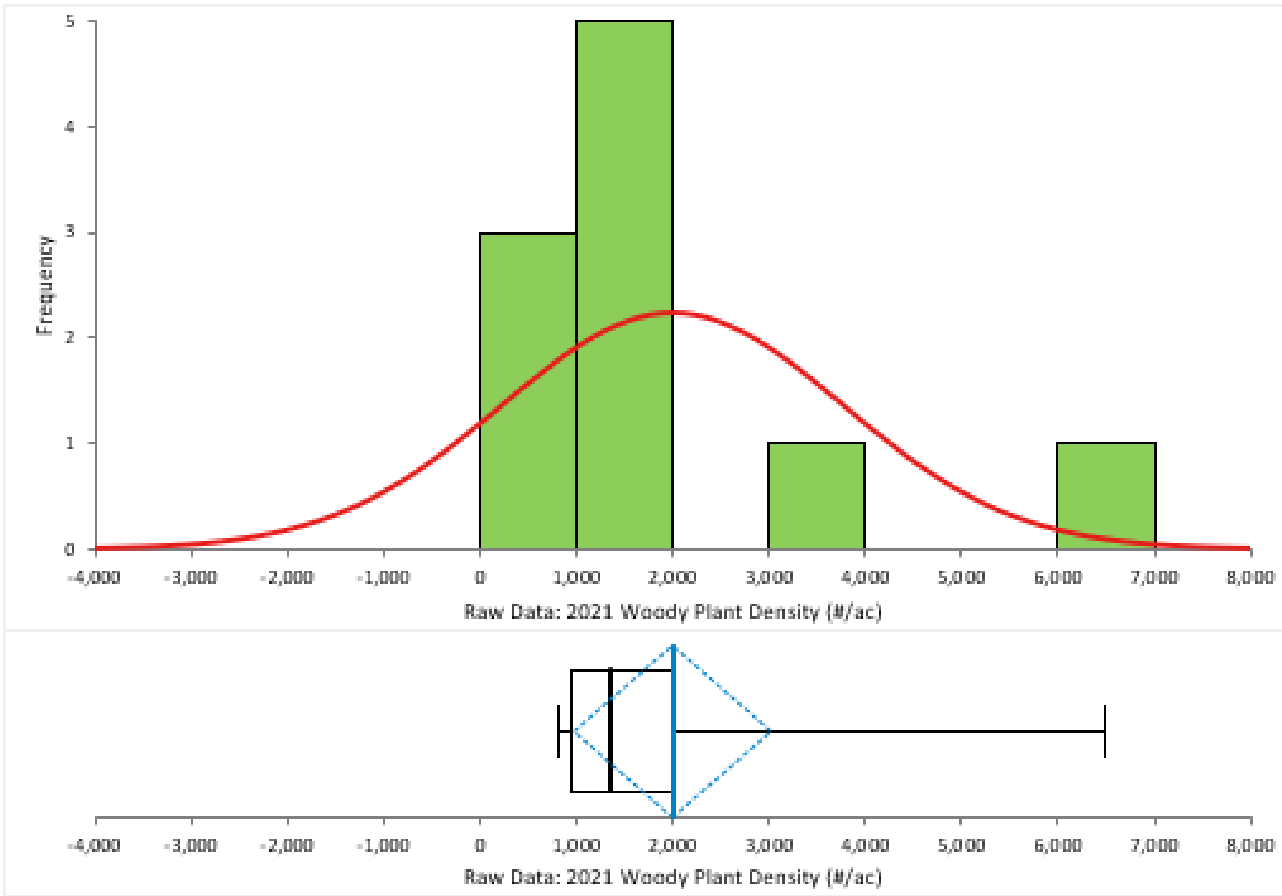
Analyse-it v5.68

Table C-2: M-VMU-4 2021 Data for Normal Distribution and Variance Analysis

Filter: No filter

Last updated 24 February 2022 at 15:58 by Buchanan, Nicholas

Descriptives

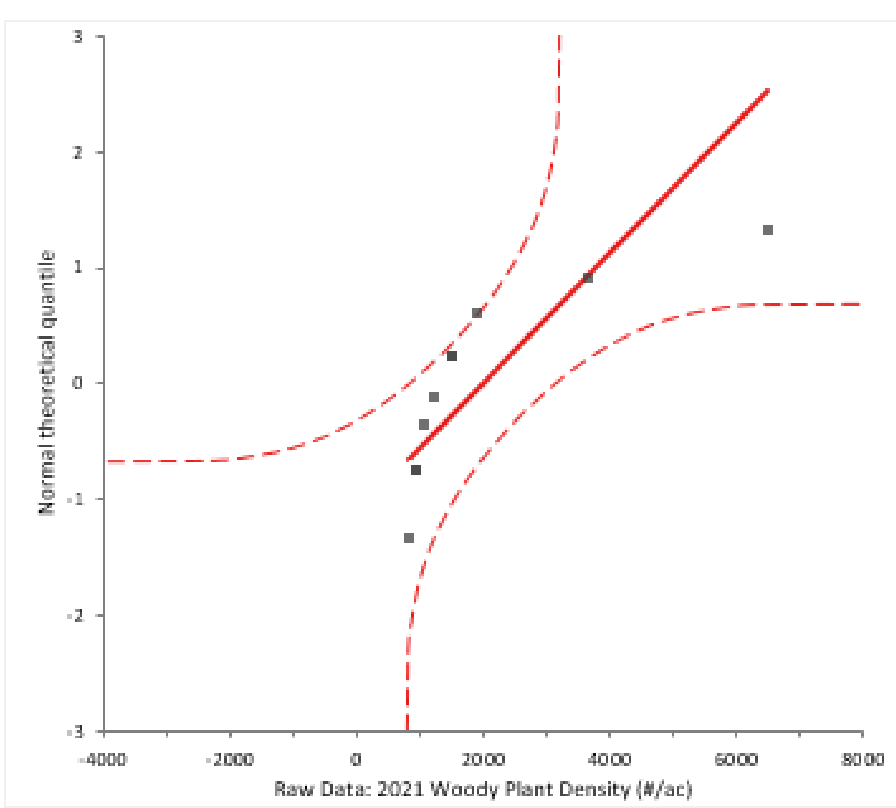


N	10

	Mean	90% CI		Mean SE	SD	Skewness	Kurtosis
Raw Data: 2021 Woody Plant Density (#/ac)	1996.4509	967.08094	to	561.54205	1775.7519	2.2	4.78

	1st quartile	Median	3rd quartile
Raw Data: 2021 Woody Plant Density (#/ac)	944.26733	1348.9533	2034.6713

Normality



Shapiro-Wilk test

W statistic	0.68
p-value	0.0005

H0: F(Y) = N(μ, σ)
The distribution of the population is normal with unspecified mean and standard deviation.
H1: F(Y) ≠ N(μ, σ)
The distribution of the population is not normal.
[1] Reject the null hypothesis in favour of the alternative hypothesis at the 10% significance level.

Figure C-6: Distribution: Transformed Data: Log WPD

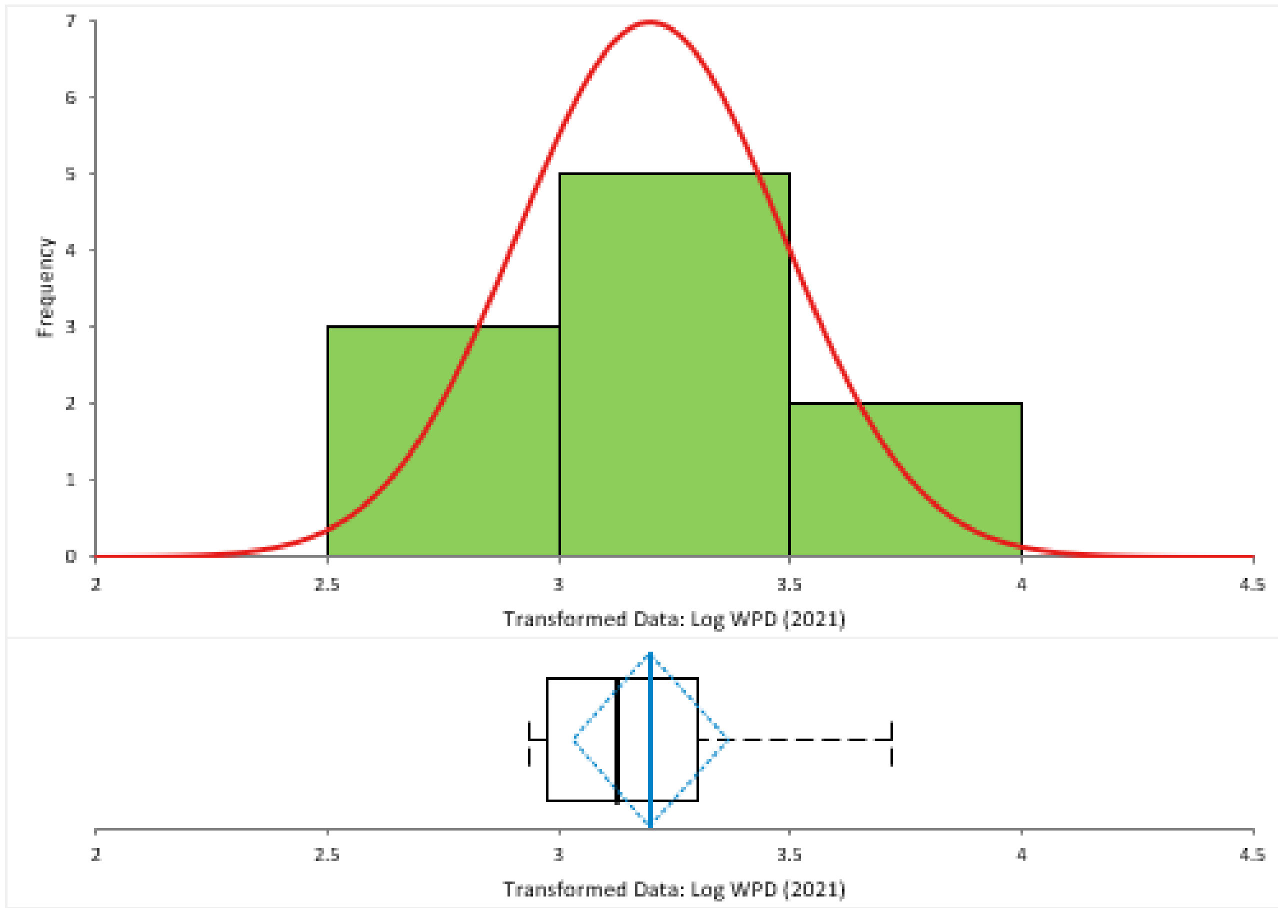
Analyse-it v5.68

Table C-2: M-VMU-4 2021 Data for Normal Distribution and Variance Analysis

Filter: No filter

Last updated 24 February 2022 at 15:58 by Buchanan, Nicholas

Descriptives

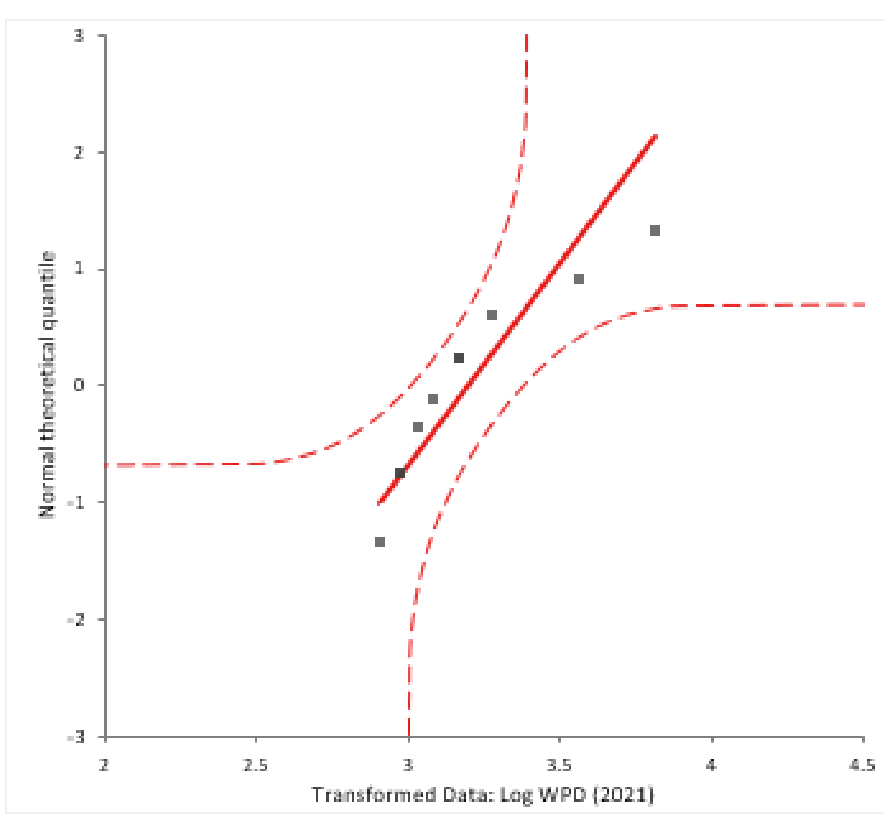


	N
	10

	Mean	90% CI	Mean SE	SD	Skewness	Kurtosis
Transformed Data: Log WPD (2021)	3.197	3.031 to 3.363	0.0906	0.286	1.4	1.26

	1st quartile	Median	3rd quartile
Transformed Data: Log WPD (2021)	2.976	3.128	3.300

Normality



Shapiro-Wilk test

W statistic	0.86
p-value	0.0706[1]

H0: F(Y) = N(μ, σ)
The distribution of the population is normal with unspecified mean and standard deviation.
H1: F(Y) ≠ N(μ, σ)
The distribution of the population is not normal.
[1] Reject the null hypothesis in favour of the alternative hypothesis at the 10% significance level.

Table C-1: Equations for Vegetation Data Analysis

Attribute	Equation	Where
Sample Size / Count	$n = \sum samples$	n = number of samples $\sum$ = sum
Mean	$\bar{x} = \frac{\sum x}{n}$	$\bar{x}$ = sample mean $\sum$x = sum of values for variable n = number of samples
Standard Deviation	$s = \sqrt{\frac{\sum(\bar{x}-x)^2}{n-1}}$	s = standard deviation $\sum$ = sum $\bar{x}$ = sample mean n = number of samples
Variance	$s^2 = \frac{\sum (x_i - \bar{x})^2}{n-1}$	s^2 = variance $\sum$ = sum x_i = Value of variable for sample *i* $\bar{x}$ = sample mean n = number of samples
t-distribution	t = 1-α, v	t = two tailed t-distribution value based on a 90% level of confidence with n-1 degrees of freedom α = significance level (0.10) v = degrees of freedom (n-1)
90% Confidence Interval	$\bar{x} \pm t\frac{s}{\sqrt{n}}$	$\bar{x}$ = sample mean t = two tailed t-distribution value based on a 90% level of confidence with n-1 degrees of freedom s = standard deviation n = number of samples
N_{min} (Sample Adequacy - Normal Data)	$N_{min} = \frac{t^2 s^2}{(\bar{x}D)^2}$	N_{min} = number of samples required t = two tailed t-distribution value based on a 90% level of confidence with n-1 degrees of freedom s = standard deviation (s^2 = variance) $\bar{x}$ = sample mean D = the desired level of accuracy, which is 10 percent of the mean
Probability of True Mean	$T = 1 - t\left(\frac{\sqrt{n(0.1xs)'^2}}{\bar{x}, 2, n, 1}\right)$	T = Probability the true value of the mean is within 10 percent of the mean for the sample size t = two tailed t-distribution value based on a 90% level of confidence with n-1 degrees of freedom n = number of samples s = standard deviation $\bar{x}$ = sample mean
one-sample, one-sided t test Method 3 (CMRP)	$t^* = \frac{\bar{x} - 0.9\,(technical\ std)}{s/\sqrt{n}}$	t* = calculated t-statistic $\bar{x}$ = sample mean s = standard deviation n = sample size
one-sample, one-sided sign test Method 5 (CMRP)	$z = \frac{(k+0.5)-0.5n}{0.5\sqrt{n}}$	z = sign test statistic k = test statistic resulting from the number of values falling below 90% of the technical standard n = sample size
Relative Cover	$R_{cvr} = Cvr_{sp.}/Cvr_{Abs.}$	R_{cvr} = Calculated Relative Cover for a Species $Cvr_{sp.}$ = Mean Absolute Cover of a Perennial/Biennial Species $Cvr_{abs.}$ = Mean Absolute Perennial/Biennial Cover
Logarithmic Transformation	Y' = log(Y + k)	log = logarithmic function Y = attribute value k = constant, here we use 1

Notes: Snedecor, G.W. and W.G. Cochran. 1967. Statistical methods applied to experiments in agriculture and biology. 6th ed. Ames, Iowa: Iowa State University Press.

Table C-2: M-VMU-4 2021 Data for Normal Distribution and Variance Analysis

Plot	Transect	Quadrat	Raw Data			Transformed Data		
			2021 Perennial / Biennial Cover (%)	2021 Annual Forage Production (lbs/ac)	2021 Woody Plant Density (#/ac)	Log P/B Cover (2021)	Log AFP (2021)	Log WPD (2021)
M-VMU-1	M-VMU-1-T01P	1	0.0	0	809	0.00	0.00	2.91
		2	1.0	16.18		0.30	1.23	
		3	data corrupted	data corrupted		data corrupted	data corrupted	
		4	0.0	0		0.00	0.00	
	M-VMU-1-T02P	1	0.0	0	944	0.00	0.00	2.98
		2	13.8	89		1.17	1.95	
		3	24.0	208		1.40	2.32	
		4	86.0	595		1.94	2.77	
	M-VMU-1-T03P	1	21.0	832	1,484	1.34	2.92	3.17
		2	14.0	207		1.18	2.32	
		3	28.0	38		1.46	1.60	
		4	24.0	259		1.40	2.41	
	M-VMU-1-T04P	1	10.5	107	3,642	1.06	2.03	3.56
		2	8.5	213		0.98	2.33	
		3	27.0	535		1.45	2.73	
		4	36.0	1700		1.57	3.23	
	M-VMU-1-T05P	1	32.0	655	1,214	1.52	2.82	3.08
		2	5.5	108		0.81	2.04	
		3	22.0	92		1.36	1.97	
		4	3.0	49		0.60	1.70	
	M-VMU-1-T06P	1	10.8	100	1,889	1.07	2.00	3.28
		2	9.0	189		1.00	2.28	
		3	38.0	97		1.59	1.99	
		4	55.0	668		1.75	2.83	
	M-VMU-1-T07P	1	44.9	916	1,484	1.66	2.96	3.17
		2	30.0	380		1.49	2.58	
		3	0.0	0		0.00	0.00	
		4	100.0	849		2.00	2.93	
	M-VMU-1-T08P	1	0.5	10	944	0.18	1.05	2.98
		2	40.0	111		1.61	2.05	
		3	20.5	236		1.33	2.37	
		4	25.0	88		1.41	1.95	
	M-VMU-1-T09P	1	3.4	106	6,475	0.64	2.03	3.81
		2	7.5	179		0.93	2.25	
		3	37.0	156		1.58	2.20	
		4	1.5	13		0.40	1.15	
	M-VMU-1-T10P	1	17.0	339	1,079	1.26	2.53	3.03
		2	38.5	1010		1.60	3.00	
		3	8.5	299		0.98	2.48	
		4	0.0	0		0.00	0.00	
Mean			21.6	294	1996	1.09	1.97	3.22
Standard Deviation			22.5	367	1776	0.59	0.88	0.30
Count			39	39	10	35	35	9
Variance			505.1	134371	3153295	0.34	0.77	0.09
90% Confidence Interval			5.9	97	924	0.16	0.24	0.16

Notes:
2021 Perennial / Biennial Cover (%) Data from Appendix A, Table A-1
2021 Annual Forage Production (lbs/ac) Data from Appendix A, Table A-4 2021 Woody Plant Density (#/ac) Data is derived from Appendix A, Table A-5

Table C-3: 2020 Perennial/ Biennial Canopy Cover, Method 5 - CMRP

Transect	Quadrat	2021 Perennial / Biennial Cover (%)	90% of Technical Standard	P/B CVR minus TS
M-VMU-1-T01P	1	0.0	13.5	-13.5
	2	1.0	13.5	-12.5
	3			
	4	0.0	13.5	-13.5
M-VMU-1-T02P	1	0.0	13.5	-13.5
	2	13.8	13.5	0.3
	3	24.0	13.5	10.5
	4	86.0	13.5	72.5
M-VMU-1-T03P	1	21.0	13.5	7.5
	2	14.0	13.5	0.5
	3	28.0	13.5	14.5
	4	24.0	13.5	10.5
M-VMU-1-T04P	1	10.5	13.5	-3.0
	2	8.5	13.5	-5.0
	3	27.0	13.5	13.5
	4	36.0	13.5	22.5
M-VMU-1-T05P	1	32.0	13.5	18.5
	2	5.5	13.5	-8.1
	3	22.0	13.5	8.5
	4	3.0	13.5	-10.5
M-VMU-1-T06P	1	10.8	13.5	-2.8
	2	9.0	13.5	-4.5
	3	38.0	13.5	24.5
	4	55.0	13.5	41.5
M-VMU-1-T07P	1	44.9	13.5	31.4
	2	30.0	13.5	16.5
	3	0.0	13.5	-13.5
	4	100.0	13.5	86.5
M-VMU-1-T08P	1	0.5	13.5	-13.0
	2	40.0	13.5	26.5
	3	20.5	13.5	7.0
	4	25.0	13.5	11.5
M-VMU-1-T09P	1	3.4	13.5	-10.2
	2	7.5	13.5	-6.0
	3	37.0	13.5	23.5
	4	1.5	13.5	-12.0
M-VMU-1-T10P	1	17.0	13.5	3.5
	2	38.5	13.5	25.0
	3	8.5	13.5	-5.0
	4	0.0	13.5	-13.5
			k	17
			n	39
			z	-0.64
			Standard one-tailed normal curve area (Table C-3; MMD, 1999)	0.2389
			P	0.2611

Notes:
P/B CVR = Perennial/Biennial Cover
TS = 90% of the Technical Standard for Perennial/Biennial Cover
P = 0.5-Area = prob of observing z; <=0.1 performance standard met
z value calculation:

$$z = \frac{(k+0.5)-0.5n}{0.5\sqrt{n}}$$

Table C-4: 2020 Annual Forage Production, Method 5 - CMRP

Transect	Quadrat	2021 Annual Forage Production (lbs/ac)	90% of Technical Standard	FP minus TS
M-VMU-1-T01P	1	0.0	315	-315.0
	2	16.2	315	-298.8
	3			
	4	0.0	315	-315.0
M-VMU-1-T02P	1	0.0	315	-315.0
	2	88.7	315	-226.3
	3	207.9	315	-107.1
	4	594.5	315	279.5
M-VMU-1-T03P	1	831.9	315	516.9
	2	207.5	315	-107.5
	3	38.4	315	-276.6
	4	258.8	315	-56.2
M-VMU-1-T04P	1	106.6	315	-208.4
	2	213.3	315	-101.7
	3	535.0	315	220.0
	4	1700.1	315	1385.1
M-VMU-1-T05P	1	654.8	315	339.8
	2	107.9	315	-207.1
	3	91.6	315	-223.4
	4	48.7	315	-266.3
M-VMU-1-T06P	1	99.8	315	-215.2
	2	188.8	315	-126.2
	3	97.2	315	-217.8
	4	668.0	315	353.0
M-VMU-1-T07P	1	916.0	315	601.0
	2	379.8	315	64.8
	3	0.0	315	-315.0
	4	848.8	315	533.8
M-VMU-1-T08P	1	10.3	315	-304.7
	2	111.1	315	-203.9
	3	235.8	315	-79.2
	4	87.6	315	-227.4
M-VMU-1-T09P	1	105.6	315	-209.4
	2	178.7	315	-136.3
	3	156.5	315	-158.5
	4	13.1	315	-301.9
M-VMU-1-T10P	1	339.3	315	24.3
	2	1010.0	315	695.0
	3	299.5	315	-15.5
	4	0.0	315	-315.0
			k	28
			n	39
			z	*2.88*
			Standard one-tailed normal curve area (Table C-3; MMD, 1999)	0.4980
			P	0.0020

Notes:
FP = Forage Production
TS = 90% of the Technical Standard for Annual Forage Production
P = 0.5-Area = prob of observing z; <=0.1 performance standard met
When k exceeds 50% of n-observations, the performance standard has not been met
z value calculation:

$$z = \frac{(k+0.5)-0.5n}{0.5\sqrt{n}}$$

Table C-5: Shrub Density by the Belt Transect Method, Method 5 - CMRP

Transect	Quadrat	2021 Woody Plant Density (#/ac)	90% of Technical Standard	WPD minus TS
M-VMU-1-T01P	1	809.4	135	674.4
	2			
	3			
	4			
M-VMU-1-T02P	1	944.3	135	809.3
	2			
	3			
	4			
M-VMU-1-T03P	1	1483.8	135	1348.8
	2			
	3			
	4			
M-VMU-1-T04P	1	3642.2	135	3507.2
	2			
	3			
	4			
M-VMU-1-T05P	1	1214.1	135	1079.1
	2			
	3			
	4			
M-VMU-1-T06P	1	1888.5	135	1753.5
	2			
	3			
	4			
M-VMU-1-T07P	1	1483.8	135	1348.8
	2			
	3			
	4			
M-VMU-1-T08P	1	944.3	135	809.3
	2			
	3			
	4			
M-VMU-1-T09P	1	6475.0	135	6340.0
	2			
	3			
	4			
M-VMU-1-T10P	1	1079.2	135	944.2
	2			
	3			
	4			
			k	0
			n	10
			z	-2.85
Standard one-tailed normal curve area (Table C-3; MMD, 1999)				0.4978
			P	0.0022

Notes:
FP = Forage Production
TS = 90% of the Technical Standard for Annual Forage Production
P = 0.5-Area = prob of observing z; <=0.1 performance standard met
z value calculation:

$$z = \frac{(k+0.5)-0.5n}{0.5\sqrt{n}}$$

GOLDER
MEMBER OF WSP

golder.com

Appendix 9: Area 9 South, Bond Release Application, Groundwater and Surface Water Evaluation

AREA 9 SOUTH

BOND RELEASE APPLICATION

GROUNDWATER AND SURFACE WATER EVALUATION

CHEVRON MINING INC. – MCKINLEY MINE

NEAR GALLUP, NEW MEXICO

August 12, 2022

Project #: 476-014-011

SUBMITTED BY: Trihydro Corporation

1252 Commerce Drive, Laramie, WY 82070

SOLUTIONS YOU CAN COUNT ON.
PEOPLE YOU CAN TRUST.

Table of Contents

Table of Contents (cont.)

List of Tables

List of Figures

List of Appendices

1.0 INTRODUCTION

This report documents the surface water and groundwater assessment at the McKinley Mine (Mine), operated by Chevron Mining Inc., required for bond release. Portions of the McKinley Mine operate under the New Mexico Mining and Minerals Division (MMD) Permit No. 2016-02 and this report was prepared in accordance with MMD Permit 2016-02, Section 3.0, Baseline and Background Information as well as the New Mexico Administrative Code (NMAC) 19.8.14.1412 Requirement to Release Performance Bonds. Requirements for Probable Hydrologic Consequences (PHC) and the Cumulative Hydrologic Impact Assessment (CHIA) are provided in MMD Permit 2016-02, Section 3.0.

The Mine is located approximately 24 miles northwest of Gallup, New Mexico. The mine began operations in the early 1960s and ceased operations in 2009. Since that time, the Mine has been in various phases of reclamation including grading to post-mine topography, placement of topsoil, and revegetation. A portion of the Mine, identified as Area 9 South, is now eligible for bond release. Trihydro Corporation (Trihydro) began collecting and managing water quality and quantity data starting in October 2012. This report provides an evaluation of water data from 2013 through 2021 because data during this time period are representative of post-mining conditions and are the most complete dataset available.

This report includes information for surface and groundwater to support bond release including:

- A map with surface water monitoring stations and long-term groundwater monitoring wells. The map also shows National Pollutant Discharge Elimination System (NPDES) Permit No. NN0029386 outfalls affiliated with the proposed bond-release area and other nearby areas.
- Long-term groundwater and surface water monitoring data with comparison to baseline information, effluent standards and the approved probable hydrologic consequences (PHC) determination.

A summary of the hydrologic setting and protection requirements for the Mine are included in this report as Section 2.0. A summary of available impoundment water quality is presented in Section 3.0. Sections 4.0 and 5.0 review the long-term chemical and physical characteristics of Defiance Draw and its tributary that runs through the mine and the groundwater wells, respectively.

2.0 HYDROLOGIC SETTING AND PROTECTION

2.1 GEOLOGIC SETTING AND CLIMATE

The Mine is located in the southwest corner of the San Juan Basin in a structural sub-basin known as the Gallup Sag. The San Juan Basin, which is roughly circular in shape, occupies much of northwestern New Mexico, a narrow strip of northeastern Arizona, and a small portion of southwestern Colorado. The basin is bordered on the north by the San Juan Mountains, on the east by the Nacimiento Uplift, on the south by several uplifts including the Lucero Uplift and Zuni Uplift, and on the west by the Defiance Monocline, which separates it from the Black Mesa Basin.

The sedimentary rocks in the San Juan Basin are predominantly of Mesozoic age with some Tertiary rocks outcropping in the central basin and some Paleozoic and Pre-Cambrian rocks upturned along the basin margins. The sediments increase in thickness toward the basin's center. The geology in the vicinity of Gallup and McKinley County is comprised of Middle to Upper Jurassic (175-145 million years old) and Quaternary (less than 1-million years old) rocks. Older rocks, the Triassic River deposits of the Chinle Group, are exposed in the plains to the south and Cretaceous rocks form the high ridges. The rock formations include sandstone, shale, limestone, coal, and mudstone.

The San Juan Basin is characterized by low surface relief. Most of the basin is a relatively featureless plain with wide shallow valleys and some low mesas and cuestas. Elevations in the area range from 5,000 ft amsl in the north to 7,000 ft amsl in the south. A prominent north-south trending range, the Chuska Mountains, occurs along the western part of the basin with elevations exceeding 9,500 ft amsl. The Mt. Taylor volcanic area, with elevations up to 10,000 ft amsl, occurs within the southeast corner of the basin. The margins of the basin are characterized by hogback ridges, which are associated with the tectonic uplifts defining the basin boundaries.

The majority of the Mine is located in the Puerco River Drainage Basin with a small portion of the mine located in the San Juan River Drainage. The main drainages or watersheds in the mine are the headwaters of Defiance Draw (DD) and its tributary, Defiance Draw Tributary (DDT), Tse Bonita Wash (TBW), Coal Mine Wash (CMW) and its tributary, Coal Mine Wash Tributary (CMWT), and an unnamed tributary to Black Creek. A small portion of the mine lease area is in the headwaters of Deer Springs Wash and Black Springs Wash (both in the San Juan River Drainage Basin). Of the drainage basins listed above, DD is the largest drainage basin with an area of 27.5 square miles. TBW is the drainage basin that encompasses the highest percentage within the mine boundary at 35.0%.

As presented in Mine Permit No. 2016-02, Section 3.4, groundwater resources within the mine fall into three main types: alluvial, bedrock, and aquifer. Alluvial and bedrock groundwater resources are discontinuous, of poor physical and chemical quality, and of limited extent. The first major deep aquifer is the Gallup Sandstone Aquifer. The aquifer lies well below the zone of mining impact and is overlain by several impermeable shale members. Most recharge to the Gallup Sandstone comes from the Chuska Mountains to the northwest of the Mine. In addition to these three types, groundwater may also be found in spoil material above bedrock.

The Mine climate is semi-arid with an average annual precipitation of approximately 11 inches (in.) per year. More than half the annual precipitation typically falls during the months of July through October. Precipitation often occurs as rainfall from intense, localized thunderstorms that occur sporadically in the region. This can result in high suspended solids levels in the runoff. In addition, the soil chemistry and geomorphology contribute to the high levels of dissolved solids, salinity, and alkalinity. Within the general area of the mine, runoff due to precipitation events occurs in the form of surface runoff. Natural drainages or watersheds convey or temporarily store the runoff as it is routed to the Puerco River or San Juan River.

Precipitation data nearest to Area 9S are reported from the meteorological monitoring station at the mine, South Tipple, located northwest of the main 9 South area (Figure 2-1). Precipitation station Rain 9 (Figure 2-1) is located near the northern boundary of Area 9 South but only operates between late April and mid-November. Precipitation from the Rain 9 station was not used for this evaluation. It should be noted that the average precipitation during the Rain 9 operating period (April to November) was approximately 33% higher at the South Tipple station than the Rain 9 station during the reporting period. This difference was particularly evident in data from 2021 where approximately 120% more precipitation was recorded at the South Tipple station than the Rain 9 station. Some of the difference is likely due to partial operating months (April and November) at the Rain 9 station.

Table 2-1 provides the monthly and annual precipitation data from South Tipple and Rain 9 for the reporting period. Average monthly precipitation at the South Tipple station ranged from 0.32 in. in June to 2.03 in. in July during the 9-year evaluation period. On average, most of the precipitation is received between July and October. The month with the highest 1-month precipitation total was July 2021 with 5.45 in. Precipitation data are referenced throughout the report to help explain some of the observations presented for surface and groundwater stations.

2.2 HISTORICAL WATER QUALITY DATA

Groundwater resources within the mine include alluvial, bedrock, Gallup Sandstone Aquifer, and spoil.

Alluvial groundwater is present in some fill and low-lying soils at the Mine. Wells penetrating the alluvial groundwater are designed to monitor the quality and quantity of shallow groundwater in alluvial valley-fill sediments.

Valley-fill sediments in the Mine area serve as a reservoir for meteoric water to reside. Because the area is semi-arid and annual precipitation is limited, the presence of alluvial groundwater is generally dependent on rainfall and, to a lesser extent, snowfall quantities.

In 1980, five bedrock wells (MBR1, MBR2, MBR3, MBR4, and MBR5) were installed approximately 50-feet (ft) below the Green Coal Seam to monitor groundwater below this unit. The Green Coal Seam was the lower-most recoverable coal seam at the mine. These monitoring wells, referred to as McKinley bedrock wells, are located in and around the major drainage watersheds throughout the mine. Three of the original five wells (MBR1, MBR3, and MBR4) were mined through and not replaced. The active bedrock monitoring wells include MBR2 and MBR5. MBR5 is a well near the southwest corner of Area 9 South and most representative of the bond release area.

The original 1980 GAI baseline groundwater report concluded that bedrock wells had little potential as a meaningful groundwater resource. The transmissivity of the bedrock deposits was less than 6 square feet per day (ft^2/day) and not capable of maintaining a sustained yield of 1 gallon per minute (gpm). Even though groundwater was present, none of the strata had sufficient continuity to be considered an aquifer. The findings from the 1980 GAI report and the discussions below indicate that minimal impacts to the quality and quantity of this resource by mining and reclamation operations have occurred.

Five water wells (1, 2, 3, 3A, and 4) have been completed in the Gallup Sandstone Aquifer throughout the Mine area. These wells were used as primary water sources for mine activities and reclamation. The wells now provide domestic water, dust-control water, or are only monitored. Because of the impermeability of the shale units overlying the Gallup Sandstone Aquifer and the geologic structure in the area, the Gallup Sandstone Aquifer can be under artesian conditions. Moreover, due to the presence of the overlying shales, there is no hydraulic connection between the underlying Gallup Sandstone and the mined strata. Well No. 1 is the closest to the bond release area.

Five spoil recharge wells (2G2, 4A, 9A, 9S, and 11) were constructed in the Mine area. Two spoil wells (4A and 9A on NMMMD lands) were installed in 1990; of these two wells, only 9A remains. Well 4A was not monitored after 2015 following approval by MMD to discontinue monitoring this well because the land at the well location had a full bond and liability release. Well 4A was abandoned October 29, 2018. In April 2013, three additional spoil recharge wells were constructed and designated as wells 2G2 (on OSM lands), 11, and 9S (on MMD lands). Spoil recharge wells were installed throughout the mine in reclaimed areas to determine chemical presence and groundwater properties. These wells were terminated at bedrock and their screens encompassed the spoil interval immediately above bedrock. Spoil wells 9A and 9S are near Area 9 South; to date, however, only Well 11, north of Highway 264, has contained sufficient groundwater for sampling.

Groundwater monitoring is required by MMD Permit Number 2016-02 and OSM Permit Number NM-0001K to be reported quarterly. The Mine began operations in the early 1960s, before the passage of the Surface Mine Control and Reclamation Act and other regulations governing coal mining on Indian lands. At that time, baseline surface and groundwater quality and quantity data were not required before mining. As a result, comparisons cannot be made with pre-mining watershed conditions of the Mine as a single unit. However, the 1980 GAI report, which was incorporated into the Mine permits, provides surface and groundwater quality and quantity data that can be referenced for evaluating trends since that time. There are no baseline groundwater data applicable to the Mine site.

Surface water has been monitored since the early 1980s through active and passive surface water monitoring stations, although the number and locations of stations have evolved over time. The currently monitored active surface water stations are located in and around the major drainage watersheds throughout the Mine and include the DD, TBW, DDT6, CMW, and CMWT watersheds. Station CMW is used to monitor flow and water quality from a relatively undisturbed drainage; the data are used as background information and to contrast against other station data from disturbed watersheds.

2.3 APPLICABLE PROTECTION STANDARDS

2.3.1 SURFACE WATER COMPARISON

Stormwater runoff from the Mine drains through impoundments and/or hydraulic control structures before discharging into Defiance Draw, a tributary to the Puerco River segment from the Arizona border to the Gallup wastewater treatment plant in McKinley County. Per the Mine Permit, surface water in Area 9 South is monitored at the DD and DDT6 monitoring stations. Data collected from the disturbed stations are compared to data collected at the undisturbed CMW station, which are considered background data. The comparison is used to determine impacts from mining activities.

2.3.2 NPDES REQUIREMENTS

The Mine operates under NPDES Permit No. NN0029386 which was last renewed July 1, 2017. A renewal application was submitted to the United States Environmental Protection Agency (USEPA) on December 27, 2021, and the Mine is currently operating under the current permit pending approval of the renewal application. As required under NPDES Permit No. NN0029386, the Mine submitted an updated Sediment Control Plan on September 5, 2017 and is currently awaiting approval. Until then, the Mine is operating under the current Sediment Control Plan dated March 15, 2013. All watersheds within the mine are classified as Western Alkaline, and in accordance with NPDES Permit No. NN0029386, reclamation inspections are conducted quarterly within the drainage basins associated with the Sediment Control Plan and inspection findings are summarized in quarterly reports. Additionally, discharge sampling is conducted at NPDES outfalls. There are several watersheds and NPDES outfalls located within Area 9 South. Outfalls are shown on Figure 2-1. The Mine will continue conducting quarterly reclamation inspections and sampling discharge through final bond release.

2.3.3 GROUNDWATER PROTECTION STANDARDS

The NMAC provides groundwater standards to protect all groundwater of the State of New Mexico which has an existing total dissolved solids (TDS) concentration of 10,000 mg/l or less, for present and potential future use as domestic and agricultural water supply (NMAC 20.6.2.3103).

Groundwater standards are numbers that represent the pH range and maximum concentrations of water contaminants in the groundwater which still allow for the present and future use of ground water resources. Quantitative criteria for these groundwater sources that correspond with available data from the Mine are listed below (NMAC 20.6.2.3103).

Analyte	Upper Limit (unless otherwise indicated)
pH	6.0-9.0 s.u.
Fluoride	1.6 mg/L
Nitrate as N	10 mg/L
Nitrite as N	1 mg/L
Selenium	0.05 mg/L
Chloride	250 mg/L
Iron	1 mg/L
Manganese	0.2 mg/L
Sulfate	600 mg/L
TDS	1000 mg/L
Zinc	10 mg/L

Criteria listed for chloride, iron, manganese, sulfate, TDS, zinc, and pH represent the maximum concentration for domestic water supply.

2.4 PROTECTION OF HYDROLOGICAL BALANCE

The Mine permit includes preventative and remedial measures for any potential adverse hydrologic consequences identified in the Probable Hydrologic Consequences (PHC) determination. The Permit includes sections on the PHC determination, groundwater and surface water monitoring plans, general plans to address possible hydrologic consequences, and a Cumulative Hydrologic Impact Assessment (CHIA), as provided by the MMD/OSM. Related permit sections are summarized below. A copy of the active and approved permit Section 3.4.4 is provided as Appendix A.

2.4.1 PHC DETERMINATION

The current and approved PHC determination is provided in Permit No. 2016-02, Section 3.4.4 of Appendix C-1. The PHC first reviews the possible impacts of the impoundments on other surface waters, which are reviewed here for the purposes of a PHC update, but there are no impoundments in Area 9S. Assumptions for and analysis of runoff to the impoundments and consumptive losses from the impoundments are provided. The impoundments have no negative impacts on regional water quantity and should enhance local property use for livestock and wildlife. The PHC also acknowledges and evaluates the possible impact from impoundment stormwater discharge on downstream water chemistry. Review of available data indicated identifiable impact as related to pre- and post-mine monitoring stations along Defiance Draw and its tributaries. Lastly, the PHC considers the possible impacts of the groundwater, located in the alluvial, bedrock, and Gallup Sandstone Aquifer. This last item will be further discussed in report Section 5.5.3.

2.4.1.1 SURFACE WATER QUANTITY

Surface water quantity may be increased on the reclaimed areas through the construction of small depressions and impoundments, which is discussed further in Section 3.0. These impoundments will be used to provide water for livestock and wildlife and to create small riparian habitats for small mammals, birds and reptiles. Small depressions, but no impoundments, occur in the Area 9 South bond release area. The amount of postmining runoff as compared to the pre-mining runoff to the Puerco River drainage will be minimally diminished by the harvesting of the water in the impoundments and other riparian areas. This reduction of runoff is supported by the hydrologic model included in the Baseline/Background – Hydrologic Information Volume (BBHIV) of the permit application. However, the impact on the Puerco River drainage will be negligible due to the small percentage of the drainage area that the Mine comprises.

2.4.1.2 SURFACE WATER QUALITY

For a short time following reclamation of an area there may be a slight increase in the levels of total dissolved solids, sulfates, and other soluble elements in the overburden. This increase will eventually lessen as the runoff leaches the overburden. This potential slight increase will be documented by the collection and analysis of surface water runoff during the permit term as described in Section 6.3. The long-term surface water PHC is described below.

Surface water physical quality will be improved through the stabilization of the reclamation areas and the construction of small depressions and impoundments. These actions will result in lower suspended solids and total settleable solids in the runoff from the disturbed areas. This is supported by the hydrologic models presented in the BBHIV of the

Permit. The models show that the per-acre sediment yields from the mining and postmining areas will be less than the pre-mining areas.

The Mine has been reclaimed with soils that meet suitability criteria that promote plant establishment. These soils, in combination with vegetation, would be expected to result in runoff with better effluent quality with regard to levels of dissolved solids, salinity, and alkalinity.

2.4.1.3 GROUNDWATER QUANTITY

2.4.1.3.1 GALLUP SANDSTONE AQUIFER

As discussed above, the Gallup Sandstone Aquifer is used as the primary source of water for the Mine and for the McKinley County area. This aquifer occurs 400 to 1,000 feet below the lowest coal seam to be recovered and has no local recharge features. The recharge area for this aquifer is located to the north of Mine in the Chuska Mountains. As noted in the Technical Analyses and Environmental Assessment performed by the OSMRE on Permit No. NM- 0001 B/3-1 OP, and adopted by the director of MMD, there may be a small amount of draw down due to usage associated with coal mining activities, but this draw down is insignificant in comparison to the City of Gallup and Navajo Nation consumption impacts.

The Permit contains information on the potentiometric surface of the Gallup Sandstone Aquifer.

2.4.1.3.2 ALLUVIAL AQUIFERS

As discussed above, the alluvial water is practically nonexistent, occurring generally in close proximity to the arroyos, and in direct relation to the rate and amount of runoff in the arroyo. This water soaks into the sides and bottoms of the arroyos during runoff events. This type of recharge occurs principally during snowmelt and the summer runoff season. The only instance where this type of groundwater will be affected by the mining operations, is where alluvial areas are actually mined. The hydrologic impact on this groundwater source will be complete removal of the resource when encountered during mining. However, due to the limited areal extent of the resource, any impacts would be considered negligible.

2.4.1.3.3 BEDROCK AQUIFERS

As discussed above, the bedrock water quantity is minimal in extent, consisting only as small pockets of perched water in the various stratums being excavated in the mining process. The quantity and areal extent of these pockets of water are not of sufficient quantity or quality to be considered usable. This water is normally observed as seepage from the highwall or small amounts of water on the pit floor. The mining operation results in removal of this insignificant groundwater source.

2.4.1.4 GROUNDWATER QUALITY

Gallup Sandstone Aquifer

As is noted above in the discussions on groundwater quantity, there will be no impact by mining on the recharge zones of the Gallup Sandstone Aquifer. Due to this, there will also be no impact on the quality of the Gallup Sandstone Aquifer by the mining operations.

Alluvial Aquifers

The alluvial water quality, in undisturbed areas, will continue to be influenced primarily by the amount of runoff in the arroyos and characteristics of the soils in the area of infiltration. There will be minimal impacts on the quality of this resource by the mining operations.

Bedrock Aquifers

The bedrock water encountered during mining will be removed in the mining process. This removal will have no effect on the water present in areas not affected by mining. This is due to the low transmissivity associated with this type of water.

2.4.2 SURFACE AND GROUNDWATER MONITORING PLANS

Per Section 6.3.2.1 of the Permit, surface-water monitoring is conducted at five stations in the DD, TBW, DDT6, CMW, and CMWT watersheds at the mine. Groundwater monitoring is conducted from the following sources: alluvial groundwater, bedrock groundwater, Gallup Sandstone Aquifer, and spoil recharge groundwater. Sample analytes required by the permit include alkalinity, bicarbonate, boron, calcium, carbonate, chloride, fluoride, iron, magnesium, manganese, field pH, nitrate, phosphate, phosphorous, potassium, selenium, sodium, sulfate, total dissolved solids, total suspended solids, and zinc. The exact analyte list is water-source dependent.

2.4.3 CUMULATIVE HYDROLOGIC IMPACT ASSESSMENT (CHIA)

A Cumulative Hydrologic Impact Assessment (CHIA) was prepared by the OSM/MMD in 1995 for the Mine. The following summarizes possible surface and groundwater impacts/material damages concluded by the CHIA:

- Surface water use in the area is primarily stock watering with some irrigation. There are no permitted water rights holders downstream of the mining operation in the cumulative impact area. Indicator parameters related to hydrologic concerns in the basin are TDS and TSS concentrations.
- Cumulative impacts to the quantity of the flow in the Puerco River are insignificant.
- Cumulative impacts to the quality (TDS and TSS) of flows in the Puerco River are minimal and should not cause significant changes in baseline conditions. No material damage to the hydrologic balance is expected.
- Groundwater is an important source of water in the Gallup area. The major groundwater pumping centers are at the Santa Fe and Yah-ta-hey well fields, both completed in the Gallup Sandstone Aquifer and operated by the city of Gallup. Other users of the Gallup Sandstone Aquifer include the McKinley and Mentmore mines northwest of Gallup. Shallow groundwater is not widely used owing to the relatively poor quality and small well yields.
- Cumulative impacts related to groundwater quality are not expected. Groundwater quality in terms of TDS and sulfate has not been demonstrated to change significantly and the poor physical properties of the near-surface deposits are not greatly altered by mining.
- Groundwater quantity in the Gallup Sandstone Aquifer may be affected by the cumulative impacts of mining, particularly if declared water rights are fully used by the Mine. Calculations of water-level drawdowns indicate that the Yah-ta-hey well field could experience up to 3 feet of drawdown attributable to mining activities; this does not constitute material damage. No material damage, based upon a criterion of a decline of 25% of available head, is predicted as a result of surface coal mining.

3.0 IMPOUNDMENT WATER MONITORING SUMMARY

3.1 INTRODUCTION

There are no permanent impoundments in Area 9 South. However, small depressions were built in accordance with 19.8.20.2055 C. These structures provide opportunistic water for livestock and wildlife and add diversity to the vegetation. Because of their small size, no water monitoring was required. Since they are small (less than one acre-ft), there would be minimal impact from small depressions to the water quantity leaving the mine. The small depressions do not pose any additional impacts to the PHC assessment in the Permit.

There are six permanent impoundments located in the Area 9 South vicinity as shown on Figure 2. No permanent impoundments are located within Area 9 South itself. Discussion follows regarding these impoundments to expand upon the overall hydrologic balance in the greater Area 9. Impoundments within the vicinity of Area 9 South include 6S, 7S, 9-15, 9-19A, 9-30, and 9-33. These impoundments were built as sediment ponds to store stormwater runoff from disturbed areas within the Defiance Draw watershed. As discussed in Section 2.3.2 above, discharge data have already been reviewed and assessed and are not included in the following discussion.

3.1.1 IMPOUNDMENT DATA

Of the six permanent impoundments listed above, only 6S and 9-33 have consistently held water. Impounded water in 6S generally originates from groundwater pumped from Well No. 1 into the impoundment. This water is used for reclamation and construction purposes (e.g., dust suppression, soil moisture conditioning). Impoundment 9-33 was not sampled during the reporting period. Therefore, the following section does not include water-quality data from the impoundments or a comparison to baseline water quality and regulatory standards. A discussion regarding the PHC is provided in Section 3.2.3.

3.2 ASSESSMENT OF IMPOUNDMENT DATA

Since the impoundments have not been sampled during the reporting period, there is no water quality data and discharge data for comparison to baseline water quality, regulatory standards, and the approved PHC, as described in Section 2.0.

3.2.1 COMPARISON TO BASELINE WATER QUALITY

Since there is no impoundment water quality data during the reporting period a comparison to baseline water quality data is not included in this discussion.

3.2.2 COMPARISON TO REGULATORY STANDARDS

The impoundments are not subject to regulatory standards, and as such, are not included within this discussion.

3.2.3 COMPARISON TO PROBABLE HYDROLOGIC CONSEQUENCES

The PHC indicates that runoff to the affected segment of the Puerco River may be minimally diminished due to the harvesting of water in the impoundments and other riparian areas. Given that most of the impoundments in Area 9 South vicinity rarely hold water, the impact to the amount of runoff to the Puerco River is likely negligible as most of the water would not have reached the river, even in the absence of the impoundments. The PHC also acknowledges discharge as having a possible short-term consequence on downstream physical water quality. However, there is no water quality data for this comparison.

4.0 LONG-TERM MONITORING, DEFIANCE DRAW

Area 9 South is located in the Puerco River Drainage Basin, with possible influence on DD and DDT6. DD and DDT6 are ephemeral streams and only carry water following storm events. Two stream discharge locations, one on DD and one on DDT6, are shown on Figure 2. In addition to discharge, stream samples are analyzed for alkalinity, bicarbonate, carbonate, conductance, total and dissolved iron, manganese, field pH, selenium, settleable solids, TDS, TSS. Station CMW is used to monitor flow and water quality from a relatively undisturbed drainage; the data are used as background information and to contrast against other station data from disturbed watersheds.

Automated sampling and recording (gauging) stations are located at the three Mine-area watersheds identified above. The data logger records stream stage, ISCO status, and battery data at 15-minute intervals. When the conductivity sensor becomes submerged by stream flow in the channel, the data logger records the discharge event and triggers the ISCO automated water sampler. Automated sample collection begins 1 minute after the onset of a significant flow event. Storm-water samples from each event are composited and submitted for analyses.

The ISCO samplers are nonoperational below 32 degrees Fahrenheit (°F). Therefore, the samplers are shut down and removed from service between approximately November 15^{th} and April 30^{th}. This annual shutdown minimizes equipment damage during a period that does not typically yield significant runoff.

A summary of data for the DD, DDT6, and CMW is provided below followed by a comparison of results to the disturbed and undisturbed watersheds and the PHC. Stream flow data for the three monitoring locations are presented in Table 4-1. Statistical analyses of water quality data for the three monitoring locations are presented in Table 4-2 with an assortment of temporal plots in Appendix B, including a plot with precipitation data over time.

4.1 SURFACE WATER DATA

4.1.1 DISCHARGE DATA

Table 4-1 presents cumulative annual discharge for the three monitoring locations along DD, DDT6, and CMW. The average annual discharge at DD, DDT6, and CMW during the reporting period was 89, 32, 140 acre-feet (ac-ft), respectively. The maximum annual discharge was 515 ac-ft from CMW in 2015.

4.1.2 STREAM WATER QUALITY DATA

Analytical data for the two stream monitoring locations along DD and DDT6 (Appendix B) are summarized below. Further discussion is then provided to highlight some of the observed geochemical trends.

4.1.2.1 DEFIANCE DRAW

A review of the analytical data and temporal plots for the reporting period associated with surface water monitoring location DD indicate that:

- Alkalinity is a useful parameter when discussing bicarbonate and carbonate, which are the two most important compounds that determine alkalinity. Alkalinity and bicarbonate have been generally stable since 2013 except for the apparent outlier value in 2020.
- Total calcium concentrations have fluctuated at DD during the reporting period.
- Carbonate concentrations have historically been reported at or near the laboratory detection limit or the limit of quantification and is an insignificant component of total alkalinity at the historical pH levels.
- The calculated cation/anion balance has varied during the reporting period. The increased cation/anion balance during these quarters is due to a general increase in many metals, and a decrease in some anions during this same timeframe.
- Chloride concentrations have been variable during the reporting period.
- Dissolved iron concentrations at DD spiked in the second quarter 2018 but have generally been stable since 2013.
- Total iron concentrations shown on the temporal plot in Appendix B exhibit a highly variable but generally neutral trend since 2013.
- Total magnesium concentrations as shown on the temporal plot in Appendix B have been highly variable but generally neutral during the reporting period.
- Consistent with other dissolved cations, the dissolved manganese concentration spiked in 2018 but then decreased in subsequent years.
- Total manganese values shown on the temporal plot in Appendix B fluctuate with a mostly neutral trend during the reporting period. Analytical results indicate that a greater amount of suspended manganese was present than dissolved manganese over most of the sample events except in 2019 when most of the manganese existed in the dissolved state.
- Total mercury concentrations were below or near the limit of quantification in 2017 and 2021 (sometimes raised due to sample matrix interference). Mercury concentrations increased to in second quarter 2018 but decreased in late 2018 and were similar in 2019 and 2020.
- Nitrate, expressed as nitrogen, concentrations are variable with a neutral trend over the reporting period.

- The pH levels as shown on the temporal plot in Appendix B have fluctuated between approximately 8 and 9 standard units during the reporting period with the highest levels occurring since 2018.
- Phosphate levels have fluctuated during the reporting period with a slightly decreasing trend.
- Total phosphorus concentrations show a slightly increasing trend with a small dip in 2021.
- Total potassium concentrations in DD are variable with a neutral trend over the reporting period.
- The sodium adsorption ratio at DD has been relatively stable over the reporting period with a slightly decreasing trend since 2017.
- Total selenium concentrations were reported below the laboratory limit of quantification.
- Total sodium concentrations at DD have varied widely with an overall decreasing trend during the reporting period.
- Sulfate concentrations have been relatively stable and slightly decreasing trend since 2017.
- Settleable solids concentrations at DD have been relatively stable with a slight decrease in 2021.
- Total dissolved solids concentrations have been relatively stable during the reporting period except for spikes in 2013, 2018, and 2021 as shown on the temporal plot in Appendix B.
- Total suspended solids concentrations fluctuate significantly from year-to-year but do not indicate a discernable trend. The majority of the cations found in surface water exist in the suspended phase relative to the dissolved phase.
- Note - precipitation gauged at the Mine is also displayed at the bottom of Appendix B.

Examination of the collective analytical trends discussed above indicates that water quality concentrations have varied significantly. Fluctuations in analyte concentrations are expected to vary to a greater degree in stormwater runoff relative to groundwater. Year-to-year concentrations of many analytes tend to rise and fall in a similar fashion, likely due to storm intensities during a particular quarter. Many analytes showed decreases in 2021, which may be a result of more frequent storm events compared to other years. However, most analytes do not exhibit any strong trends, supporting the presumption that adverse impacts from mining and reclamation operations on surface water quality at DD have not occurred.

4.1.2.2 DEFIANCE DRAW TRIBUTARY 6

Defiance Draw Tributary 6 was only sampled in 2013, 2014, 2015, 2018 and 2021 during the reporting period. A review of the analytical data and temporal plots for the reporting period associated with surface water monitoring location DDT6 indicate that:

- Alkalinity and bicarbonate have been relatively stable during the reporting period.
- Total calcium concentrations at DDT6 have fluctuated during the reporting period.
- Carbonate concentrations have been below detection limits each year except for 2018.
- The calculated cation/anion balance have been slightly higher in 2018 and 2021 than in previous years.
- Chloride concentrations have been relatively stable since 2013.
- Dissolved iron concentrations at DDT6 have fluctuated since 2013.
- Total iron concentrations have been relatively stable since 2013 as shown on the temporal plot in Appendix B.
- Total magnesium concentrations have been relatively stable since 2013 as shown on the temporal plot in Appendix B.
- Dissolved manganese concentrations have fluctuated since 2013.
- Total manganese has been relatively stable since 2013 as shown on the temporal plot in Appendix B. Analytical results indicate that a greater amount of suspended manganese was present than dissolved manganese over most of the sample events.
- Total mercury concentrations were below or only slightly above the limit of quantification since 2013.
- Nitrate, expressed as nitrogen, concentrations have been relatively stable since 2013.
- The pH levels, as shown on the temporal plot in Appendix B, have fluctuated since 2013 between 7.5 and 8.5 with slightly higher levels in 2021.
- Phosphate concentrations have fluctuated since 2013.
- Total phosphorus concentrations have fluctuated since 2013 but have been decreasing since 2015.
- Total potassium concentrations have been relatively stable since 2013.
- The sodium adsorption ratio at DDT6 has been relatively stable since 2013 with spikes in 2013 and 2015.
- Total selenium concentrations were reported below or only slightly above the laboratory limit of quantification since 2013.

- Total sodium concentrations have been relatively stable since 2013 with a slight decrease in 2021.
- Sulfate concentrations have been relatively stable since 2013 with a slight decrease in 2021.
- Total dissolved solids concentrations have been relatively stable since a peak in 2013 as shown on the temporal plot in Appendix B.
- Total suspended solids concentrations have fluctuated since 2013 with a general decreasing trend since 2015. The majority of the cations found in surface water exist in the suspended phase relative to the dissolved phase.

Examination of the collective analytical trends discussed above indicates that water quality concentrations have generally been stable since 2013 with many analytes showing decreases in 2021, which may be a result of a slight decrease in flow at DDT6 compared to other years. The relatively stable trends in concentrations at this watershed indicate that there have been no adverse impacts.

4.2 ASSESSMENT OF SURFACE WATER DATA

4.2.1 COMPARISON TO BACKGROUND WATER QUALITY

The following discussion provides a comparison of surface-water quality, by analyte, between the relatively undisturbed CMW watershed and the other disturbed watersheds, DD and DDT6. A review of the analytical data and temporal graphs indicate that:

- Alkalinity and bicarbonate concentrations at CMW were similar to the other watersheds during the reporting period with 2018 values showing the most variability between the watersheds. Alkalinity/bicarbonate concentrations in DD in 2020 were the highest concentrations of any of the watersheds during the reporting period as shown on the temporal plot in Appendix B.
- Carbonate results are near or below laboratory limits during the reporting period.
- Chloride concentrations at CMW are relatively similar to those at the two disturbed watersheds throughout the reporting period. The chloride concentration of 26.6 mg/L at DD in 2013 was the highest of the reporting period.
- Dissolved iron concentrations for CMW are similar to or higher relative to the disturbed watersheds, particularly in 2021 with similar values at all watersheds. The dissolved iron concentration in CMW in 2019 was highest value during the reporting period.
- Total iron concentrations shown on the temporal plot (Appendix B) have generally increased at all watersheds during the reporting period. Total iron concentrations in CMW during 2021 were highest during the reporting period.

- Total magnesium concentrations at CMW have increased and are consistently higher than the other watersheds since 2016 as shown on temporal plot in Appendix B.
- Dissolved manganese concentrations indicate no obvious trend at the three watersheds during the reporting period.
- Total manganese values were similar to or slightly elevated at CMW relative to the disturbed watersheds.
- Mercury concentrations are generally below or slightly above the limits of quantification since 2013.
- Nitrate concentrations at CMW are slightly higher than the values at the two other disturbed watersheds during the reporting period.
- The pH values from disturbed watersheds have generally behaved in a similar manner relative to the undisturbed values at CMW throughout the reporting period as shown on the temporal plot in Appendix B.
- Phosphate concentrations from disturbed watersheds were similar to or lower than the relatively undisturbed value at CMW since 2013.
- Total phosphorus concentrations were higher at CMW relative to the disturbed watersheds during the reporting period.
- Total potassium from disturbed watersheds were lower than the relatively undisturbed concentration at CMW throughout the reporting period.
- The sodium adsorption ratio at CMW was similar to the disturbed watersheds during the reporting period.
- Total selenium concentrations from both CMW and the disturbed watersheds were generally below the laboratory limit of quantification.
- Total sodium concentrations at CMW are slightly higher than those reported at the disturbed watersheds.
- Sulfate concentrations from CMW have been higher than the disturbed watersheds during the reporting period.
- Total settleable solids concentrations in CMW have generally been elevated compared to the other watersheds during the reporting period.
- Total dissolved solids values shown on the temporal plot in Appendix B are similar at all watersheds during the reporting period except for a spike in concentrations at CMW in 2019 and a spike at DD in 2018.
- Total suspended solids concentrations at the CMW station have generally been higher relative to the other disturbed watersheds, as shown on the temporal plot in Appendix B.

A statistical comparison of the analytical data from the disturbed watersheds (DD and DDT6) and the undisturbed watershed (CMW) is presented in Table 4-2. The statistical analyses in Table 4-2 show the minimum, maximum, mean, median, and standard deviation of analyte concentrations for samples from the three watersheds between 2013 and 2021. In cases where data were estimated below the reporting limit (j-flag) or nondetect, the method detection limit was used. Comparisons of analyte concentrations from the two groups of watersheds indicate that the mean and median concentrations of each analyte are higher in the undisturbed watershed than the disturbed watersheds except for chloride. The mean chloride concentrations in DD and DDT6 are approximately 1.1 and 2.2 mg/L higher than in CMW. However, the median concentrations in DD and DDT6 are only 1.0 and 1.2 mg/L higher than in CMW, and the standard deviations of the disturbed watershed samples are 63 percent to 118 percent higher than the undisturbed watershed samples. These factors indicate the mean value is biased high due to a few higher values, and the overall chloride concentrations are similar in the three watersheds. Based on the comparison of water quality in the disturbed watersheds versus the undisturbed watershed, the data indicate that mining and reclamation did not adversely impact water quality in the disturbed watersheds. Raw surface water analytical data were provided in the annual reports and available by request.

4.2.2 COMPARISON TO PROBABLE HYDROLOGIC CONSEQUENCES

The PHC determination (Permit Section 3.4.4) acknowledges the possible consequence of stormwater on downstream water chemistry. Based on data from DD and DDT6 and comparison to the relatively undisturbed watershed CMW, the results indicate that permanent changes to the surface water quality and quantity in the mine area are not anticipated.

5.0 LONG-TERM GROUNDWATER MONITORING

Groundwater at the Mine is monitored from five sources: alluvial, bedrock, Gallup Sandstone Aquifer, and spoil. A summary of data for the five groundwater sources is provided below followed by a comparison of results to baseline water quality, regulatory standards, and the PHC, as applicable. Water level data for the groundwater sources are presented in Table 5-1. Tabulated water quality data for the groundwater sources are presented in Table 5-2 with an assortment of temporal plots in Appendix C.

5.1 ALLUVIAL GROUNDWATER

Alluvial wells are located in and around major drainage watersheds throughout the Mine. Since water levels in these wells are dependent on direct precipitation, the depth to groundwater and the saturated thickness in wells vary to some degree based on rain and snowfall.

In 2016, OSM and MMD approved a permit modification to monitor only seven alluvial wells. Four of these wells have historically been considered recharging (DT2A, DT2B, TB2B2, and TB3D) whereas the remainder of the wells (CMC, D2C, and D3B2) have historically been dry. Well D2C is near Area 9 South. However, because the well has historically been dry, groundwater quality data are not available for this evaluation. The alluvial wells being dry is consistent with the PHC.

5.2 GALLUP SANDSTONE AQUIFER

Five water wells (1, 2, 3, 3A, and 4) have been completed in the Gallup Sandstone Aquifer throughout the Mine area. These wells were used as primary water sources for mine activities and reclamation. The wells now provide domestic water, dust-control water, or are only monitored. Because of the impermeability of the shale units overlying the Gallup Sandstone Aquifer and the geologic structure in the area, the Gallup Sandstone Aquifer can be under artesian conditions. Moreover, due to the presence of the overlying shales, there is no hydraulic connection between the underlying Gallup Sandstone and the mined strata. Of the five Gallup Sandstone wells only Well 1 is located in the vicinity of Area 9 South.

5.2.1 WATER LEVELS

Water level and saturated thickness are presented in Table 5-1 for Well 1. Depth to groundwater in Well 1 has been increasing (i.e. water level dropping) since 2018. Saturated thickness plotted with precipitation and well production since 2013 is presented on Figure 5-1. Yearly water usage was generally consistent between 2002 and 2009 when mining operations ceased. Between 2011 and 2021, yearly water use was significantly less during reclamation activities although Well 1 has been the primary source for water for dust control through 2021. The figure shows that reductions in saturated thickness in Well 1 are likely a result of a combination of reduced precipitation and increased production.

5.2.2 WATER QUALITY

Sampling of Gallup Sandstone Aquifer Well 1 has been conducted quarterly for multiple parameters. Significant chemical parameters are included in the Groundwater Database Summary 2013-2021 (Table 5-2). Appendix C-1 presents select temporal plots for Well 1 based on available 2013 to 2021 data.

Examination of the analytical data and temporal plots for the reporting period associated with Well 1 indicate that:

- Alkalinity is a useful parameter when discussing bicarbonate and carbonate trends below. Alkalinity and bicarbonate concentrations have generally shown a slight increase since 2017 at Well 1. Nearly all the alkalinity present in bedrock groundwater is attributable to bicarbonate as carbonate is a relatively minor component. These results were expected given the neutral to slightly basic pH of the groundwater. Field pH values have consistently ranged between 7.2 and 7.6 SU at Well 1 and has shown a generally inverse relationship to alkalinity over the reporting period as shown on the temporal plot in Appendix C-1a. Carbonate concentrations were not above the detection limit in Well 1 during the reporting period. These results indicate that carbonate concentrations are an insignificant component of total alkalinity.
- Fluoride concentrations were mostly below detection limit (0.5 mg/L) between 2013 and 2016. Detection limits decreased (0.25 and 0.28 mg/L) after 2016 but concentrations remained near the previous detection limit.
- Dissolved calcium, magnesium, sodium and hardness are plotted together on the temporal plot in Appendix C-1b. Dissolved calcium, magnesium, and sodium concentrations have been stable in Well 1 since 2013 except a spike in dissolved sodium in August 2021. Hardness as a function of calcium carbonate has fluctuated between approximately 200 and 300 mg/L since 2014.
- The calculated ion balance percentages have been consistently less than 10%, other than two anomalous values in November 2011 and March 2017.
- Chloride, sulfate, TDS, and turbidity are plotted together on the temporal plot in Appendix C-1c. Chloride concentrations at Well 1 have been relatively stable since 2013. Sulfate concentrations at Well 1 have been relatively stable except for spike in June 2020. Total dissolved solids concentrations at Well 1 have varied between approximately 325 mg/L and 450 mg/L since 2013. Turbidity in Well 1 has been below 21 Nephelometric Turbidity Units (NTU) since 2013.

- Total iron and manganese are plotted together on the temporal plot in Appendix C-1d. Total iron concentrations at Well 1 have varied between 1 and 2 mg/L since May 2013. Total manganese concentrations presented on the temporal plot have varied between 0.105 and 0.13 mg/L since 2013.
- Phosphate concentrations have been below the detection limit in Well 1 since 2013.

Examination of the previously discussed analytical trends suggests that water-quality concentrations have remained relatively consistent since 2013 at Well 1. Overall, these trends support the presumption that impacts from mining and reclamation operations on Gallup Sandstone Aquifer groundwater have not occurred or are limited. Reductions in water levels in Well 1 are likely due to the prolonged drought conditions in the region and to a lesser extent production for dust control.

5.3 SPOIL GROUNDWATER

Five spoil recharge wells (2G2, 4A, 9A, 9S, and 11) were constructed in the Mine area. Two spoil wells (4A and 9A on MMD lands) were installed in 1990; of these two wells, only 9A remains. Well 4A was not monitored after 2015 following approval by MMD to discontinue monitoring this well because the land at the well location had a full bond and liability release. Well 4A was abandoned October 29, 2018. In April 2013, three additional spoil recharge wells were constructed and designated as wells 2G2 (on OSM lands), 11, and 9S (on MMD lands). Spoil recharge wells were installed throughout the mine in reclaimed areas to determine chemical presence and groundwater properties. These wells were terminated at bedrock and their screens encompassed the spoil interval immediately above bedrock. To date, only Well 11 has contained sufficient groundwater for sampling.

Only wells 9A and 9S are near or within Area 9 South. However, neither well has had sufficient water for sampling since 2013. Therefore, spoil groundwater is not included in the groundwater quality discussion. Upon the ultimate stages of bond release, the two spoil wells will be plugged and abandoned in accordance with NMAC 19.27.4.30.C.1.

5.4 BEDROCK GROUNDWATER

Five bedrock wells (MBR1, MBR2, MBR3, MBR4, and MBR5) were installed approximately 50-feet (ft) below the Green Coal Seam to monitor groundwater below this unit. These monitoring wells, referred to as McKinley bedrock wells, are located in and around the major drainage watersheds throughout the mine. Three of the original five wells (MBR1, MBR3, and MBR4) were mined through and not replaced. The active bedrock monitoring wells include MBR2 and MBR5. MBR5 is located near Area 9 South.

5.4.1 WATER LEVELS

Water level and saturated thickness are presented in Table 5-1 for well MBR5. Depth to groundwater and the corresponding saturated thickness values for MBR5 have been relatively consistent (less than 1.5 ft of fluctuation) since 2016. Saturated thickness plotted with precipitation since 2013 is presented on Figure 5-1. The figure shows increased saturated thickness in MBR5 in 2016 following above average precipitation in 2015.

5.4.2 WATER QUALITY

Sampling of bedrock monitoring well MBR5 has been conducted annually for multiple parameters. Significant chemical parameters are included in the Groundwater Database Summary 2013-2021 (Table 5-2). Appendix C-2 presents select temporal plots for well MBR5 based on available 2013 to 2021 data

Examination of the analytical data and temporal plots for the reporting period associated with bedrock monitoring wells MBR5 indicate that:

- Alkalinity is a useful parameter when discussing bicarbonate and carbonate trends below. Alkalinity and bicarbonate concentrations have generally shown a slight increase since 2017 at MBR5. Nearly all the alkalinity present in bedrock groundwater is attributable to bicarbonate as carbonate is a relatively minor component. These results were expected given the neutral to slightly basic pH of bedrock groundwater. Field pH values have consistently ranged between 7.4 and 8.7 SU at MBR5 and has shown a generally inverse relationship to alkalinity over the reporting period as shown on the temporal plot in Appendix C-2a. Carbonate concentrations were only above the detection limit in MBR5 between 2016 and 2019. These results indicate that carbonate concentrations are an insignificant component of total alkalinity.
- Boron, fluoride, and zinc concentrations are plotted on the temporal plot in Appendix C-2b. Boron trends varied year-to-year but have consistently been between 0.14 milligrams per liter (mg/L) and 0.18 mg/L concentration levels. Fluoride concentrations roughly doubled in 2018 and then decreased at MBR5 the past 3 years. Total zinc concentrations have been variable during the reporting period.
- Total calcium, magnesium, potassium, and sodium are plotted together on the temporal plot in Appendix C-2c. Total calcium concentrations indicate no obvious trend at MBR5 since 2013. Total magnesium concentrations show similar variability as total calcium during the reporting period. Total potassium concentrations at MBR5 were generally stable since 2013. Total sodium concentrations have been relatively stable since a peak in 2013.
- The calculated ion balance percentages have been consistently less than 10%.
- Chloride, sulfate, TDS, and specific conductivity are plotted together on the temporal plot in Appendix C-2d. Chloride concentrations at MBR5 have been relatively stable since 2013. Specific conductivity has been relatively

stable at MBR5 over the reporting period except for an outlier result in 2021. Sulfate concentrations at MBR5 have been relatively stable except for spike in 2019. TDS concentrations at MBR5 have varied between approximately 1,300 mg/L and 1,700 mg/L except a spike in 2016 to 2420 mg/L.

- Total and dissolved iron and manganese are plotted together on the temporal plot in Appendix C-2e. Total and dissolved iron concentrations at MBR5 have been variable since 2013. Comparing the total and dissolved iron concentrations indicate that the majority of iron exists in the suspended phase. Total and dissolved manganese concentrations presented on the temporal plot have been relatively stable since 2013. The majority of manganese exists in the dissolved phase.
- Nitrate concentrations, expressed as nitrogen, presented on the temporal plot are below the limit of quantification since 2013.
- Phosphate concentrations have been below the detection limit in MBR5 except in 2016.
- Total phosphorus at MBR5 has been relatively stable during the reporting period except for a spike in 2016.
- Total selenium concentrations have been below the limit of quantification since 2013.
- Dissolved zinc has only been analyzed since 2018. Dissolved zinc at MBR5 has been decreasing since 2018.

Examination of the previously discussed analytical trends suggests that water-quality concentrations have remained relatively consistent over the past 5 years at MBR5. The reason for variability in concentrations of some analytes may be related to recent dry conditions at the mine and the shallow water levels in this well. Overall, these trends support the presumption that impacts from mining and reclamation operations on bedrock groundwater have not occurred or are limited.

5.5 ASSESSMENT OF GROUNDWATER DATA

5.5.1 COMPARISON TO BASELINE WATER QUALITY

There are no baseline groundwater data from pre-mining conditions available for comparison to current groundwater quality data. Therefore, this comparison is not included in this report.

5.5.2 COMPARISON TO REGULATORY STANDARDS

Water quality from the bedrock aquifer and Gallup Sandstone Aquifer are subject to the regulatory standards established for the maximum allowable concentrations of groundwater of 10,000 mg/L TDS or less (NMAC 20.6.2.3103). Table 5-2 include these standards at the bottom, allowing for easy comparison to water quality data from well MBR5 and Well 1, with bolded values indicating exceedances. Only the following monitored constituents are regulated by the referenced standards: fluoride, nitrate and nitrite as N, and selenium for human health standards and chloride, iron, manganese, sulfate, TDS, zinc, and pH for domestic water supply. There were no exceedances of water quality from Well 1 for standards associated with chloride, fluoride, manganese, nitrate, nitrite, pH, sulfate, and TDS. Concentrations of fluoride, iron, manganese, sulfate, and TDS exceeded water quality standards in samples from MBR5. However, as discussed in Section 2.2 above, water from the bedrock aquifer is limited in quantity and extent. Therefore, water from this aquifer is unlikely to be used for domestic or agricultural purposes.

5.5.3 COMPARISON TO PROBABLE HYDROLOGIC CONSEQUENCES

Data establish that bedrock groundwaters are of poor quality that cannot be used for beneficial purposes. Data also show, however, that they have had no deleterious effect on established surface or groundwater uses. Upon the final stages of bond release, wells will be plugged and abandoned in accordance with NMAC 19.27.4.30.C.1.

6.0 SURFACE AND GROUNDWATER ASSESSMENT SUMMARY

As required for bond release of long-term surface and groundwater monitoring, water quality and quantity data are provided in this report. Evaluation of the data was presented in three separate sections to confirm that mining activities at the McKinley Mine have not disturbed the hydrologic balance in or around the site. In each of the sections, data were assessed with respect to baseline data, regulatory standards, and the PHC determination, as applicable. The following provides a brief summary of those findings.

6.1 LONG-TERM ASSESSMENT OF IMPOUNDMENTS

No permanent impoundments are located within Area 9 South. Additionally, impoundments in the vicinity of Area 9 South have not been sampled during the reporting period and therefore, have not been included in this discussion.

6.2 LONG-TERM ASSESSMENT OF SURFACE WATER

Comparison of surface water quality from DD and DDT6 to background water quality data (CMW) indicate that water quality in the DD and DDT6 watersheds is consistent with background levels for the monitored analytes. Data agree with the PHC determination that no permanent changes to the surface water quality and quantity would result from mining activities, qualifying the McKinley Mine for bond release of long-term surface-water monitoring.

6.3 LONG-TERM ASSESSMENT OF GROUNDWATER

Comparison of groundwater quality from Well 1 to water quality standards indicate that water quality in the Gallup Sandstone Aquifer is below water quality standards for the regulated analytes fluoride, nitrate and nitrite as N, selenium chloride, iron, manganese, sulfate, TDS, zinc, and pH. As discussed in the PHC, because of the impermeability of the shale units overlying the Gallup Sandstone Aquifer and the geologic structure in the area, there is no hydraulic connection between the underlying Gallup Sandstone and the mined strata. Concentrations of fluoride, iron, manganese, sulfate, and TDS exceeded water quality standards in samples from MBR5. However, as discussed in Section 5.5.2 above, water from the bedrock aquifer is limited in quantity and extent and is unlikely to be used. Data agree with the PHC determination that no permanent changes to the groundwater quality and quantity would result from mining activities, qualifying the McKinley Mine for bond release of long-term groundwater monitoring. Upon the final stages of bond release, the bedrock wells will be plugged and abandoned. Groundwater from Well 1 may continue to be used for domestic and agricultural purposes.

7.0 REFERENCES

Geohydrology Associates, Inc. (GAI). 1980. Hydrology Study of the McKinley Mine.

National Pollutant Discharge Elimination System (NPDES) Permit No. NN0029386. 2017. July 1.

New Mexico Administrative Code (NMAC). 2022. Title 20, Environmental Protection Chapter 6, Water Quality Part 4: Standards for Interstate and Intrastate Surface Waters. April 23.

New Mexico Administrative Code (NMAC). 2017. Title 19, Natural Resources and Wildlife Chapter 27, Underground Water Part 4: Well Driller Licensing; Construction, Repair, and Plugging of Wells. June 30.

New Mexico Administrative Code (NMAC). 2007. Title 20, Environmental Protection Chapter 6, Water Quality Part 2: Ground and Surface Water Protection. June 1.

TABLES

TABLE 2-1. PRECIPITATION DATA, SOUTH TIPPLE AND RAIN 9
MCKINLEY MINE, CHEVRON MINING INC.
NEAR GALLUP, NEW MEXICO

	2013		2014		2015		2016		2017		2018		2019		2020		2021		Average (2013-2021)	Maximum (2013-2021)
Month	Rain 9 (in)	S. Tipple (in)	Rain 9 (in)	S. Tipple (in)	Rain 9 (in)	S. Tipple (in)	Rain 9 (in)	S. Tipple (in)	Rain 9 (in)	S. Tipple (in)	Rain 9 (in)	S. Tipple (in)	Rain 9 (in)	S. Tipple (in)	Rain 9 (in)	S. Tipple (in)	Rain 9 (in)	S. Tipple (in)	S. Tipple (in)	S. Tipple (in)
January	--	1.38	--	0.04	--	2.05	--	0.62	--	1.25	--	0.35	--	1.30	--	0.98	--	1.11	1.01	2.05
February	--	0.15	--	0.06	--	1.59	--	0.22	--	1.64	--	0.79	--	1.81	--	1.44	--	0.34	0.89	1.81
March	0.00	0.39	--	0.73	--	0.11	--	0.05	--	0.48	--	0.54	--	1.23	--	1.35	--	0.4	0.59	1.35
April	0.27	0.23	0.08	0.36	0.50	0.52	1.20	1.31	0.22	0.35	0.07	0.09	0.16	0.44	0.16	0.17	0.00	0.07	0.35	1.31
May	0.02	0	0.19	0.14	1.38	1.64	1.02	0.80	0.62	0.77	0.27	0.29	1.36	1.77	0.02	0.01	0.10	0.08	0.62	1.77
June	0.02	0.05	0.00	0	1.22	1.11	0.01	0.07	0.45	0.42	0.25	0.51	0.24	0.33	0.11	0.04	0.27	0.37	0.32	1.22
July	2.02	1.8	0.88	0.85	2.88	2.37	0.82	1.37	1.24	2.48	2.16	2.61	0.46	0.22	0.60	1.13	1.81	5.45	1.71	5.45
August	2.61	2.53	1.04	1.44	1.25	1.62	1.40	1.74	0.50	0.90	0.74	1.34	0.37	0.05	0.06	0.24	1.22	1.24	1.04	2.53
September	2.87	3.03	2.20	2.12	0.22	0.3	1.64	1.75	1.05	1.34	0.67	1.1	1.84	1.59	0.14	0.15	1.11	2.12	1.32	3.03
October	0.62	0.58	0.24	0.36	1.13	1.36	0.37	0.40	0.05	0.15	1.31	1.65	0.05	0.09	0.08	0.26	0.78	1.77	0.63	1.77
November	0.54	1.67	0.03	0.09	0.99	1.31	0.91	1.57	0.00	0.09	0.00	0.19	0.07	1.14	0.45	0.40	0.00	0.55	0.56	1.67
December	--	0.2	--	1.53	--	0.76	--	1.84	--	0.02	--	0.67	--	0.85	--	0.27	--	2.26	0.93	2.26

Total Annual Precipitation

Year	2013		2014		2015		2016		2017		2018		2019		2020		2021		Rain 9 Average	S. Tipple Average
Total (inches)	--	12.01	--	7.72	--	14.74	--	11.74	--	9.89	--	10.13	--	10.82	--	6.44	--	15.76	--	11.03
Apr-Nov (inches)	8.97	10.28	4.66	5.36	9.57	10.23	7.37	9.01	4.13	6.50	5.47	7.78	4.55	5.63	1.62	2.40	5.29	11.65	5.74	7.65

Notes:

-- - precipitation station not operating due to freezing temperatures

Partial operating month

in - inches

Apr - April

Nov - November

TABLE 4-1. SURFACE WATER DISCHARGE DATA
CHEVRON MINING INC., MCKINLEY MINE
NEAR GALLUP, NEW MEXICO

Watershed	2013 (ft^3)	2013 (ac-ft)	2014 (ft^3)	2014 (ac-ft)	2015 (ft^3)	2015 (ac-ft)	2016 (ft^3)	2016 (ac-ft)	2017 (ft^3)	2017 (ac-ft)
DD	8,780,798	202	7,985,148	183	4,112,178	94	4,047,021	93	1,108,868	25
DDT6	1,905,221	44	1,347,142	31	2,690,529	62	-	-	-	-
CMW	6,943,946	159	1,776,160	41	22,428,950	515	3,032,811	70	1,809,229	42

Watershed	2018 (ft^3)	2018 (ac-ft)	2019 (ft^3)	2019 (ac-ft)	2020 (ft^3)	2020 (ac-ft)	2021 (ft^3)	2021 (ac-ft)	Average (ft^3)	Average (ac-ft)	Maximum (ft^3)	Maximum (ac-ft)
DD	6,557,234	151	477,324	11	175,241	4	1,471,258	34	3,857,230	89	8,780,798	202
DDT6	530,125	12	-	-	-	-	475,508	11	1,389,705	32	2,690,529	62
CMW	7,219,414	166	5,258,259	121	382,050	9	1,707,449	39	5,617,585	140	22,428,950	515

TABLE 4-2. STATISTICAL ANALYSES FOR SURFACE WATER ANALYTE CONCENTRATIONS (2013 - 2021)
CHEVRON MINING, INC., MCKINLEY MINE
NEAR GALLUP, NEW MEXICO

Analyte	Sample Location	Category	Nb. Samples	Nb. Detects	% Detects	Nb. Distinct Values	Sample Mean	Sample Median	Sample Std. Dev.	Minimum (Detects)	Maximum (Detects)	Minimum (ND = MDL)	Maximum (ND = MDL)
Alkalinity	CMW	GENERAL	26	26	100%	24	181.046	119.5	120.40	65.9	526	--	--
Alkalinity	DD	GENERAL	38	38	100%	38	201.363	113.8	374.09	27.8	2400	--	--
Alkalinity	DDT6	GENERAL	9	9	100%	9	184.202	105	166.80	80.32	601	--	--
Bicarbonate	CMW	GENERAL	26	26	100%	24	181.046	119.5	120.40	65.9	526	--	--
Bicarbonate	DD	GENERAL	38	38	100%	38	198.179	113.8	373.63	27.8	2400	--	--
Bicarbonate	DDT6	GENERAL	9	9	100%	9	181.202	105	165.69	80.32	601	--	--
Calcium, Total	CMW	METALS	26	26	100%	26	382.381	372	223.43	57.4	917	--	--
Calcium, Total	DD	METALS	38	38	100%	38	237.511	186	219.34	34.9	1200	--	--
Calcium, Total	DDT6	METALS	9	9	100%	9	185.900	120	163.17	36.9	471	--	--
Carbonate	CMW	GENERAL	26	0	0%	9	25.827	5.95	30.95	--	--	0.7	70
Carbonate	DD	GENERAL	38	4	11%	14	10.295	2	17.08	17.8	35.4	0.7	70
Carbonate	DDT6	GENERAL	9	1	11%	4	11.689	0.7	23.58	27.7	27.7	0.7	70
Chloride	CMW	GENERAL	26	25	96%	20	4.715	4.2	1.85	2.6	10.7	2.5	2.5
Chloride	DD	GENERAL	38	36	95%	30	5.821	5.2	4.03	2.5	26.6	2.5	2.5
Chloride	DDT6	GENERAL	9	9	100%	8	6.967	5.4	3.01	3.3	12.5	--	--
Hardness, Total	CMW	GENERAL	24	24	100%	24	1723.250	1620	942.87	279	3400	--	--
Hardness, Total	DD	GENERAL	34	33	97%	34	940.832	734	744.07	97.3	3600	600	600
Hardness, Total	DDT6	GENERAL	7	7	100%	7	637.857	460	590.08	131	1680	--	--
Ion Balance	CMW	GENERAL	23	23	100%	23	53.070	50.389	28.40	1.946650355	89.42511	--	--
Ion Balance	DD	GENERAL	33	33	100%	33	50.297	58.31403	29.59	0.127562158	86.80659	--	--
Ion Balance	DDT6	GENERAL	7	7	100%	7	39.499	48.85989	26.72	8.478393608	65.04665	--	--
Iron, Dissolved	CMW	METALS	26	26	100%	26	64.001	0.915	112.57	0.0933	402	--	--
Iron, Dissolved	DD	METALS	38	36	95%	38	56.766	18.45	88.69	0.0594	387	0.04	0.0805
Iron, Dissolved	DDT6	METALS	9	9	100%	9	11.222	1.77	18.83	0.082	57.1	--	--
Iron, Total	CMW	METALS	26	26	100%	25	309.650	238.5	266.88	22.8	1000	--	--
Iron, Total	DD	METALS	38	38	100%	35	183.861	149.5	151.81	15.6	810	--	--
Iron, Total	DDT6	METALS	9	9	100%	9	72.287	67.7	53.11	4.78	160	--	--
Magnesium, Dissolved	CMW	METALS	22	22	100%	22	31.098	6.665	46.34	2.73	185	--	--
Magnesium, Dissolved	DD	METALS	34	34	100%	34	26.872	13.4	32.38	1.57	113	--	--
Magnesium, Dissolved	DDT6	METALS	7	7	100%	7	7.289	3.7	7.10	2.08	22.1	--	--
Magnesium, Total	CMW	METALS	26	26	100%	26	120.027	116	70.63	22	270	--	--
Magnesium, Total	DD	METALS	38	38	100%	37	67.292	49.65	53.45	11.7	270	--	--
Magnesium, Total	DDT6	METALS	9	9	100%	9	32.861	33.7	19.76	9.6	65.2	--	--
Manganese, Dissolved	CMW	METALS	26	26	100%	26	2.160	0.2457	3.23	0.0033	14.2	--	--
Manganese, Dissolved	DD	METALS	38	38	100%	37	1.721	0.5605	2.20	0.0015	7.8	--	--
Manganese, Dissolved	DDT6	METALS	9	9	100%	9	0.345	0.214	0.40	0.0025	1.12	--	--

TABLE 4-2. STATISTICAL ANALYSES FOR SURFACE WATER ANALYTE CONCENTRATIONS (2013 - 2021)
CHEVRON MINING, INC., MCKINLEY MINE
NEAR GALLUP, NEW MEXICO

Analyte	Sample Location	Category	Nb. Samples	Nb. Detects	% Detects	Nb. Distinct Values	Sample Mean	Sample Median	Sample Std. Dev.	Minimum (Detects)	Maximum (Detects)	Minimum (ND = MDL)	Maximum (ND = MDL)
Manganese, Total	CMW	METALS	26	26	100%	26	10.123	9.74	6.44	1.14	24.5	--	--
Manganese, Total	DD	METALS	38	38	100%	37	5.107	4.11	4.30	0.444	23	--	--
Manganese, Total	DDT6	METALS	9	9	100%	9	3.239	2.7	2.89	0.323	7.43	--	--
Mercury, Total	CMW	METALS	24	19	79%	20	0.002	0.00205	0.00	0.00029	0.0057	0.00005	0.00048
Mercury, Total	DD	METALS	33	23	70%	24	0.001	0.00048	0.00	0.000095	0.0066	0.00005	0.0005
Mercury, Total	DDT6	METALS	7	3	43%	7	0.000	0.00024	0.00	0.000098	0.00094	0.00005	0.00048
Nitrogen, Nitrate	CMW	GENERAL	26	25	96%	20	1.444	1.5	0.63	0.66	2.8	0.22	0.22
Nitrogen, Nitrate	DD	GENERAL	38	37	97%	28	1.147	1.05	0.77	0.3	4.8	0.04	0.04
Nitrogen, Nitrate	DDT6	GENERAL	9	9	100%	6	1.269	1.4	0.64	0.34	2.5	--	--
pH, field	CMW	GENERAL	29	29	100%	13	8.362	8.4	0.50	7.3	9.6	--	--
pH, field	DD	GENERAL	40	40	100%	15	8.467	8.5	0.39	7.8	9.6	--	--
pH, field	DDT6	GENERAL	9	9	100%	9	8.442	8.3	0.58	7.9	9.8	--	--
Phosphate	CMW	GENERAL	24	20	83%	21	19.854	11.7	19.12	3.5	68.4	1.2	2.5
Phosphate	DD	GENERAL	33	27	82%	30	13.865	7.9	14.11	1.1	52.2	0.25	2.5
Phosphate	DDT6	GENERAL	7	5	71%	7	8.631	2.5	10.92	0.52	25	1.2	2.5
Phosphorus, Total	CMW	METALS	26	26	100%	26	8.940	5.355	10.12	1.07	37	--	--
Phosphorus, Total	DD	METALS	38	38	100%	38	3.882	3.68	2.86	0.59	14	--	--
Phosphorus, Total	DDT6	METALS	9	9	100%	9	2.839	3	1.90	0.445	5.48	--	--
Potassium, Total	CMW	METALS	26	26	100%	26	54.412	42.9	33.55	16.5	140	--	--
Potassium, Total	DD	METALS	38	38	100%	38	32.355	27.7	17.67	8.37	100	--	--
Potassium, Total	DDT6	METALS	9	9	100%	9	25.622	24.4	11.72	11	43.7	--	--
Selenium, Total	CMW	METALS	26	12	46%	21	0.044	0.0148	0.06	0.0079	0.28	0.0082	0.105
Selenium, Total	DD	METALS	38	8	21%	18	0.019	0.01225	0.02	0.0085	0.041	0.0048	0.105
Selenium, Total	DDT6	METALS	9	5	56%	9	0.016	0.0113	0.01	0.0085	0.0356	0.0048	0.021
Sodium Adsorption Ratio	CMW	GENERAL	23	23	100%	23	1.092	0.956053	0.61	0.27	2.356122	--	--
Sodium Adsorption Ratio	DD	GENERAL	33	33	100%	33	1.117	0.82237	0.75	0.34	3.815798	--	--
Sodium Adsorption Ratio	DDT6	GENERAL	7	7	100%	7	1.091	0.727012	0.96	0.25	2.94358	--	--
Sodium, Dissolved	CMW	METALS	22	22	100%	21	32.114	30	9.00	19.9	54.3	--	--
Sodium, Dissolved	DD	METALS	34	34	100%	31	30.756	28.55	9.24	12	53.4	--	--
Sodium, Dissolved	DDT6	METALS	7	7	100%	7	28.129	25.1	10.33	16.1	47.6	--	--
Sodium, Total	CMW	METALS	26	26	100%	26	36.431	34.95	11.50	16.1	64	--	--
Sodium, Total	DD	METALS	38	38	100%	37	32.861	31.55	11.38	12	66.9	--	--
Sodium, Total	DDT6	METALS	9	9	100%	9	24.711	25.2	7.43	10	35.2	--	--
Solids, Total Dissolved	CMW	GENERAL	25	25	100%	24	2151.920	563	4757.44	240	24000	--	--
Solids, Total Dissolved	DD	GENERAL	38	38	100%	38	1558.842	613	1937.57	120	7740	--	--
Solids, Total Dissolved	DDT6	GENERAL	8	8	100%	8	1047.125	573.5	1272.30	235	3970	--	--

TABLE 4-2. STATISTICAL ANALYSES FOR SURFACE WATER ANALYTE CONCENTRATIONS (2013 - 2021)
CHEVRON MINING, INC., MCKINLEY MINE
NEAR GALLUP, NEW MEXICO

Analyte	Sample Location	Category	Nb. Samples	Nb. Detects	% Detects	Nb. Distinct Values	Sample Mean	Sample Median	Sample Std. Dev.	Minimum (Detects)	Maximum (Detects)	Minimum (ND = MDL)	Maximum (ND = MDL)
Solids, Total Suspended	CMW	GENERAL	26	26	100%	26	47686.923	45750	33534.81	1370	135000	--	--
Solids, Total Suspended	DD	GENERAL	38	38	100%	36	14408.737	8570	13472.73	432	46400	--	--
Solids, Total Suspended	DDT6	GENERAL	9	9	100%	9	14363.222	11100	15040.41	499	42500	--	--
Sulfate	CMW	GENERAL	26	26	100%	26	79.188	72.3	43.71	28.3	182	--	--
Sulfate	DD	GENERAL	38	38	100%	35	24.676	22.55	11.97	5.1	55.7	--	--
Sulfate	DDT6	GENERAL	9	9	100%	9	23.567	24	8.14	6.4	36.6	--	--
Zinc, Dissolved	CMW	METALS	8	8	100%	8	0.978	0.4525	1.03	0.11	2.74	--	--
Zinc, Dissolved	DD	METALS	16	15	94%	16	0.471	0.319	0.49	0.024	1.59	0.003	0.003
Zinc, Dissolved	DDT6	METALS	3	3	100%	3	0.070	0.061	0.04	0.038	0.11	--	--

Abbreviations:
MDL: Method Detection Limit
Nb.: Number of
ND: Non-Detect
Std. Dev.: Standard Deviation

Notes:
NDs are replaced by their respective MDLs.
Trace values are reported as detected values and reported with their respective MDLs.
Highlighted rows indicated disturbed watersheds (locations DD and DDT6).

TABLE 5-1. DEPTH TO WATER AND SATURATED THICKNESS
CHEVRON MINING, INC., MCKINLEY MINE
NEAR GALLUP, NEW MEXICO

Location	Year	DTW	Well Depth	Saturated Thickness
		ft bmp	ft bmp	ft
MBR5	2013	24.67	117.40	92.73
	2014	24.81	117.40	92.59
	2015	32.4	117.40	85.00
	2016	21.66	119.40	97.74
	2017	27.32	119.40	92.08
	2018	27.6	119.40	91.80
	2019	26.4	119.40	93.00
	2020	27.25	119.40	92.15
	2021	27.75	119.40	91.65
WELL 1	2013	482.00	930.00	448.00
	2014	466.33	930.00	463.67
	2015	466.00	930.00	464.00
	2016	489.00	930.00	441.00
	2017	483.00	930.00	447.00
	2018	462.20	930.00	467.80
	2019	481.85	930.00	448.15
	2020	526.90	930.00	403.10
	2021	530.35	930.00	399.65

Notes:
DTW - depth to water
ft - feet
bmp - below measuring point

TABLE 5-2. GROUNDWATER QUALITY SUMMARY WELL 1 AND MBR5, 2013-2021
CHEVRON MINING, INC., MCKINLEY MINE
NEAR GALLUP, NEW MEXICO

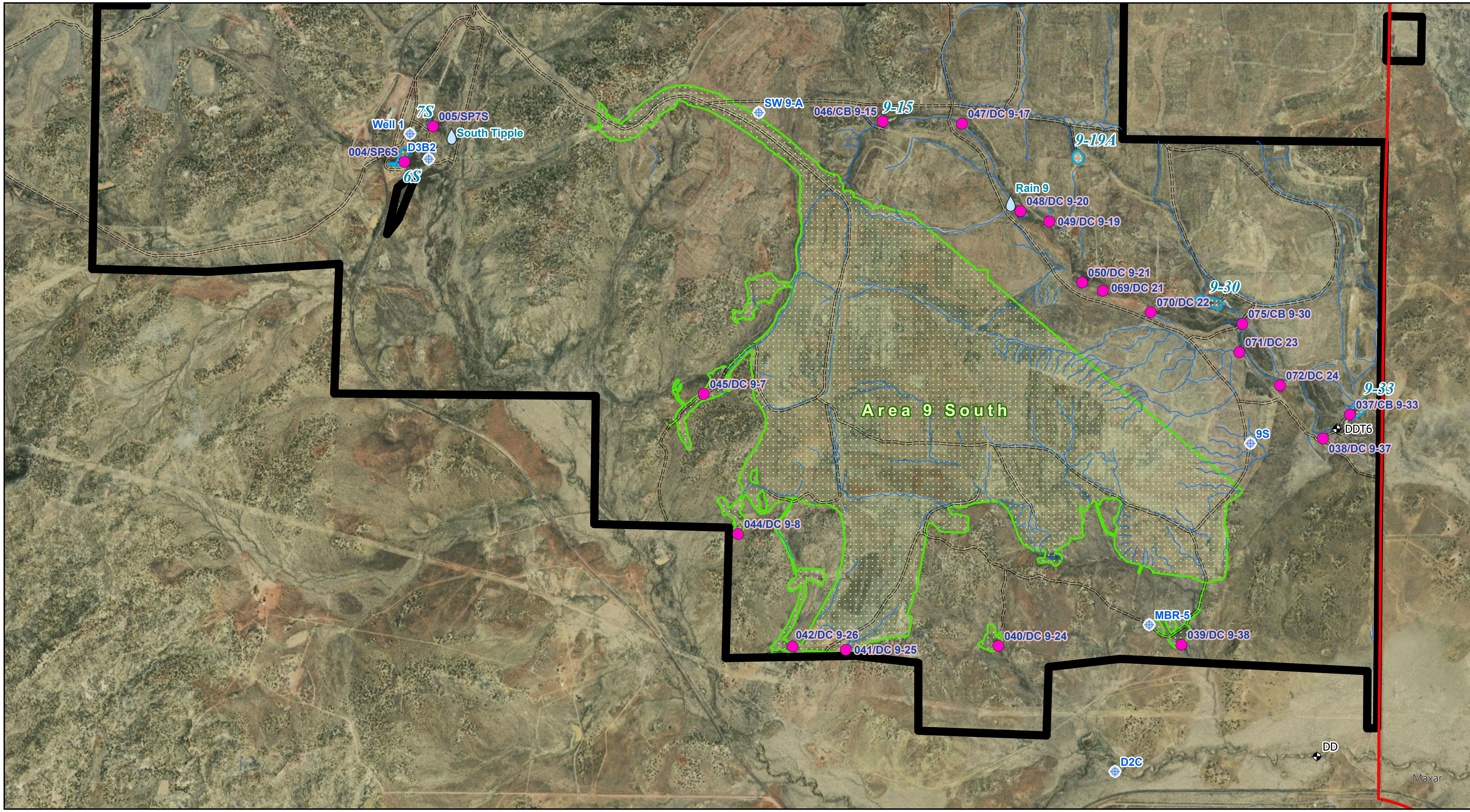
Station ID	Date Sampled	Alkalinity mg/L $CaCO_3$	Bicarbonate mg/L $CaCO_3$	Boron, Total mg/L	Calcium, Dissolved mg/L	Calcium, Total mg/L	Carbonate mg/L $CaCO_3$	CAT_AN_BAL %	Chloride mg/L	Fluoride mg/L	Hardness, Total mg/L $CaCO_3$	Iron, Dissolved mg/L	Iron, Total mg/L	Magnesium, Dissolved mg/L	Magnesium, Total mg/L	Manganese, Dissolved mg/L	Manganese, Total mg/L
MBR5	11/12/2013	985	985			28.8	ND (2)	1.16	95.5	**4.4**		0.442	1.72		14.6	**0.372**	0.394
MBR5	10/22/2014	903	903	0.172		15.7	ND (2)	3.52	84.7	**5.1**	81	0.208	1.42		8.25	0.183	0.207
MBR5	11/5/2015	812	809	0.154		4.31	ND (2)	9.63	58.6	**7.8**	25.3	ND (0.2)	1.55		1.81	0.0324	0.0343
MBR5	11/9/2016	854	830	0.173		23.1	23.1		70.6	**6.8**	139	0.323	29.6		10.1	0.151	0.247
MBR5	11/14/2017	828	797	0.158		3.1	30.9	3.20	66.4	**8.9**	11.7	ND (0.0805)	0.49		1.14	0.0098	0.0125
MBR5	11/14/2018	830	808	0.146		2.83	21.5	5.36	79.5	**13.3**	10.8	0.727	ND (0.04)		0.961	0.0134	0.009
MBR5	11/13/2019	875	824	0.178		8.17	51.4	8.99	130	**6.7**	43	**1.38**	4.23		4.23	0.0943	0.106
MBR5	10/28/2020	940	930	0.17		14	ND (2.6)	4.77	92	**5.9**	74	0.22	2.1		7.4	0.2	0.23
MBR5	10/27/2021	909	909	0.18		7.6	ND (2)	7.41	77	**7.5**	34	0.19	0.86		3.6	0.09	0.11
Well 1	3/20/2013	145	145		63.5		ND (2)	4.67	3.7	ND (0.5)			2.57	13.9			0.118
Well 1	5/23/2013	152	152		62.1		ND (2)		4.2	0.48 (J)			1.12	13.5			0.11
Well 1	8/22/2013	154	154		62		ND (2)	3.30	4	ND (0.5)			1.41	13.6			0.107
Well 1	11/7/2013	150	150		64		ND (2)	35.15	3.7	ND (0.5)			1.67	14.2			0.121
Well 1	3/19/2014	152	152		63.9		ND (2)	5.06	4.1	ND (0.5)	212		1.63	14.2			0.115
Well 1	4/15/2014	155	155		69.3		ND (2)	9.48	3.8	ND (0.5)	235		1.69	15.1			0.114
Well 1	9/9/2014	154	154		64.3		ND (2)	4.53	4.1	0.36 (J)	232		1.60	13.9			0.115
Well 1	10/22/2014	155	155		65.8		ND (2)	6.05	3.9	ND (0.5)	221		1.83	14.8			0.124
Well 1	2/10/2015	152	152		69		ND (2)	6.57	3.4	ND (0.5)	238		1.92	15.4			0.121
Well 1	4/29/2015	153	153		66.2		ND (2)	5.29	4.4	ND (0.5)	237		1.48	14.9			0.117
Well 1	9/2/2015	145	145		68.5		ND (2)	5.84	4.4	ND (0.5)	252		1.61	15.4			0.122
Well 1	11/3/2015	144	144		72.2		ND (2)	8.49	3.6	ND (0.5)	227		1.65	16.2			0.125
Well 1	3/9/2016	149	149		67.9		ND (2.0)		4	0.27	257		1.95	15.2			0.128
Well 1	6/24/2016	148	148		70.2		ND (5.0)		4.3	0.33	251		1.82	15.9			0.129
Well 1	7/28/2016	149	149		68.3		ND (5.0)		4.3	ND (0.50)	252		1.6	15.4			0.12
Well 1	11/9/2016	151	151		65.2		ND (5.0)		4.3	0.46	250		1.51	14.5			0.118
Well 1	3/3/2017	154	154		72		ND (1.7)	56.77	4.4	0.47	301		1.93	16.1			0.13
Well 1	6/7/2017	148	148		70.9		ND (1.7)	8.76	3.6	0.45	265		1.62	15.8			0.123
Well 1	9/13/2017	144	144		64.7		ND (1.7)	2.64	4.2	ND (0.25)	228		1.75	15.2			0.125
Well 1	11/16/2017	148	148		62.8		ND (1.7)	0.81	4.2	0.38	217		1.33	14.2			0.115
Well 1	2/21/2018	145	145		69.2		ND (1.7)	4.15	4.1	0.32	241		1.91	15.4			0.13
Well 1	5/17/2018	142	142		69.5		ND (1.7)	7.56	4.3	0.53	229		1.46	15.5			0.119
Well 1	9/13/2018	149	149		68.3		ND (1.7)	5.08	3.9	0.49	229		1.82	15.4			0.129
Well 1	11/14/2018	152	152		66.8		ND (1.7)	3.11	4.2	0.39	226		1.41	15.1			0.122
Well 1	2/28/2019	151	151		69.2		ND (1.7)	0.128	3.9	0.69	225		1.78	15.4			0.128
Well 1	5/14/2019	146	146		71.6		ND (1.7)	0.124	4.2	0.97	269		1.8	15.6			0.124
Well 1	8/20/2019	150	150		71.7		ND(2.6)	0.124	4.8	0.64	244		1.12	16.2			0.124
Well 1	11/13/2019	151	151		67.5		ND(2.6)	0.113	4.2	0.51	264		1.02	15.5			0.113
Well 1	2/19/2020	149	149		68.5		ND(2.6)	4.16	3.8	0.56	254		1.15	15.2			0.121
Well 1	6/3/2020	150	150		65		ND(8)	9.53	4.3	0.68	280		1.3	14			0.12
Well 1	7/30/2020	150	150		69		ND(8)	3.94	4.6	ND (0.25)	250		1.3	16			0.12
Well 1	11/4/2020	150	150		71		ND(8)	5.43	4.1	0.42	270		1.2	15			0.12
Well 1	2/24/2021	160	160		71		ND(8)	5.53	4.9	0.46	260		1.7	16			0.13
Well 1	5/11/2021	158	158		71		ND(2)	5.35	3.6	ND (0.28)	240		1.1	16			0.11
Well 1	8/10/2021	166	166		69		ND(2)	5.85	5.3	ND (0.28)	240		1.6	16			0.12
Well 1	11/4/2021	151	151		69		ND(2)	5.71	3.7	0.36	240		1.4	16			0.12
Water Quality Standards		None	None	None	None	None	None	None	250	1.6	None	1	None	None	None	0.2	None

TABLE 5-2. GROUNDWATER QUALITY SUMMARY WELL 1 AND MBR5, 2013-2021
CHEVRON MINING, INC., MCKINLEY MINE
NEAR GALLUP, NEW MEXICO

Station ID	Date Sampled	Nitrogen, Nitrate mg/L	Nitrogen, Nitrite mg/L	pH, Field SU	Phosphate mg/L	Phosphorus, Total mg/L	Potassium, Total mg/L	Selenium, Total mg/L	Sodium, Dissolved mg/L	Sodium, Total mg/L	Sodium Adsorption Ratio	Sulfate mg/L	Zinc, Dissolved mg/L	Zinc, Total mg/L	Total Dissolved Solids mg/L	Turbidity SU
MBR5	11/12/2013	ND (0.1)	ND (0.05)	7.7	ND (0.31)	ND (0.1)	5.11	ND (0.02)		810	30.66	**877**		0.0122 (J)	**2420**	
MBR5	10/22/2014	ND (0.1)	ND (0.05)	7.9	ND (0.31)	0.0358 (J)	3.7	ND (0.02)		689	36.30	590		0.0541	**1790**	
MBR5	11/5/2015	ND (0.1)	ND (0.05)	8.3	ND (0.31)	0.0577 (J)	2.4	ND (0.02)		579	61.28	289		0.0137 (J)	**1540**	
MBR5	11/9/2016	ND (0.10)	ND (0.050)	8.4	1.1	0.474	7.5	ND (0.0200)		573		389		0.17	**1650**	
MBR5	11/14/2017	ND (0.04)	ND (0.05)	8.5	ND (0.25)	0.0317	2.18	ND (0.0093)		582	71.48	308		ND (0.0065)	**1290**	
MBR5	11/14/2018	ND (0.04)	ND	8.4	ND (0.25)	ND (0.0275)	2.02	ND (0.021)		536	70.23	319	0.0082	ND (0.003)	**1490**	
MBR5	11/14/2019	ND (0.04)		8.3	ND (0.25)	0.0314	3.03	ND(0.016)		630	44.56	410	0.0059	0.016	**1,660**	
MBR5	10/28/2020	ND (0.04)		8.2	ND (0.25)	0.043	3.8	ND(0.016)		680	36.57	480	0.0054	0.0096	**1,400**	
MBR5	10/27/2021	ND (0.05)		8.39	ND (0.25)	0.035	2.8	ND (0.0019)		660	49.38	380	ND (0.0032)	ND (0.0064)	**1700**	
Well 1	3/20/2013			7.5		ND (0.1)			32.2		0.95	136			370	10
Well 1	5/23/2013			7.5		ND (0.1)			33.1			134			348	11.2
Well 1	8/22/2013			7.3		ND (0.1)			31.6		0.95	130			349	6.1
Well 1	11/7/2013			7.3	ND (0.31)				32.7		0.96	131			357	7.1
Well 1	3/19/2014			7.6	ND (0.31)				33.9		1.00	133			382	5.9
Well 1	4/15/2014			7.4	ND (0.31)				36.8		1.04	128			361	9
Well 1	9/9/2014			7.6	ND (0.31)				33.9		1.00	133			356	8.3
Well 1	10/22/2014			7.2	ND (0.31)				34.4		1.00	133			378	11
Well 1	2/10/2015			7.8	ND (0.31)				34.8		0.99	143			408	13.5
Well 1	4/29/2015			7.5	ND (0.31)				33.8		0.98	138			351	12.8
Well 1	9/2/2015			7.7	ND (0.31)				34.2		0.97	149			415	17.8
Well 1	11/3/2015			7.3	ND (0.31)				35.2		0.97	149			444	6.3
Well 1	3/9/2016			7.7	ND (0.31)				33.6			150			385	20.8
Well 1	6/24/2016			7.4	ND (0.31)				33.4			153			379	3.1
Well 1	7/28/2016			7.5	ND (0.31)				32.7			159			428	11.7
Well 1	11/9/2016			7.3	ND (0.31)				31.7			174			399	9.8
Well 1	3/3/2017			7.5	ND (0.25)				34.9		10.29	152			371	13.9
Well 1	6/7/2017			7.6	ND (0.25)				34.5		0.96	138			396	4.8
Well 1	9/13/2017			7.6	ND (0.25)				32		0.93	154			384	0.2
Well 1	11/16/2017			7.4	ND (0.25)				31.4		0.93	150			373	7.3
Well 1	2/21/2018			7.6	ND (0.25)				34.5		0.98	160			432	16
Well 1	5/17/2018			7.6	ND (0.25)				34.5		0.97	144			368	13
Well 1	9/13/2018			8.1	ND (0.25)				34.2		0.97	149			328	6.3
Well 1	11/14/2018			7.5	ND (0.25)				32.8		0.94	150			397	16
Well 1	2/28/2019			7.0	ND (0.25)				34		0.96	155			389	6.2
Well 1	5/14/2019			7.0	ND (0.25)				34.2		0.95	152			395	11
Well 1	8/20/2019			6.8	ND (0.25)				34.4		0.95	145			412	12
Well 1	11/13/2019			7.1	ND (0.25)				32.8		0.94	151			385	8.8
Well 1	2/19/2020			6.8	ND (0.25)				33.3		0.95	152			402	12
Well 1	6/3/2020			7.0	ND (0.25)				33		0.97	220			370	19
Well 1	7/30/2020			7.1	ND (0.25)				35		0.99	160			400	7.6
Well 1	11/4/2020			7.0	ND (0.25)				34		0.96	150			380	11
Well 1	2/24/2021			7.3	ND (0.25)				37		1.03	150			360	12
Well 1	5/11/2021			7.3	ND (2)				34		0.95	150			395	12
Well 1	8/10/2021			7.5	ND (2)				48		1.35	160			372	14
Well 1	11/4/2021			7.4	ND (2)				35		0.99	150			387	6.2

Water Quality Standards		Nitrogen, Nitrate	Nitrogen, Nitrite	pH, Field	Phosphate	Phosphorus, Total	Potassium, Total	Selenium, Total	Sodium, Dissolved	Sodium, Total	Sodium Adsorption Ratio	Sulfate	Zinc, Dissolved	Zinc, Total	Total Dissolved Solids	Turbidity
Water Quality Standards		10	1	6.0 - 9.0	None	None	None	0.05	None	None	None	600	None	10	1000	None

FIGURES



EXPLANATION

- NPDES OUTFALL (JAN. 2019)
- WATER WELL
- STREAM MONITORING STATION
- WEATHER MONITORING STATION
- DRAINAGE
- HIGHWAY
- TWO TRACK TRAIL
- POND
- MMD BOUNDARY
- AREA 9 SOUTH RELEASE AREA

N

0 2,000'

Trihydro CORPORATION
1252 Commerce Drive
Laramie, WY 82070
www.trihydro.com
(P) 307/745.7474 (F) 307/745.7729

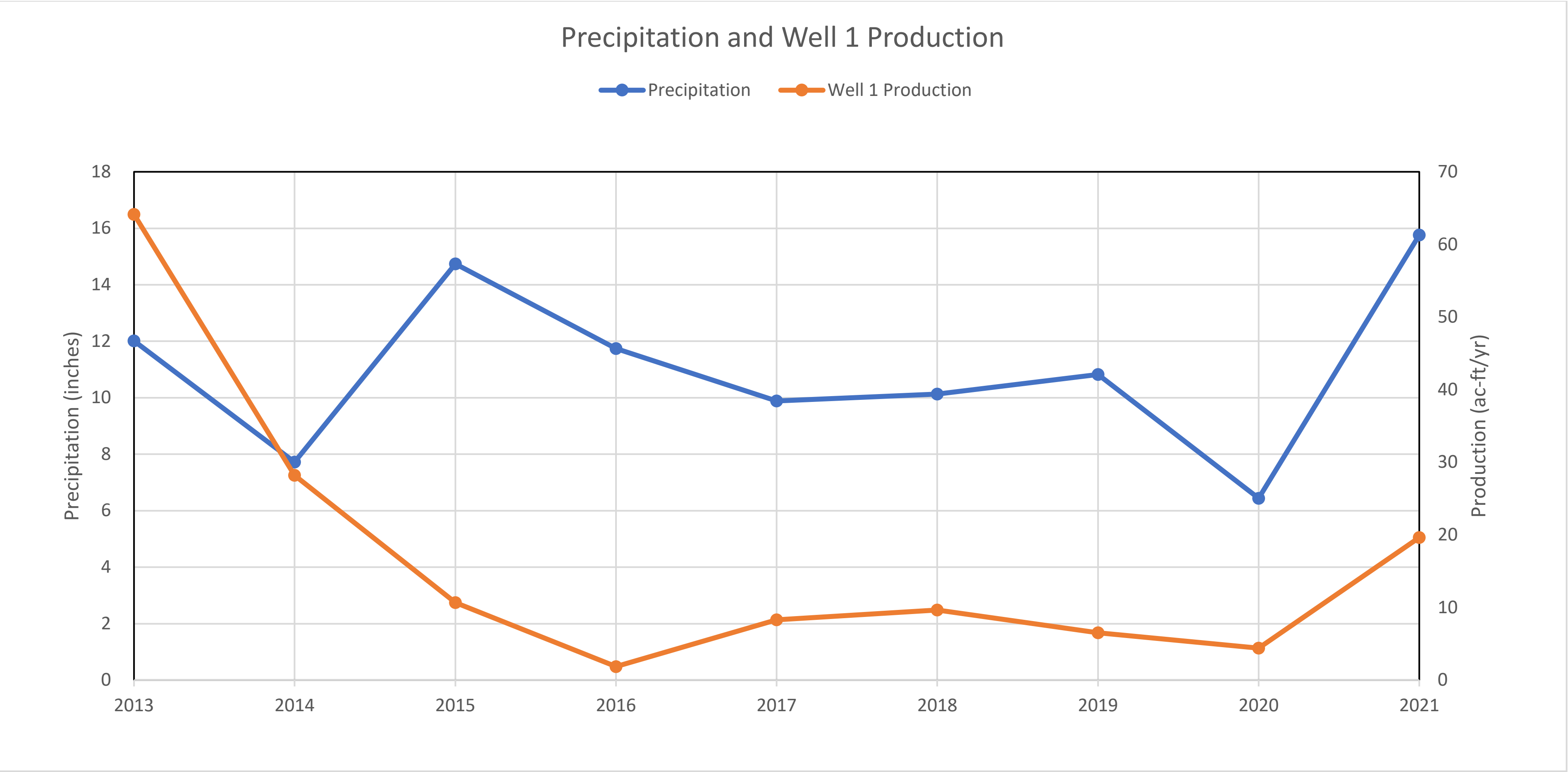
FIGURE 2-1

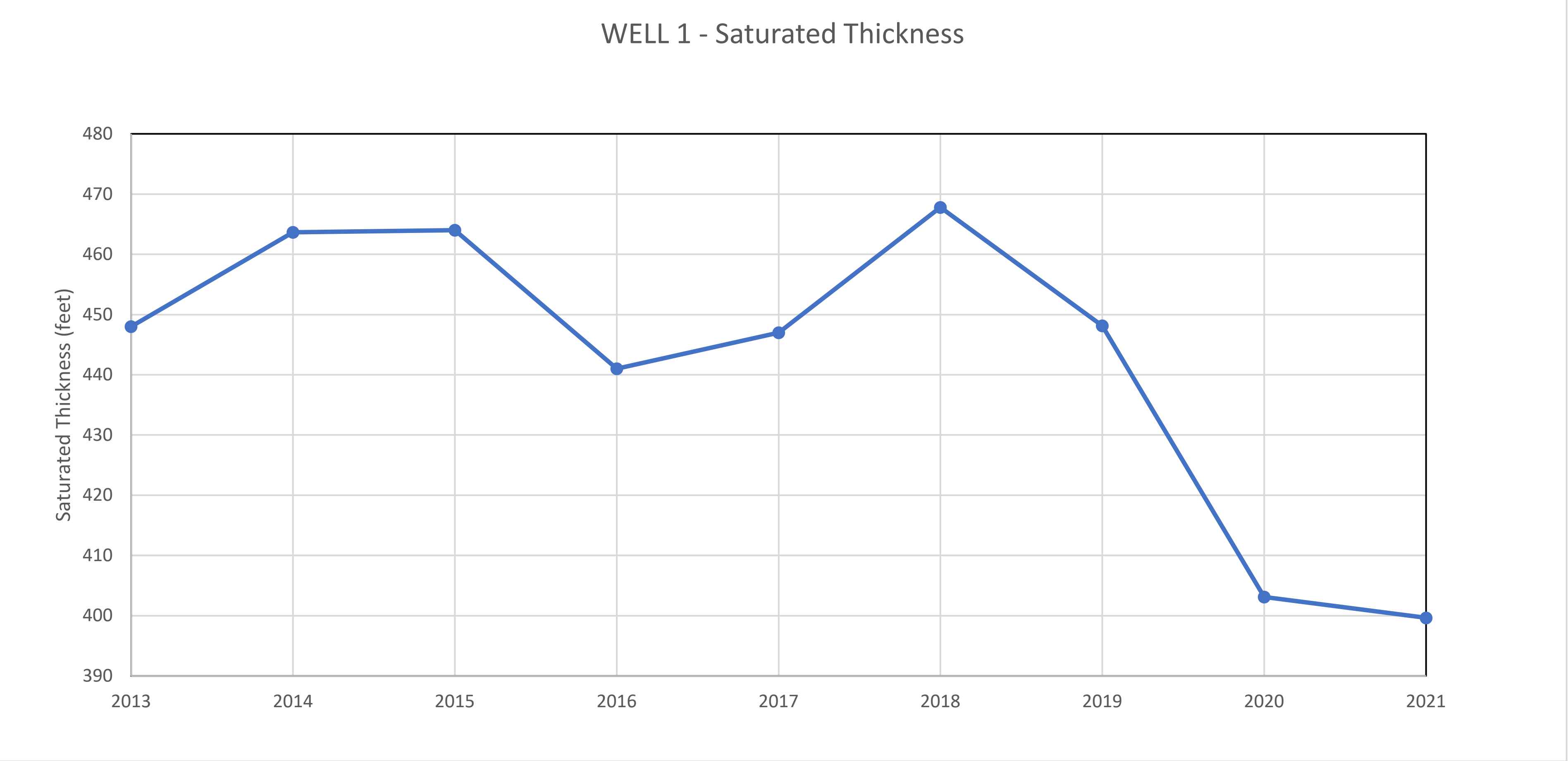
AREA 9 SOUTH PROPOSED BOND RELEASE AREAS

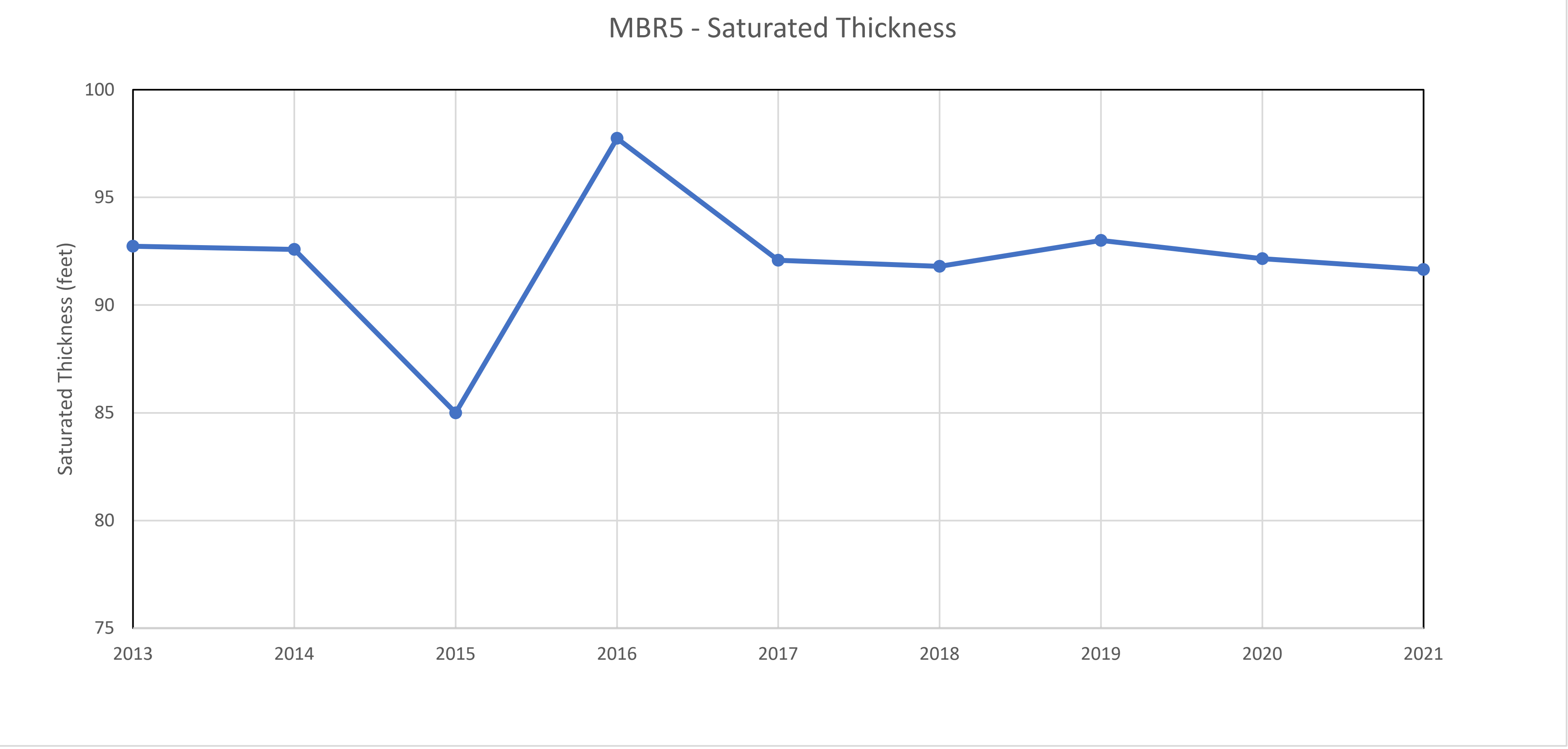
CHEVRON MINING INC.
MCKINLEY MINE
MCKINLEY COUNTY, NEW MEXICO

Drawn By: BR	Checked By: RA	Scale: 1" = 2,000'	Date: 8/4/22	File: 2_Area9South

FIGURE 5-1. SATURATED THICKNESS, PRECIPITATION, AND PRODUCTION DATA
CHEVRON MINING, INC., MCKINLEY MINE
NEAR GALLUP, NEW MEXICO







APPENDIX A

MCKINLEY MINE PERMIT SECTION 3.4, HYDROLOGY INFORMATION

3.4 HYDROLOGY INFORMATION

3.4.1 BACKGROUND

GENERAL INFORMATION

The McKinley Mine area is semiarid with annual precipitation averaging 11 inches. Normally, more than half of the annual precipitation falls during the months of July through October. Generally, this precipitation is received as rainfall from intense, localized thunderstorms that occur sporadically in the area.

The average annual pan evaporation rate is 70 to 75 inches which, when adjusted for pond conditions is 47 to 50 inches. Water quickly evaporates from surface reservoirs and to a very limited extent infiltrated upper soil zones. A study completed by P&M and provided in the Baseline/Background - Soil Information volume contains detailed information documenting the nature of the soil-water deficit.

In 1979/1980 a hydrology study of the McKinley Mine was conducted by Geohydrology Associates, Inc. In 1983, Geohydrology Associates, Inc. provided P&M with the computations for the unit hydrographs provided in the 1981 report. In 1980, a report entitled "A Literature Review Mined-Land Sediment Control and the Dryland Fluvial System" was prepared for P&M by the Research Institute of Colorado. Copies of these reports are located in the hydrology background volume.

SURFACE WATER RESOURCES

All surface water flows in the mine area are ephemeral. There are no known streams containing biological communities per CSMC Rule 80-1 Part 20-57(c) downstream of the mine within reasonable distances. Undisturbed area surface water quality is moderately poor relative to chemical quality, and extremely poor relative to physical quality. Surface runoff from the McKinley Mine indicates suspended solids contents for flow events ranging from 6,000 milligrams per liter to just under 250,000 milligrams per liter.

The rainfall patterns (intense localized thunderstorms) that occur in this geographic area, in combination with the inherent geomorphological characteristics, result in extremely high soil erosion rates. This in turn equates to tremendous suspended solids levels in the runoff. The soil chemistry and geomorphology contribute to the high levels of dissolved solids, salinity and alkalinity. Additional discussions concerning surface water resources are provided in Section 4.7.

GROUNDWATER RESOURCES

Groundwater resources within the mine fall into three main types: alluvial, bedrock and aquifer. Alluvial and bedrock groundwater resources are discontinuous, of poor physical and chemical quality and of limited extent.

The first major deep aquifer in the area is the Gallup Sandstone Aquifer. This aquifer lies well below the zone of mining impact and is overlain by several impermeable shale members. Most recharge to the Gallup Sandstone comes from the Chuska Mountains to the northwest of McKinley Mine. Additional discussions concerning ground water resources are provided in Section 4.7.

3.4.2 WATER RIGHTS

SURFACE

A search of the records of surface water rights maintained by the State Engineer's Office shows that within the McKinley Mine Lease boundary, the only known existing surface water rights are owned by P&M. These rights, File 3294, approved December 14, 1972, have a diversion point on the Tse Bonita Wash at the northeast corner of the NE¼, NE¼, Sec 5, T16N, R20W, and are for 20 acre-feet per year. There are no other owners of surface water rights recorded within five miles of the lease boundary.

GROUNDWATER

Groundwater rights in the Gallup basin were not required prior to declaration of that basin on March 5, 1980. Since then, P&M has made the following declarations:

- (SE¼, SW¼, NW¼, Sec 17, T16N, R20W) 1,005.2 ac-ft/annum (File No. G-87)
- (NE¼, SW¼, SW¼ Sec 29, T17N, R20W) 634 ac-ft/annum (File No. G-88)
- (SE¼, NW¼, SW¼ Sec 5, T16N, R20W) 795.8 ac-ft/annum (FileG89)
- (NE¼, SW¼, NW¼ Sect 17, T16N, R20W) 6.5 ac-ft/annum (File No. G-90)
- (NW¼, SW¼, NW¼ Sec 26, T16N, R20W) 29 ac-ft/annum (File No. G-91)
- (NE¼, NE¼, SW¼ Sec 4 T16N, R20W) 16.1 ac-ft/annum (File No.G-92)
- (108°56'40"; 35°41'38") 16.1 ac-ft/annum (File No. G-93)
- (108°54'35"; 35°40'52") 16.1 ac-ft/annum (File No. G-94)
- (SW¼, NW¼, SE¼ Sec 14, T16N, R20W) 16.1 ac-ft/annum (File No. G-95)

3.4.3 HYDROLOGIC MODELING

The Baseline/Background - Hydrologic Information volume (BBHIV) contains modeling information which characterizes and contrasts surface water quality and quantity for medium sized watersheds in undisturbed, disturbed, and reclaimed conditions.

3.4.4 PROBABLE HYDROLOGIC CONSEQUENCES (PHC)

SURFACE WATER QUANTITY

Surface water quantity may be increased on the reclaimed areas through the construction of small impoundments. These impoundments will be used to provide water for livestock and wildlife and to create small riparian habitats for small mammals, birds and reptiles. The amount of postmining runoff as compared to the premining runoff to the Puerco River drainage will be minimally diminished by the harvesting of the water in the impoundments and other riparian areas. This reduction of runoff is supported by the hydrologic model included in the BBHIV of this application. However, the impact on the Puerco River drainage will be negligible due to the small percentage of the drainage area that the McKinley Mine comprises.

SURFACE WATER QUALITY

For a short term following reclamation of an area there may be a slight increase in the levels of total dissolved solids, sulfates, and other soluble elements in the overburden. This increase will eventually lessen as the runoff leaches the overburden. This potential slight increase will be documented by the collection and analysis of surface water runoff during the permit term as described in Section 6.3. The long term surface water PHC is described below.

Physical Quality

Surface water physical quality will be improved through the stabilization of the reclamation areas and the creation of small post-mining impoundments. These actions will result in lower suspended solids and total settleable solids in the runoff from the disturbed areas. This is supported by the hydrologic models presented in the BBHIV of this application. The models show that the per acre sediment yields from the mining and postmining areas will be less than the premining areas.

Chemical Quality

Surface water chemical quality will be unaffected or could possible improve by minimizing the potential of runoff coming into contact with potentially acid or toxic materials (PATFM). These materials consist of those uncovered during the mining operations, native soil materials that are of poor quality, and naturally occurring exposed coal seams. The PATFM Management program, which is discussed in Sections 5.2 and 6.6, will identify graded spoil areas that have acid or toxic materials present in or near the top 48 inches (rooting zone) of spoil. Areas identified through this program will be mitigated prior to revegetation. These actions will prevent the degradation of the surface water quality within the mine and improve the effluent levels of dissolved soilds, salinity, and alkalinity.

GROUNDWATER QUANTITY

Gallup Sandstone Aquifer

As discussed above, the Gallup Sandstone Aquifer that is used as the primary source of water for the mine and for the McKinley County area. This aquifer occurs 400 to 1,000 feet below the lowest coal seam to be recovered and has no local recharge features. The recharge area for this aquifer is located to the north of McKinley Mine in the Chuska Mountains. As noted in the Technical Analyses and Environmental Assessment performed by the OSMRE on Permit No. NM- 0001B/3-10P, and adopted by the director of MMD, there may be a small amount of draw down due to usage associated with coal mining activities, but this draw down is insignificant in comparison to the City of Gallup and Navajo Nation consumption impacts.

To further substantiate this information and to show current information pertaining to the Gallup Sandstone formation, P&M has developed a revised structure map of the Gallup Sandstone formation. This map has been included in this application as Exhibit 3.4-1. It should be noted that this map supplements or supersedes information provided in the BBHIV pertaining to the Gallup Sandstone formation. The changes made in the Gallup Sandstone Structure map are based on information collected from the drill logs for the four Gallup Sandstone Aquifer wells in use at McKinley Mine, therefore only the information in the immediate vicinity of the Mine has been modified.

In addition P&M has developed a new map showing the current potentiometric surface of the Gallup Aquifer. This map has been included in this application as Exhibit 3.4-2. Elevations of the potentiometric surface of the Gallup Sandstone Aquifer have been modified to reflect the current static water levels for the four Gallup Sandstone Aquifer wells in use at McKinley Mine. As with Exhibit 3.4-1, only the information in the immediate vicinity of the Mine has been modified. P&M has been unable to gather information on any of the other wells in the area due to a lack of ownership. Therefore, the information provided is the most complete and accurate available.

Alluvial Aquifers

As discussed above, the alluvial water is practically nonexistent, occurring generally in close proximity to the arroyos, and in direct relation to the rate and amount of runoff in the arroyo. This water soaks into the sides and bottoms of the arroyos during runoff events. This type of recharge occurs principally during snowmelt and the summer runoff season. The only instance where this type of groundwater will be affected by the mining operations, is where alluvial areas are actually mined. The hydrologic impact on this groundwater source will be complete removal of the resource when encountered during mining. However, due to the limited areal extent of the resource, any impacts would be considered negligible.

Bedrock Aquifers

As discussed above, the bedrock water quantity is minimal in extent, consisting only as small pockets of perched water in the various stratums being excavated in the mining process. The quantity and areal extent of these pockets of water are not of sufficient quantity or quality to be considered usable. This water is normally observed as seepage from the highwall or small amounts of water on the pit floor. The mining operation results in removal of this insignificant groundwater source.

GROUNDWATER QUALITY

Gallup Sandstone Aquifer

As is noted above in the discussions on groundwater quantity, there will be no impact by mining on the recharge zones of the Gallup Sandstone Aquifer. Due to this, there will also be no impact on the quality of the Gallup Sandstone Aquifer by the mining operations.

Alluvial Aquifers

The alluvial water quality, in undisturbed areas, will continue to be influenced primarily by the amount of runoff in the arroyos and characteristics of the soils in the area of infiltration. There will be minimal impacts on the quality of this resource by the mining operations.

Bedrock Aquifers

The bedrock water encountered during mining will be removed in the mining process. This removal will have no effect on the water present in areas not affected by mining. This is due to the low transmissivity associated with this type of water.

3.4.5 CUMULATIVE HYDROLOGIC IMPACT ASSESSMENT

The Cumulative Hydrologic Impact Assessment (CHIA) completed by the Radian Corporation for the Office of Surface Mining as part of the Technical Analyses and Environmental Assessment by OSMRE on Permit No. NM-0001B/3-10P, and adopted by the Director of MMD, covers all of the areas to be mined by this application and is still valid. Included below is a brief synopsis of the conclusions of the CHIA:

- Surface-water use in the area is primarily stock watering with some irrigation. There are no permitted water rights holders downstream of the mining operation in the cumulative impact area. Indicator parameters related to hydrologic concerns in the basin are total dissolved solids and total suspended soilds (TSS) concentrations.

- Cumulative impacts to the quantity of the flow in the Puerco River are insignificant.

- Cumulative impacts to the quality (TDS and TSS) of flows in the Puerco River are minimal and should not cause significant changes in baseline conditions. No material damage to the hydrologic balance is expected.

- Ground water is an important source of water in the Gallup area. The major ground water pumping centers are at the Santa Fe and Yah-ta-hey well fields, both completed in the Gallup Sandstone and operated by the city of Gallup. Other users of the Gallup Aquifer include the McKinley and Mentmore mines north west of Gallup. Shallow ground water is not widely used owing to the relatively poor chemical quality and small well yields.

- Cumulative impacts related to ground-water quality are not expected: ground-water quality in terms of TDS and sulfate has not been demonstrated to change significantly and the poor physical properties of the near-surface deposits are not greatly altered by mining.

  Ground-water quantity in the Gallup aquifer may be affected by the cumulative impacts of mining, particularly if declared water rights are fully used by P&M. Calculations of water-level drawdowns indicate that the Yah-ta-hey well field could experience up to 3 feet of drawdown attributable to mining activities; this does not constitute material damage. No material damage, based upon a criterion of a decline of 25% of available hydraulic head, is predicted as a result of surface coal mining.

Thus, based upon the report, P&M feels that any impacts which have or will occur on the hydrologic systems at the McKinley Mine are insignificant.

3.4.6 DEVELOPED WATER RESOURCES

All identified developed water resources in the proposed permit area and within 1000 feet of the proposed permit boundary are shown on Exhibit 3.4-3 and are listed in Tables 3.4-1 and 3.4-2. A total of 55 developed water resources were identified:

- 18 wells;
- 20 impoundments;
- 10 storage tanks;
- 2 cisterns;

- 2 windmills;
- 1 spring;
- 1 watering trough; and
- 1 pipeline.

Thirty one of the developed water resources are within the permit boundary and 23 are within 1000 feet of the permit boundary. One developed water resource, the NTUA pipeline, is located both outside and inside the proposed permit area.

SURFACE WATER RESOURCES

Developed surface water resources in the proposed permit area and within 1000 feet of the proposed permit boundary consist of 18 impoundments and 2 cisterns. The 18 impoundments are used for harvesting water from precipitation events. The two cisterns are associated with Impoundment 31. Table 3.4-1 provides a listing of these structures along with their associated coordinates.

Thirteen of the impoundments (Nos. 12, 13, 14, 15, 16, 17, 19, 22, 23, 24, 31, 32, and 33) and the two cisterns are located within the proposed permit area. Of these developed water resources, only ten impoundments (Nos. 12, 13, 14, 15, 16, 17, 19, 22, 23, and 24) will be disturbed during the life of operations in this application. These impoundments will be replaced with stock ponds as shown on Exhibit 5.6-2 during final reclamation.

TABLE 3.4-1
DEVELOPED SURFACE WATER RESOURCES

ID#	DESCRIPTION	NORTHING	EASTING
11	Impoundment	1,697,985	177,374
12	Impoundment	1,694,686	174,879
13	Impoundment	1,693,735	175,646
14	Impoundment	1,692,544	176,124
15	Impoundment	1,692,011	174,862
16	Impoundment	1,691,236	174,871
17	Impoundment	1,691,052	175,149
19	Impoundment	1,686,502	172,716
22	Impoundment	1,684,310	172,871
23	Impoundment	1,684,253	175,964
24	Impoundment	1,682,725	175,078
31	Impoundment	1,680,006	176,880
31A	Cistern	1,679,694	177,031
31B	Cistem	1,679,779	177,337
32	Impoundment	1,675,475	176,282
33	Impoundment	1,672,150	173,462
34	Impoundment	1,673,635	162,954
35	Impoundment	1,671,459	165,024
37	Impoundment	1,670,010	168,053
38	Impoundment	1,669,920	171,666

Four impoundments (Nos. 34, 35, 37, and 38) located outside the permit area are located downslope of Area 9 mining activities and could be impacted temporarily as mining progresses to the east. However, the decrease in recharge capacity to the impoundments will be short term and minimal since post mining contours are designed to recreate original drainage patterns and only a portion of the drainage area to the impoundments will be disturbed. Impoundment 11 will not be affected by mining because it is located on the Navajo Indian Reservation and is upslope of Area 11 mining activities.

GROUND WATER RESOURCES

Developed ground water resources in the proposed permit area and within 1000 feet of the proposed permit boundary consist of 18 wells, 2 impoundments, 10 storage tanks, 1 spring, 2 windmills, 1 watering trough, and the NTUA water pipeline. These water resources are listed in Table 3.4-2 along with their associated coordinates.

Six water storage tanks (Nos. 1A, 5A, 6A, 10A, 20A, 20B), 1 impoundment (No. 10B), 1 watering trough (No. 36), and 2 windmills (Nos. 4A and 10C) are located off the proposed permit area and will not be disturbed.

Location of the NTUA pipeline (No. 39) is shown on Exhibit 3.4-3. The pipeline crosses within the proposed permit area on the eastern boundary parallel to County Road 1. This area will not be disturbed by mining operations.

Storage Tanks 8A, 18A, 21A and 26A and Impoundment 8B are located within the proposed permit area. These storage facilities will not be disturbed by mining operations and will be left in place for post mining use.

A hand dug, concrete-lined gallery known as Claw Springs (No. 9) is the only known bedrock ground water resource identified in the permit area. This site was developed by the Navajo Tribe for use by area residents and their livestock. Claw Springs consists of a concrete-lined water trough, a hand pump, and an overhead loading facility. The facility is in dire need of repair and is not usable in its present condition. Information (e.g. well depth, quantity, and rate of discharge) was not available from the Navajo Tribe. Water samples were collected on February 6, 1990 by P&M. Analytical results from the February 6, 1990 sample and initial sampling conducted in 1980 are provided in the BBHIV.

Table 3.4-3 contains information that has been gathered concerning the intended use, static water level, date measured, date sampled, source of water, and depth drilled for all developed water wells in and within 1000 feet of the proposed permit boundary. Five of the water wells (Nos. 25, 27, 28, 29 and 30) have been plugged with drilling fluids in accordance with New Mexico State Engineer Office guidelines. The remaining 13 wells (Nos. 1, 2, 3, 4, 5, 6, 7, 8, 10, 18, 20, 21, and 26) will not be disturbed by mining activities.

TABLE 3.4-2
DEVELOPED GROUND WATER RESOURCES

WELL ID#	DESCRIPTION	NORTHING	EASTING
1	NTUA Well 18T516	1,698,339	148,768
1A	Water Tank	1,698,359	147,870
2	NTUA Well 18T517	1,698,732	149,891
3	NTUA Well 18T551	1,698,889	154,286
4	Well (Bald)	1,695,175	148,601
4A	Windmill	1,695,407	148,429
5	Well (Mag 7A)	1,688,099	152,022
5A	Water Tank	1,687,746	151,867
6	Well (Mag 7B)	1,689,405	154,430
6A	Water Tank	1,689,321	154,364
7	Well (CDK)	1,691,754	157,629
8	NTUA Well 16T550	1,691,632	167,573
8A	Water Tank	1,691,706	167,649
8B	Impoundment	1,691,748	167,525
9	Claw Spring	1,696,185	168,751
10	NTUA Well 14T509	1,697,936	176,244
10A	Water Tank	1,698,031	176,265
10B	Impoundment	1,697,989	176,015
10C	Windmill	1,697,923	176,109
18	Well (Wilhelm)	1,687,316	177,471
18A	Water Tank	1,687,162	177,429
20	Well (Blackhat)	1,685,759	166,462
20A	Water Tank	1,685,965	166,005
20B	Water Tank	1,685,853	166,178
21	Well (McAvoy)	1,684,677	169,126
21A	Water tank	1,684,724	168,982
25	Well (plugged)	1,683,897	171,649
26	Well (South Tipple)	1,683,897	157,875
26A	Water Tank	1,682,480	157,803
27	Well (plugged)	1,681,514	168,621
28	Well (plugged)	1,681,435	169,841
29	Well (plugged)	1,681,158	168,729
30	Well A-61 (plugged)	1,680,417	168,646
36	Watering Trough	1,670,895	164,471
39	NTUA Water Pipeline	See Exhibit 3.4-3	

Water samples from Wells 7 and 26 were collected on June 20, 1990 by P&M. Analytical results for the two June 20 samples plus NTUA Wells 14T-509 and 16T-550 are provided in the BBHIV.

Wells 7 and 21 are deep wells drilled into the Gallup aquifer by P&M for mine use. Well 26 is a Gallup aquifer well that was developed by a private business prior to P&M purchasing the property around the well. These wells and two storage tanks (Nos. 21A and 26A) will be left in place for post mining use to replace plugged wells. Well construction details for Wells 7 and 26, (a.k.a Well #1 and Well #3) and Gallup aquifer Wells #2 and #3A, which are Gallup aquifer wells drilled by P&M on the North Mine area, have been included as Figures 1 through 4 following this section.

TABLE 3.4-2
SUMMARY OF WATER WELL RESOURCE INFORMATION

WELL ID#	WELL NAME	INTENDED USE OF WATER	STATIC WATER LEVEL	DATE MEASURED	DATE SAMPLED	SOURCE OF WATER	DEPTH DRILLED
1	18T516	HC	488.0	11-23-87	*	GD	1600
2	18T517	HC	448.0	11-23-87	*	GD	1680
3	18T551	HC	493.6	06-09-88	*	GDM	1750
4	Bald	HC	*	*	*	G	700
5	Mag 7A	HC	530	*	*	G	777
6	Mag 7B	HC	*	*	*	G	900**
7	CDK	WHR	503	Sep-77	06-20-90	G	1055
8	16T550	HC	684	08-14-69	04-23-70	GD	1363
10	14T509	HC	36	04-04-59	05-16-66	G	477
18	Wilhelm	HC	*	*	*	G	400
20	Blackhat	HC	Dry	Oct-88	*	G	455
21	McAvoy	HC	*	*	*	G	*
25	Section 15 (plugged)	HC	185	05-15-90	*	G	460
26***	South Tipple 1	HC/WHR	332	Sep-75	06-20-90	G	930
27	Section 15 (plugged)	HC	240	05-14-90	*	G	460
28	Section 15 (plugged)	HC	165	05-15-90	*	G	360
29	Section 15 (plugged)	HC	200	05-15-90	*	G	450
30	Section 15 (plugged)	HC	200	05-14-90	*	G	340

NOTES: HC = Human Consumption, WHR = Watering Haulroads, G = Gallup , D = Dakota, M = Morrison
* = Data not Available, ** = Estimated by John Engles, P&M Land Agent, *** = Measured capacity of South Tipple was 1.75 to 2.00 gallons per minute per linear foot.

ALTERNATE WATER SOURCES

If the Gallup Sandstone aquifer were to be determentally affected by mining, P&M has identified alternate water sources that could be developed to replace existing sources. Information was obtained from Mr. John W. Shomaker, geohydrologist, with John W. Shomaker, Inc. of Santa Fe and Albuquerque.

Alternate water sources available from aquifers that underlie the Gallup Sandstone include the aquifer comprised of the Dakota Sandstone and the Westwater Canyon

Member of the Morrison Formation, and the sequence of sandstone beds of the San Rafael Group, including the Cow Springs Sandstone and the Entrada Sandstone. At still greater depth, the San Andres Limestone-Glorieta Sandstone aquifer is likely to be usable for water supply.

A Dakota-Westwater well is likely to be similar to the City of Gallup's Allan No. 1 or Lewis No. 1 North Well, near Yah-Ta-Hey. These wells reached the base of the Westwater at about 3,450 and 3,200 feet, and had one-day specific capacities of 0.38 and 0.18 gpm per foot of drawdown, respectively. Water quality is indicated by specific conductance, which was 1,260 μmhos for the Allan well, and 1,030 μmhos for the Lewis well.

Drilling depths would depend on location within the P&M lands, but would be on the order of 2,000 feet. Locations as far north and east as possible are likely to provide the best well-yield.

The San Rafael Group aquifer consists of several hundred feet of fine-grained sandstone; drilling depth would be about 3,400 feet to fully penetrate the Entrada. Specific capacity is likely to be similar to that of the Westwater Canyon, but water quality may be somewhat poorer. Analysis of the logs of the Kerr-McGee No. 1 Santa Fe well, about 12 miles southeast of the McKinley Mine, indicated salinity equivalent to about 2,100 mg/l sodium chloride, but a well at the mine would be very close to the Entrada outcrop and water quality can be expected to be better.

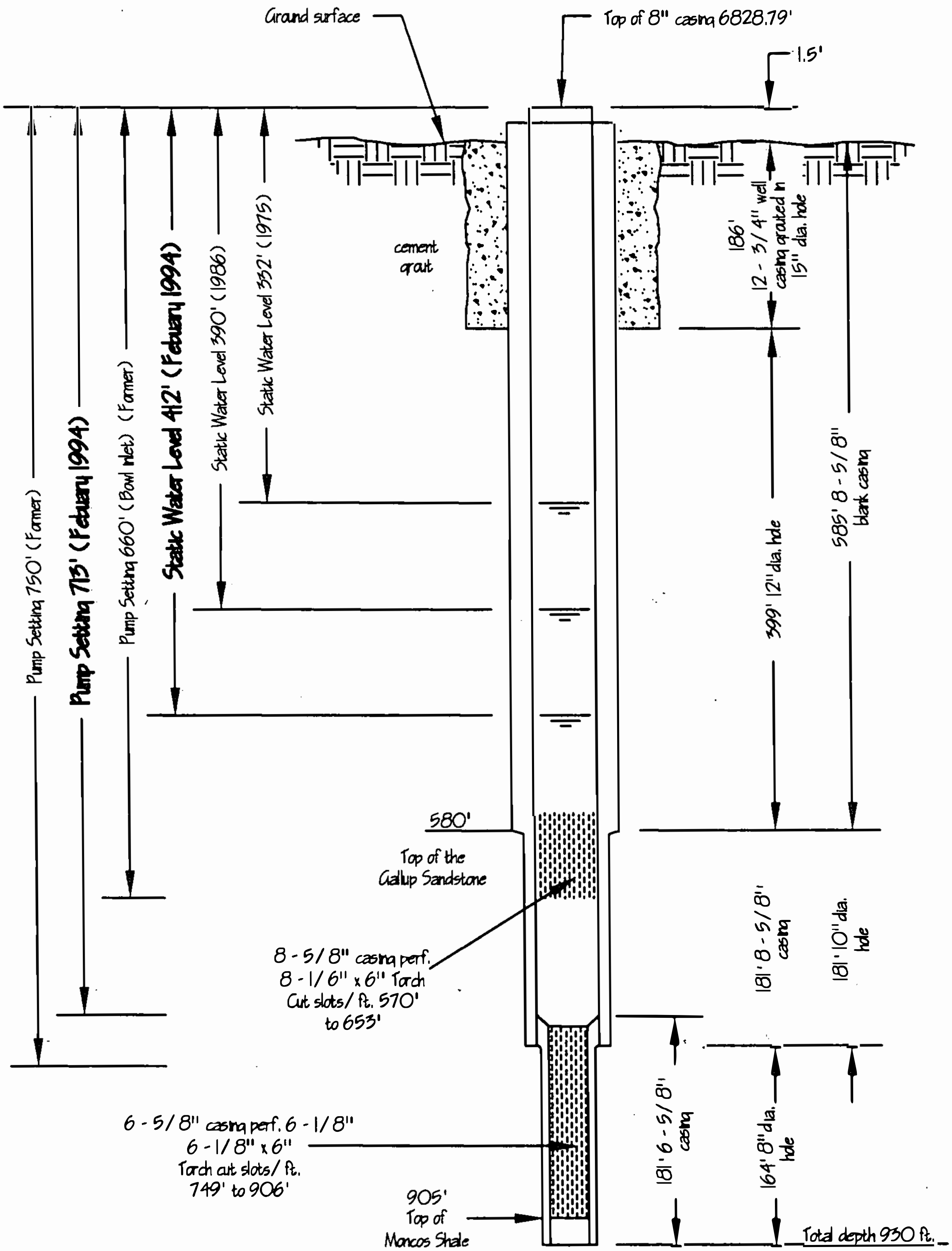
The San Andres-Glorieta aquifer could be completed in a well about 4,000 feet deep. Yield is difficult to estimate, but a specific capacity of 0.1 gpm/ft is a reasonable expectation. Water quality is not known, although in the Kerr-McGee well, the upper part of the aquifer had an apparent salinity equivalent to 4,000 mg/l sodium chloride.

TRANSFER OF WELLS

During this permit term, no water wells are anticipated to be transferred from P&M's control for usage by any other parties. However, should a transfer be contemplated, P&M will apply for approval by both the director of MMD and the State Engineer for the transfer of the well in question.

3.4.7 STREAM BUFFER ZONES

At the McKinley Mine - South there are no channels that are considered to be intermittent; thus, no stream buffer zones are required.



REVISION	DATE	APP'D

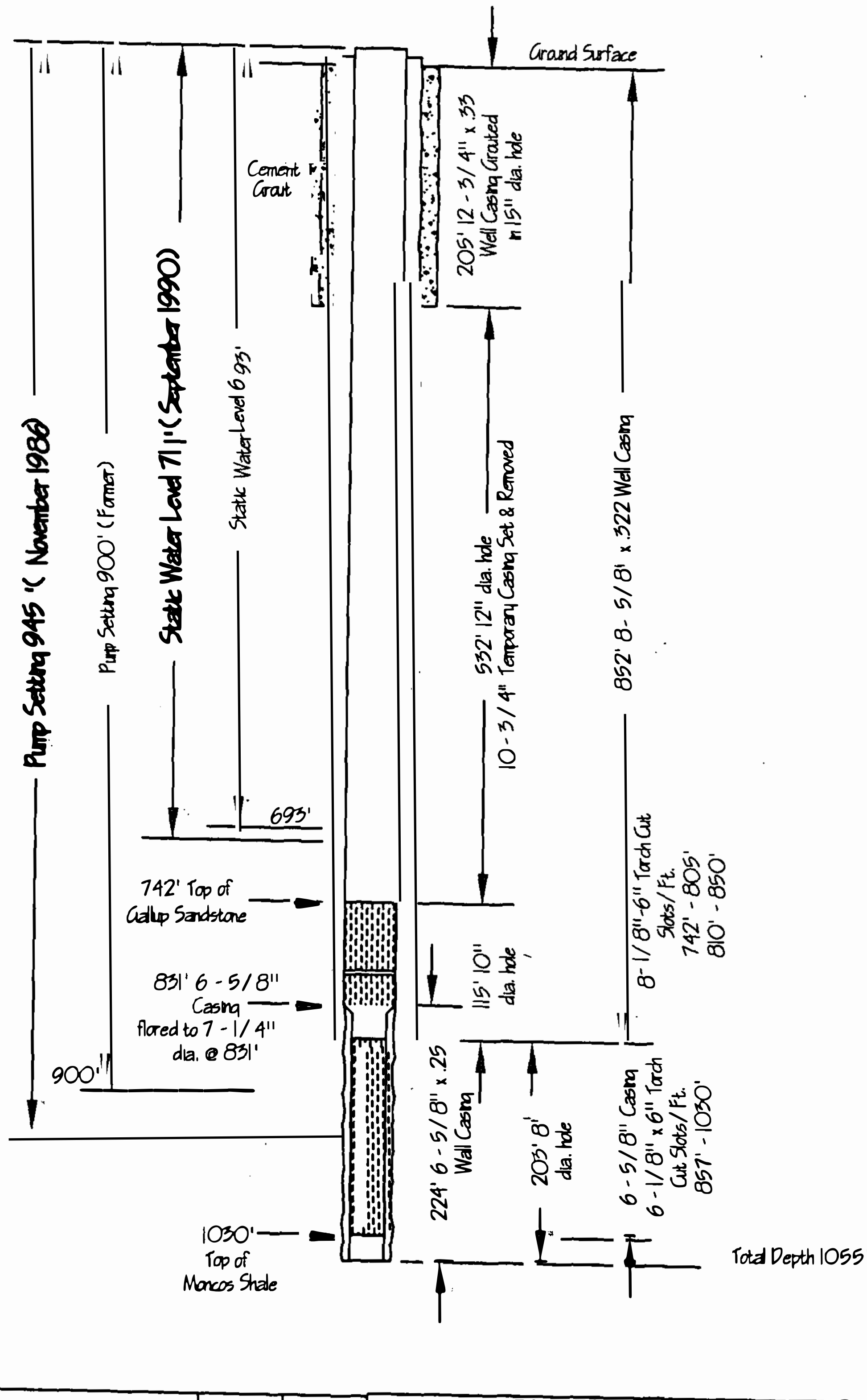
This drawing is the exclusive property of the Pittsburg & Midway Coal Mining Co. with all rights reserved. This drawing must not be copied without explicit permission from P & M management and must be returned upon request.

P&M

The Pittsburg & Midway Coal Mining Co.
A Chevron Company
McKINLEY MINE

FIGURE [illegible]
WELL NO. 1
SCHEMATIC DIAGRAM

Drawn By: A.GRASS
Date Drawn: 2/8/96
Checked By:
Approved By:
Scale: NONE
Drawing No: 0490-1



REVISION	DATE	APP'D

...is drawing is the exclusive property of the Pittsburg & Midway Coal Mining Co. with ...l rights reserved. This drawing must not be copied without explicit permission from ...' & M management and must be returned upon request.

P&M

The Pittsburg & Midway Coal Mining Co.

A Chevron Company

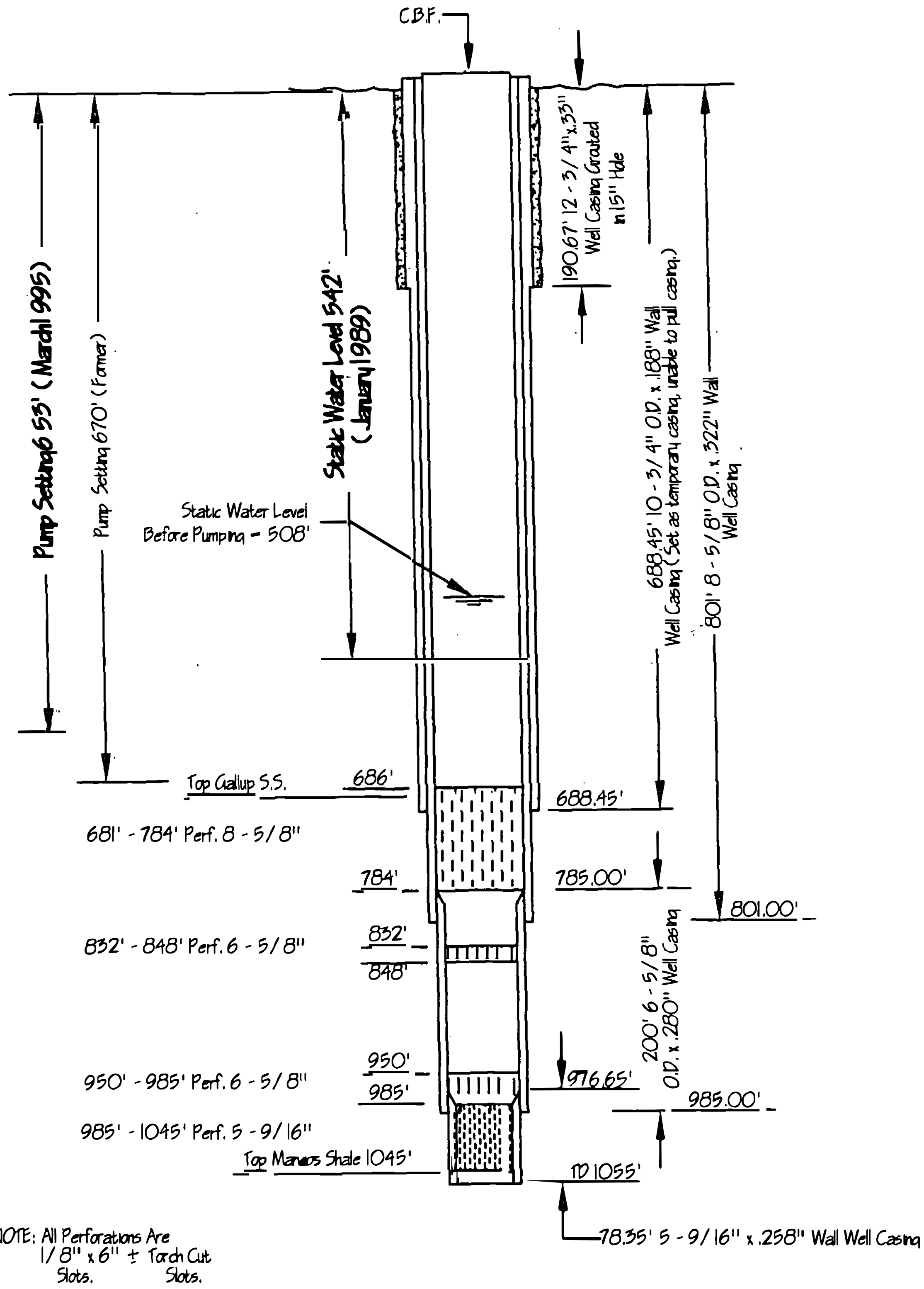
McKINLEY MINE

FIGURE [illegible]2
WELL No. 2
SCHEMATIC DIAGRAM

Drawn By: A.GRASS
Date Drawn: 2/8/96

Checked By:
Approved By:

Scale: NONE
Drawing No: 0490-2



NOTE: All Perforations Are 1/8" x 6" ± Torch Cut Slots.

REVISION	DATE	APP'D

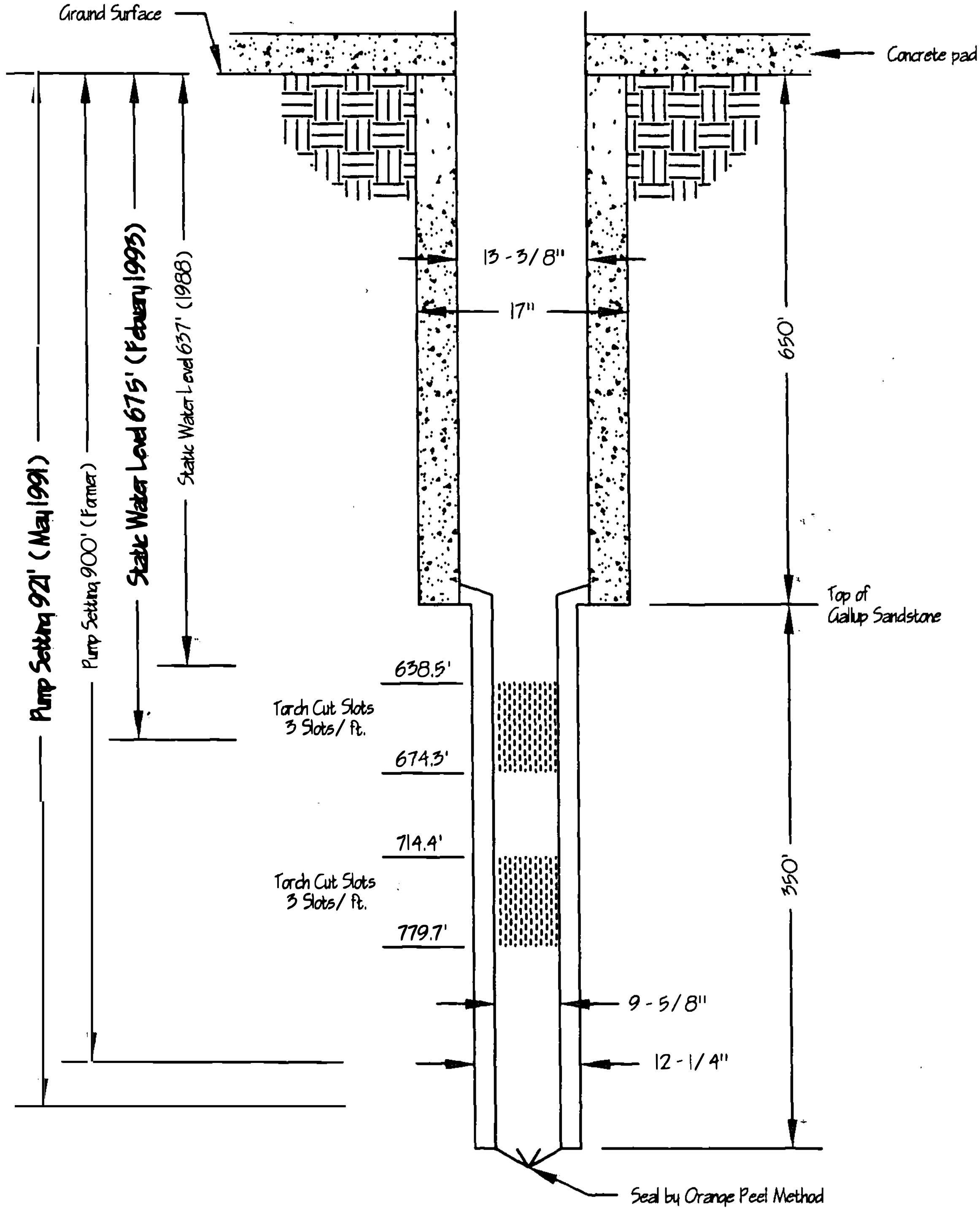
This drawing is the exclusive property of the Pittsburg & Midway Coal Mining Co. with all rights reserved. This drawing must not be copied without explicit permission from P & M management and must be returned upon request.

P&M

The Pittsburg & Midway Coal Mining Co.
A Chevron Company
McKINLEY MINE

FIGURE [illegible]-3
WELL No. 3
SCHEMATIC DIAGRAM

Drawn By: A.GRASS
Date Drawn: 2/8/96
Checked By:
Approved By:
Scale: NONE
Drawing No: 0490-3



REVISION	DATE	APP'D

This drawing is the exclusive property of the Pittsburg & Midway Coal Mining Co. with all rights reserved. This drawing must not be copied without explicit permission from P & M management and must be returned upon request.

P&M

The Pittsburg & Midway Coal Mining Co.
A Chevron Company
McKINLEY MINE

FIGURE [redacted]-4
WELL NO. 3A
SCHEMATIC DIAGRAM

Drawn By: A.GRASS
Date Drawn: 2/8/96

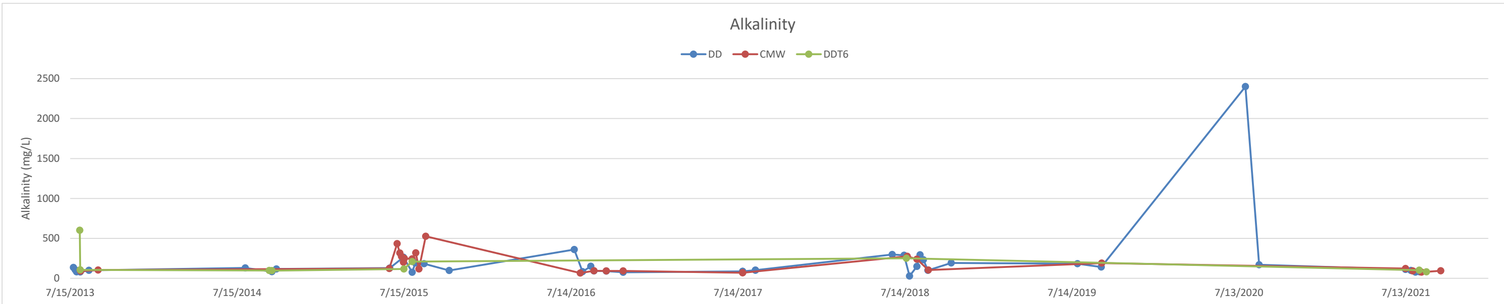
Checked By:
Approved By:

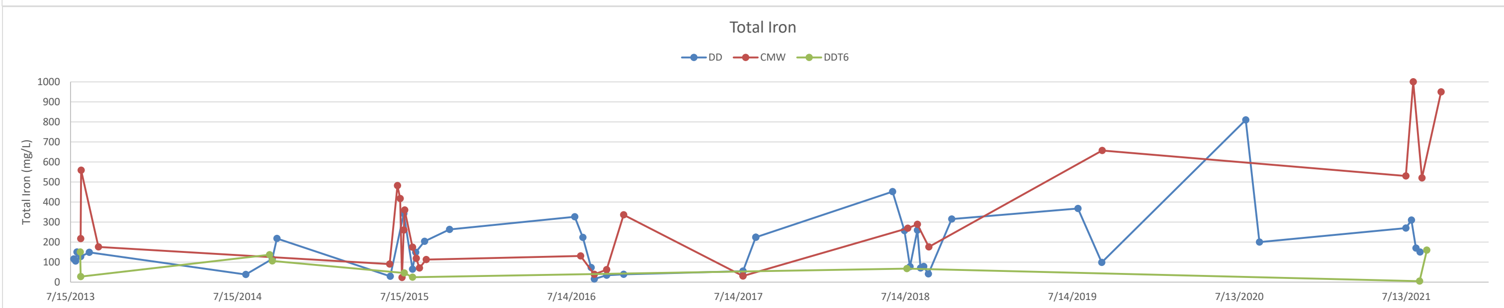
Scale: NONE
Drawing No: 0490-4

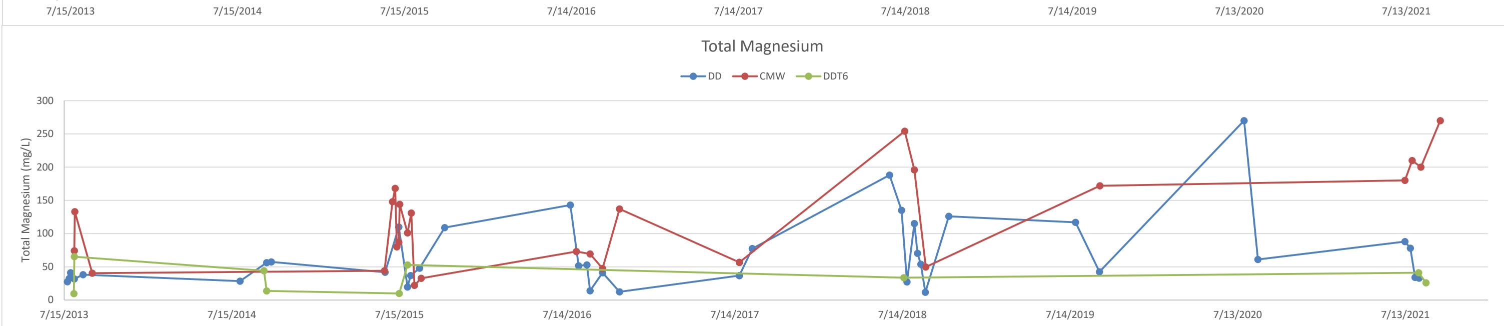
APPENDIX B

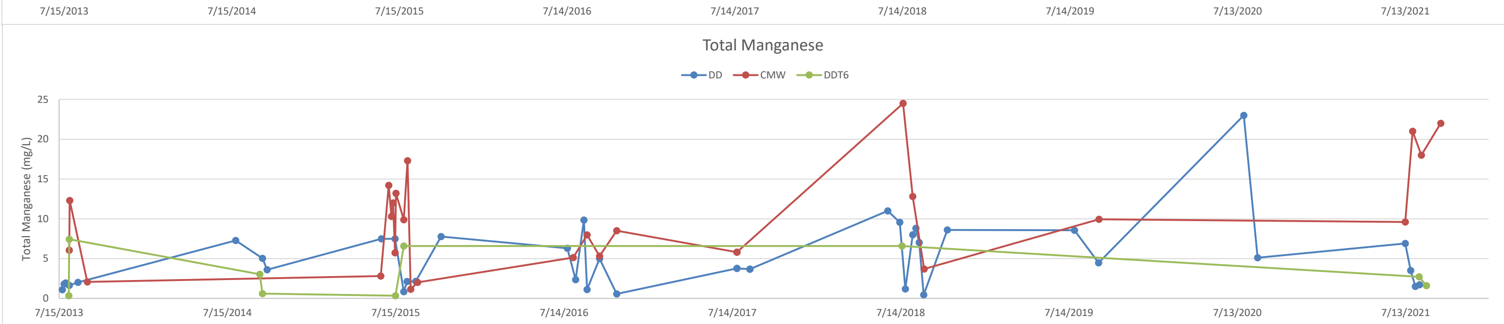
SURFACE WATER QUALITY: TEMPORAL PLOTS

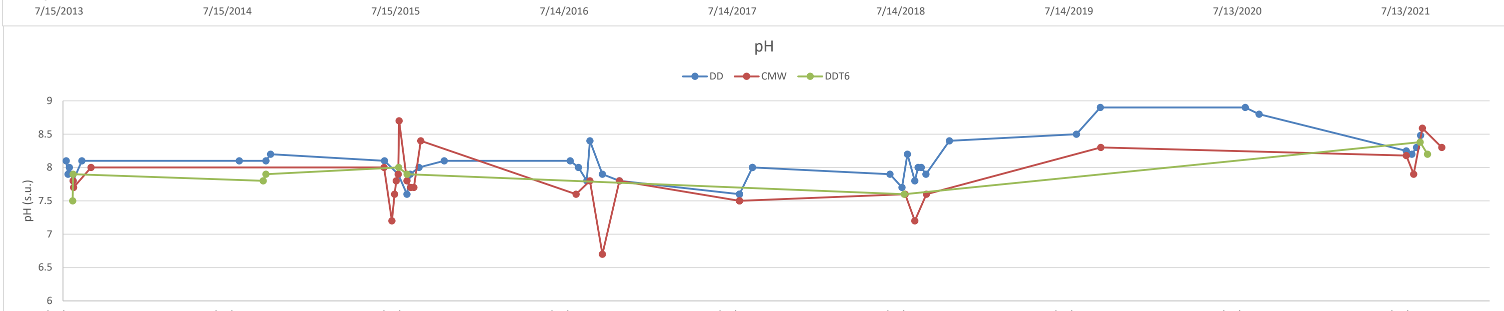
APPENDIX B. SURFACE WATER QUALITY DATA
CHEVRON MINING INC., MCKINLEY MINE
NEAR GALLUP, NEW MEXICO

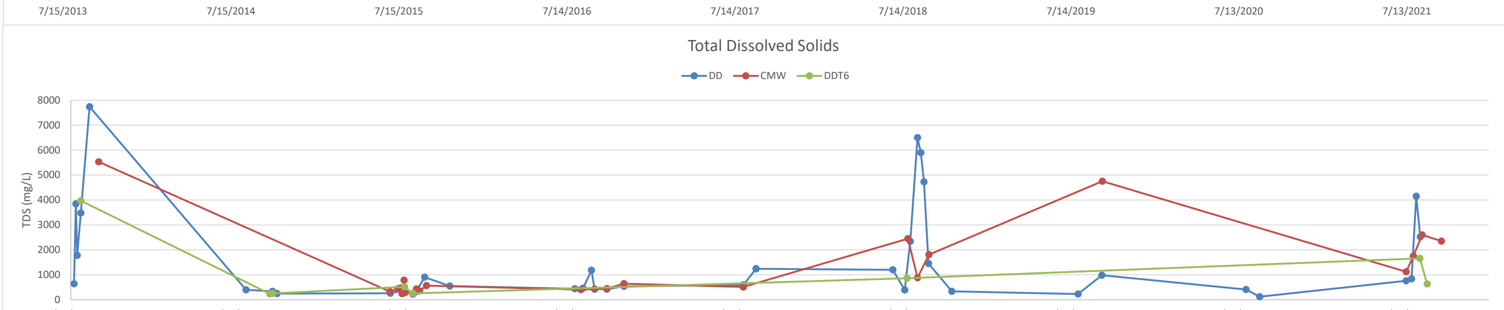


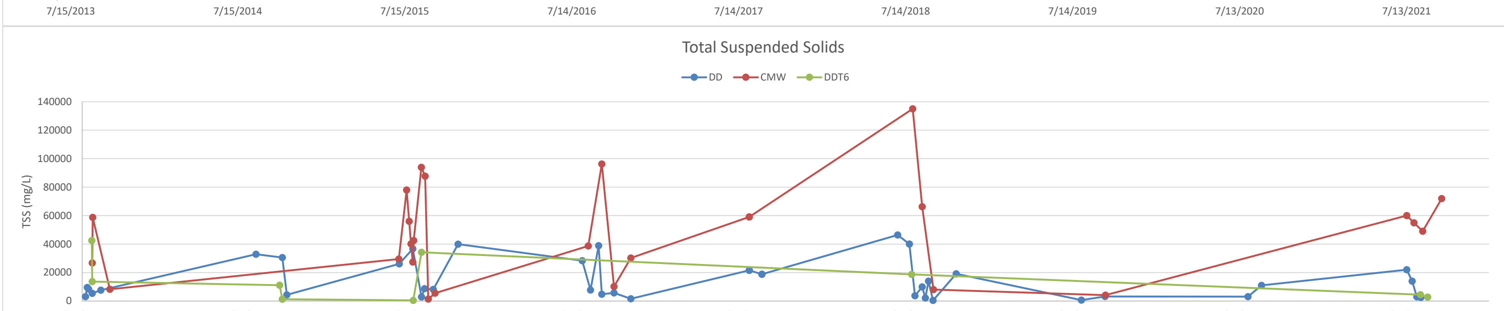


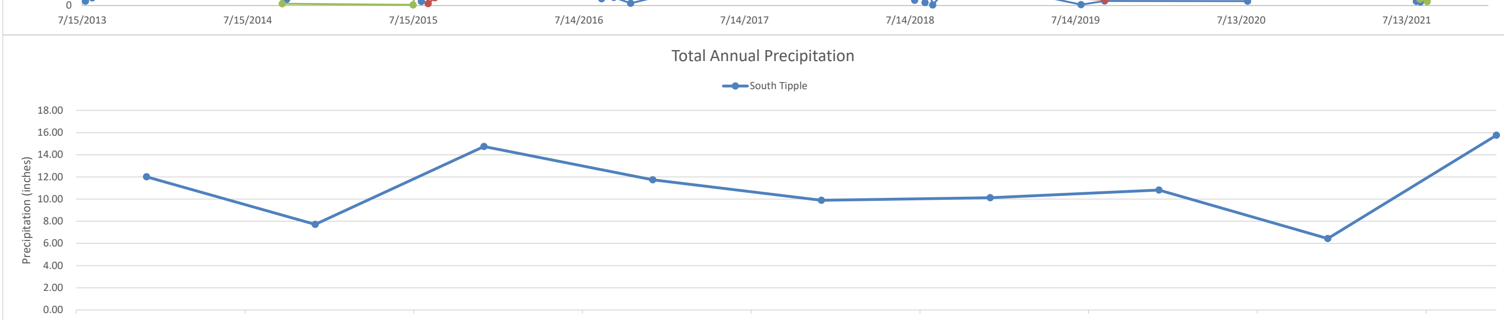


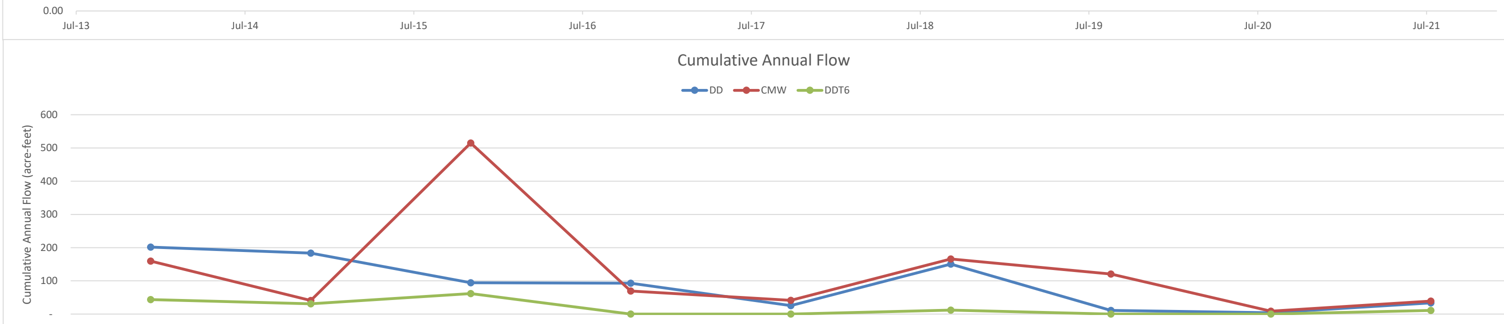












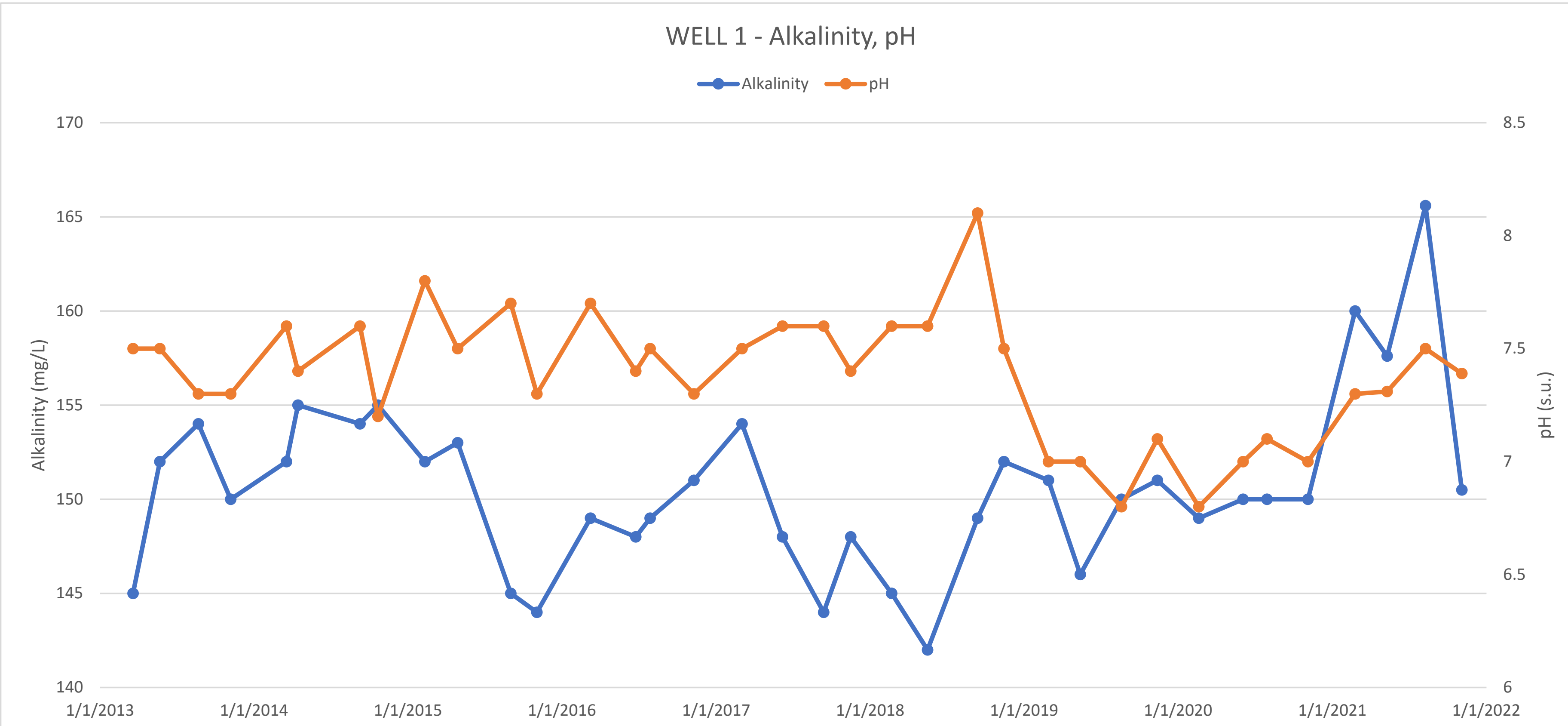
APPENDIX C

GROUNDWATER QUALITY DATA: TEMPORAL PLOTS

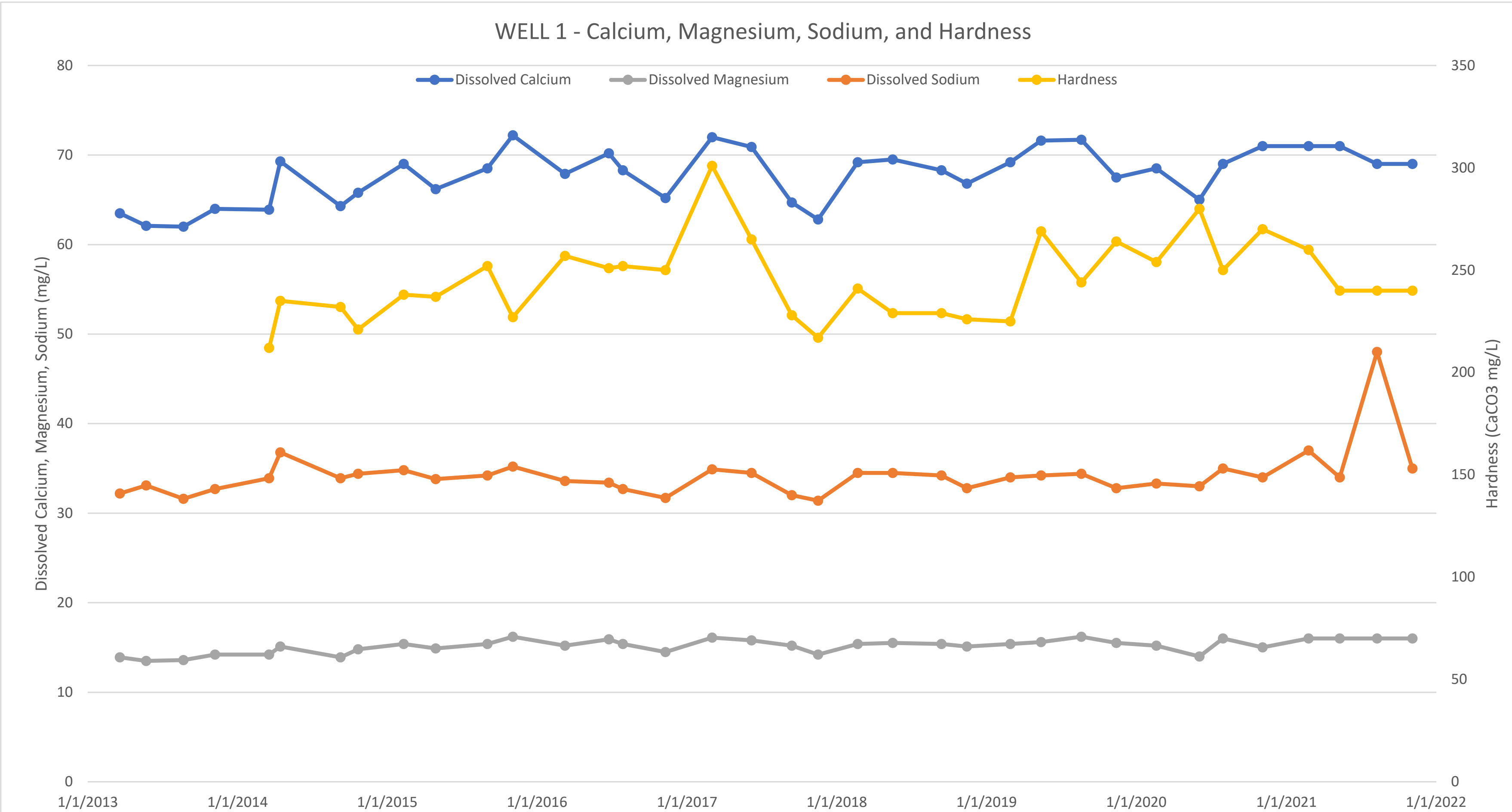
APPENDIX C-1

GROUNDWATER QUALITY – WELL 1: TEMPORAL PLOTS

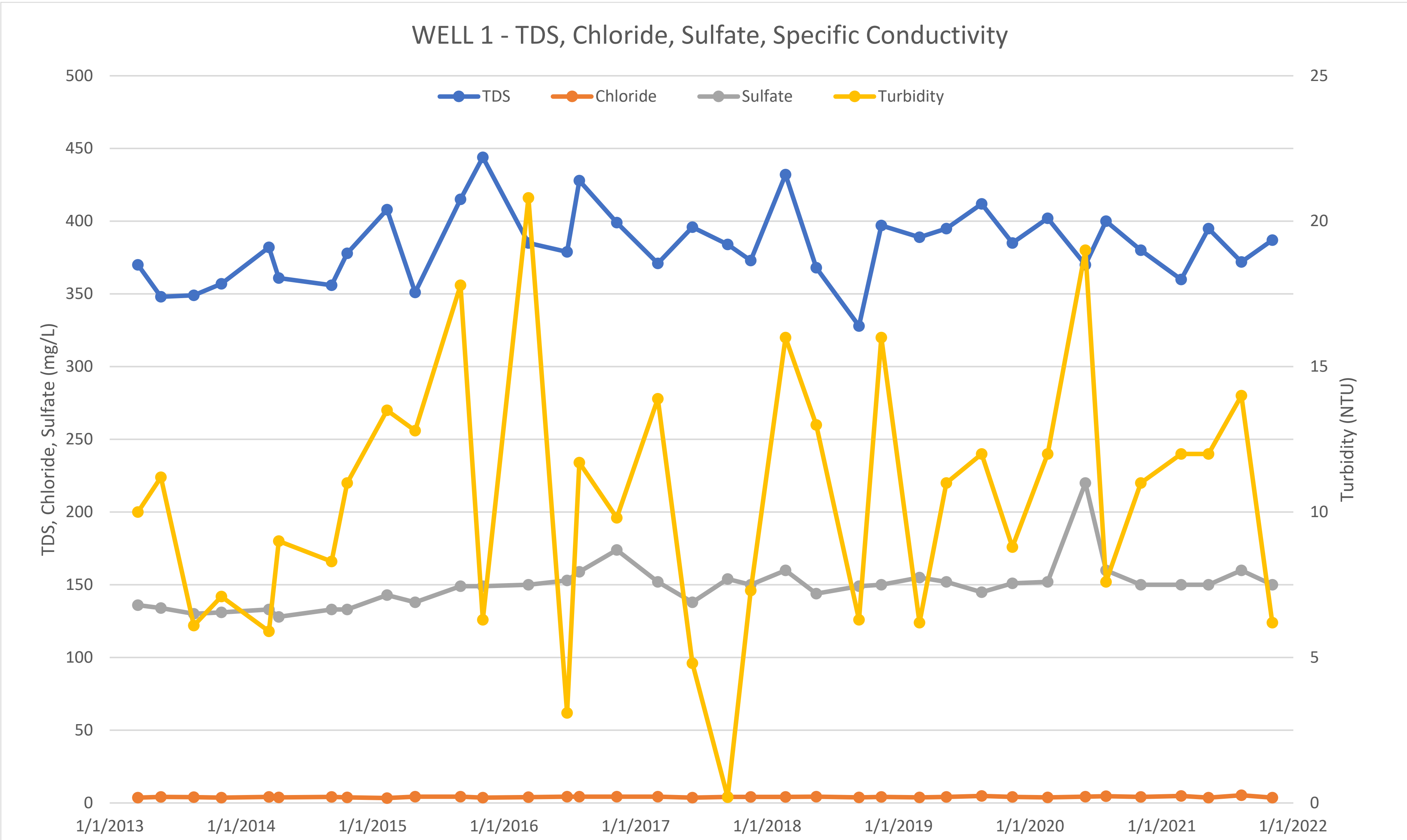
APPENDIX C-1a. WATER QUALITY - WELL 1
CHEVRON MINING, INC., MCKINLEY MINE
NEAR GALLUP, NEW MEXICO



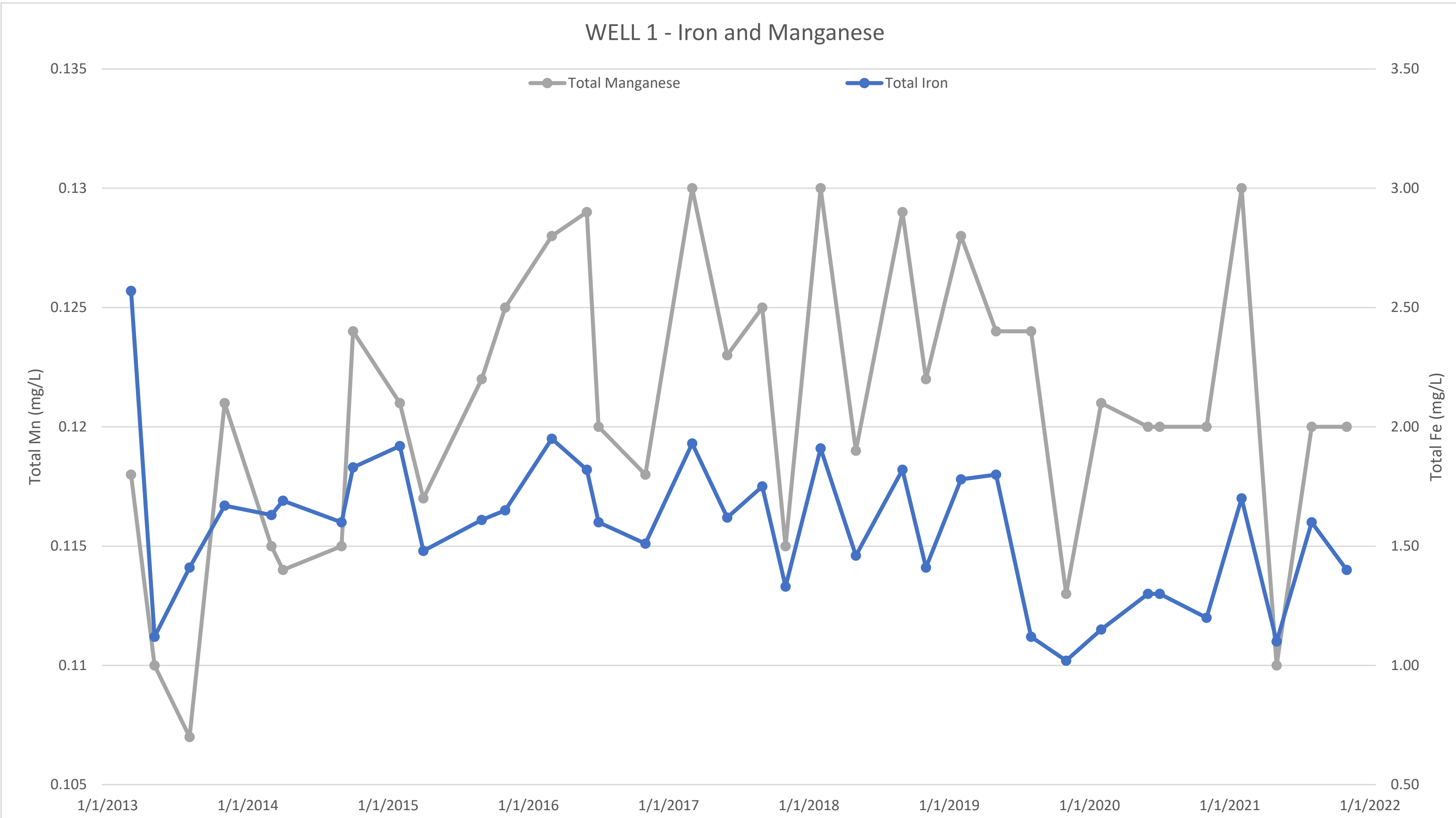
APPENDIX C-1b. WATER QUALITY - WELL 1
CHEVRON MINING, INC., MCKINLEY MINE
NEAR GALLUP, NEW MEXICO



APPENDIX C-1c. WATER QUALITY - WELL 1
CHEVRON MINING, INC., MCKINLEY MINE
NEAR GALLUP, NEW MEXICO



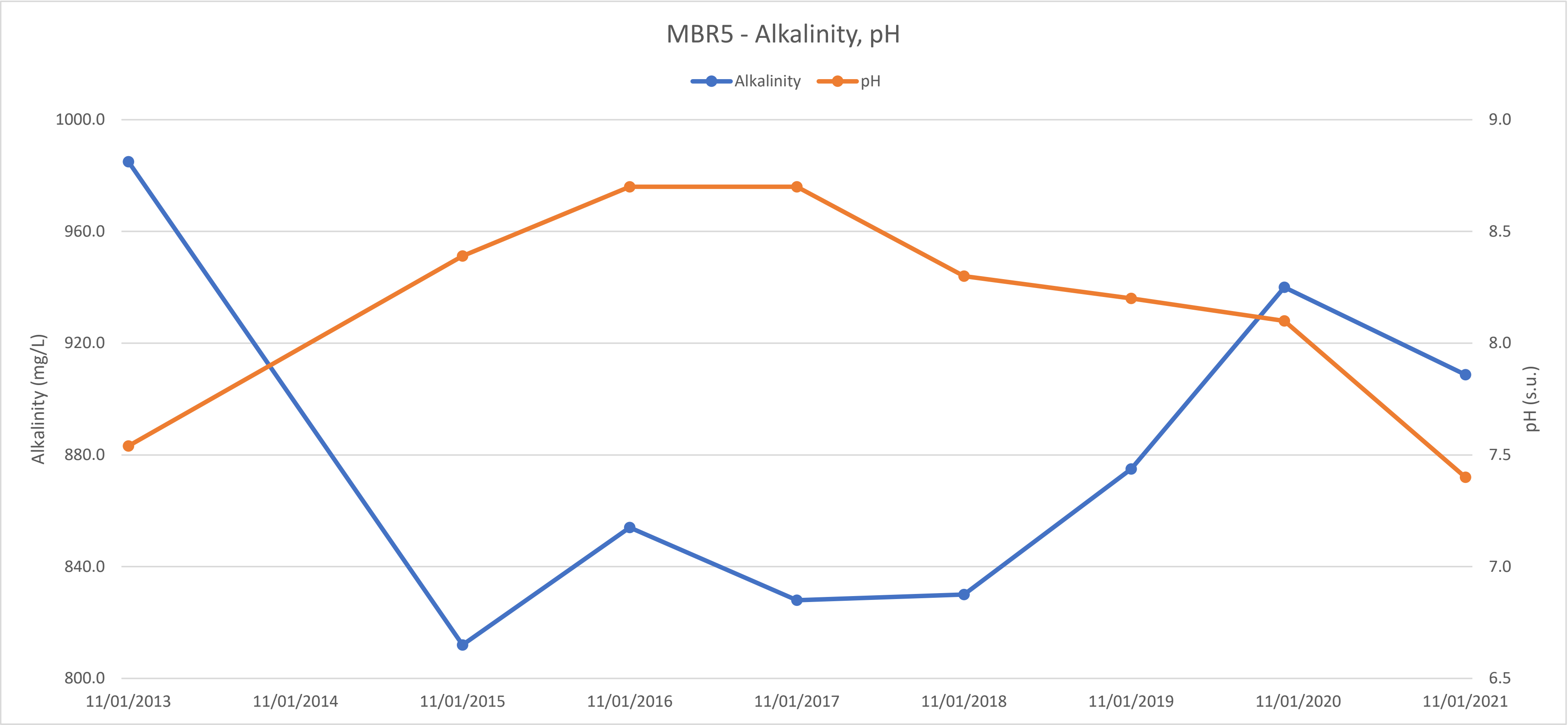
APPENDIX C-1d. WATER QUALITY - WELL 1
CHEVRON MINING, INC., MCKINLEY MINE
NEAR GALLUP, NEW MEXICO



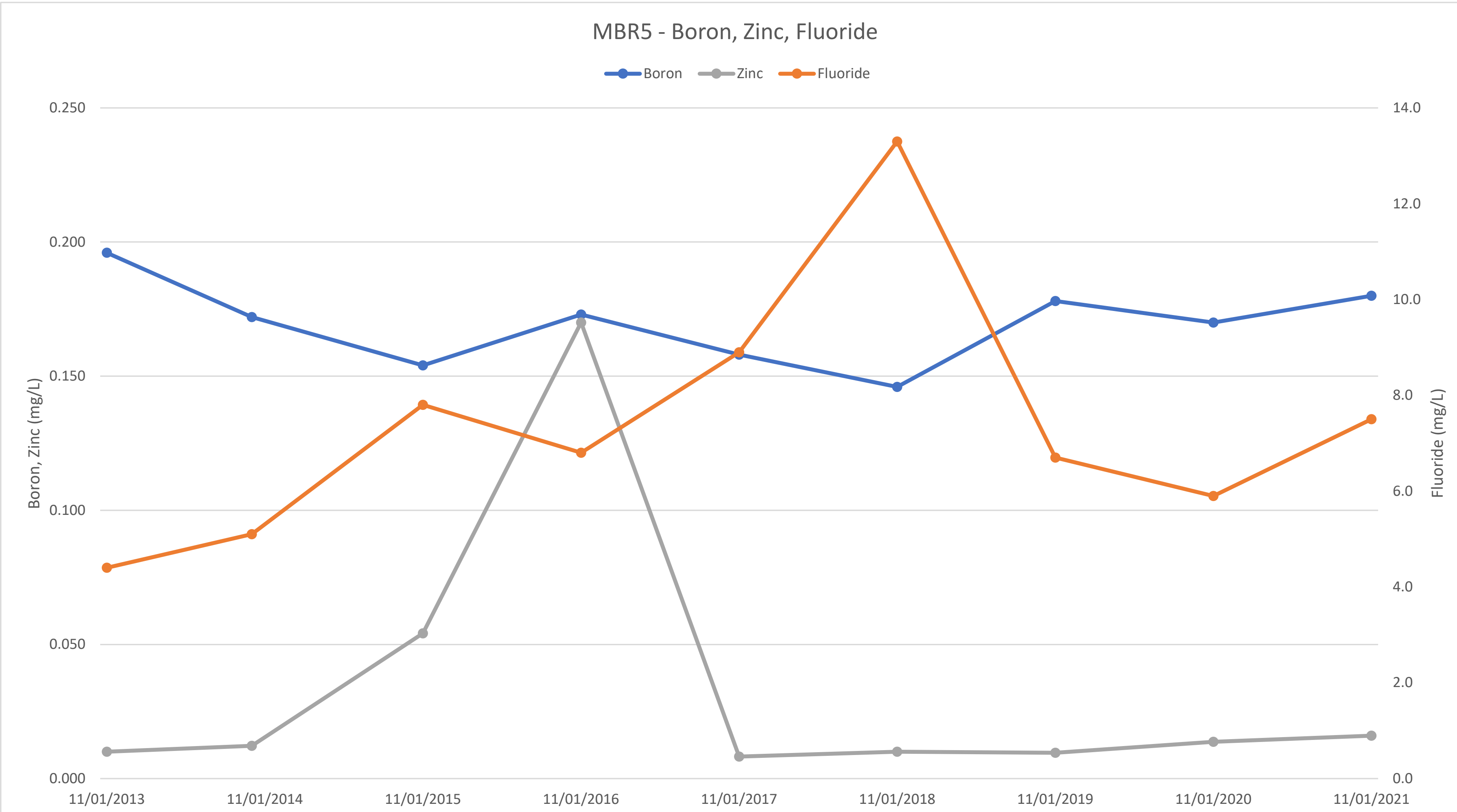
APPENDIX C-2

GROUNDWATER QUALITY – MBR5: TEMPORAL PLOTS

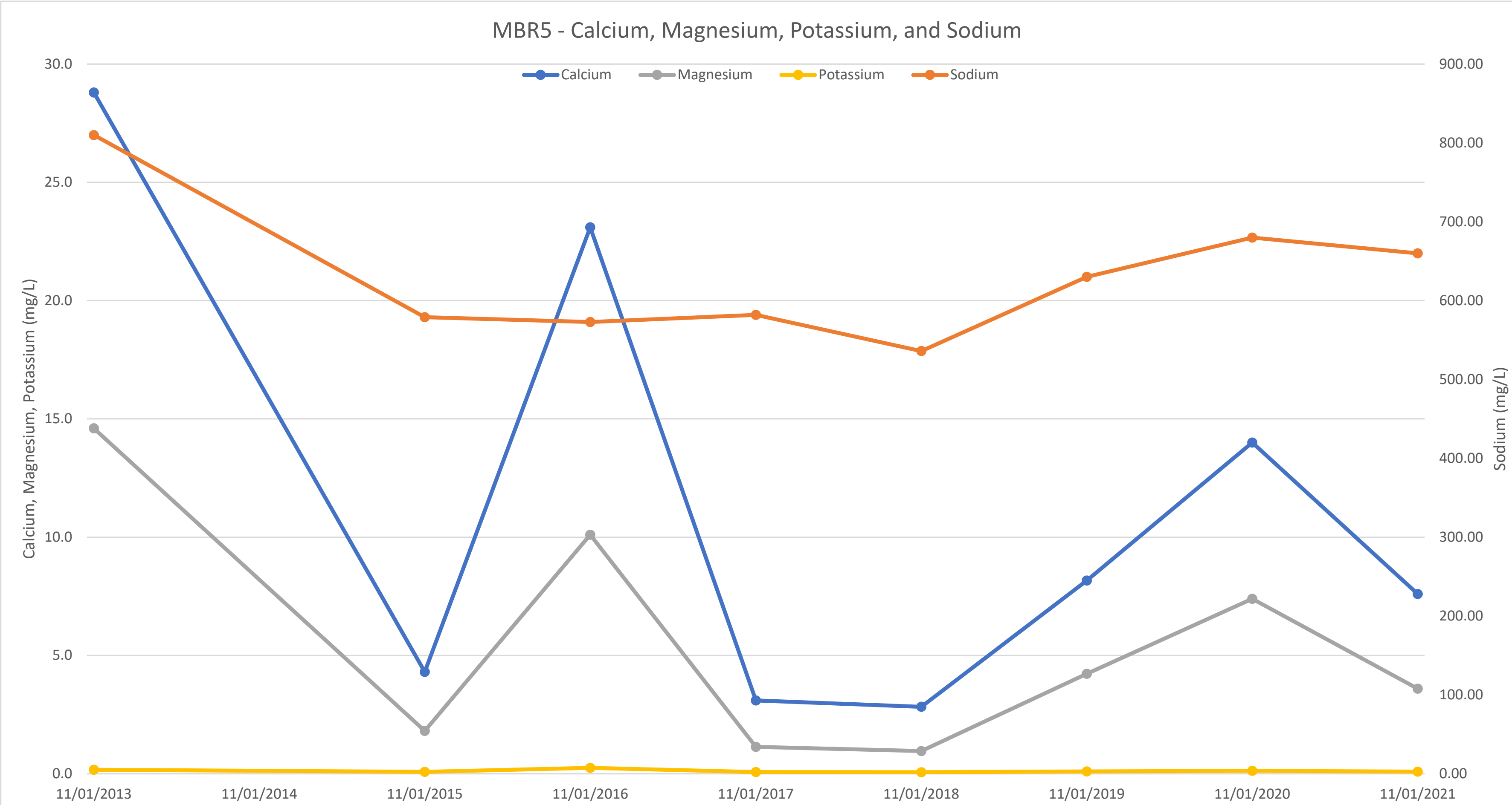
APPENDIX C-2a. WATER QUALITY - MBR5
CHEVRON MINING, INC., MCKINLEY MINE
NEAR GALLUP, NEW MEXICO



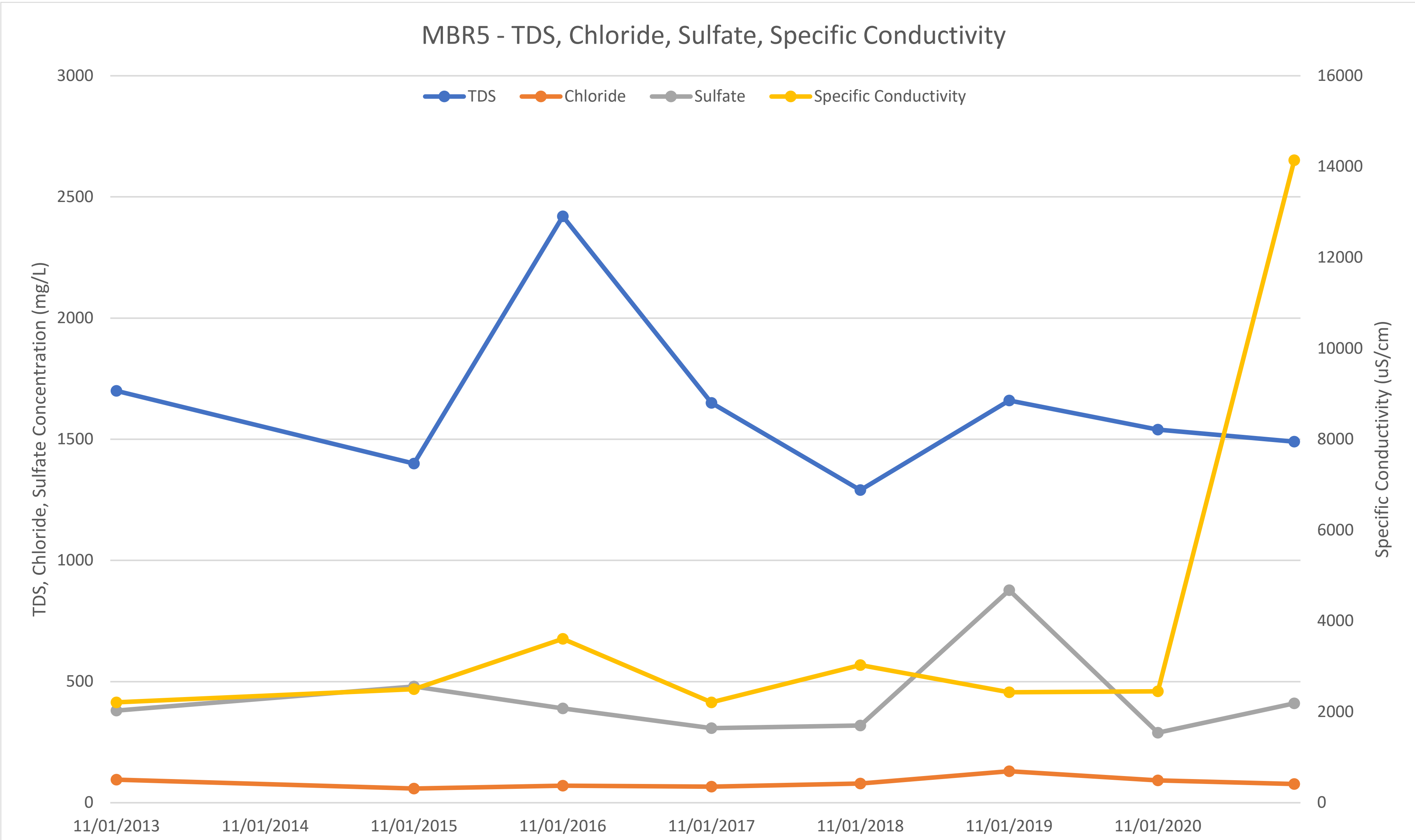
APPENDIX C-2b. WATER QUALITY - MBR5
CHEVRON MINING, INC., MCKINLEY MINE
NEAR GALLUP, NEW MEXICO



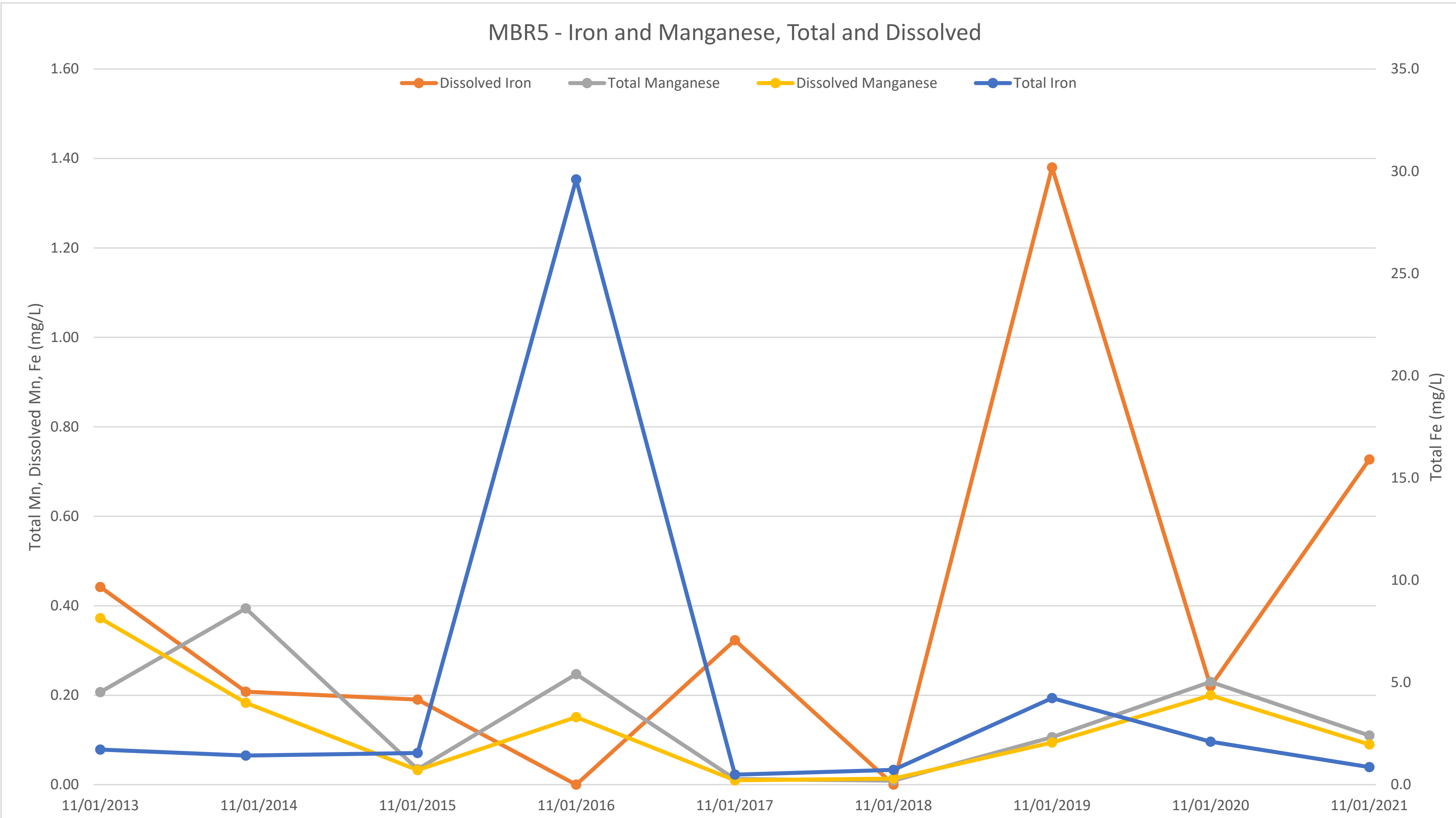
APPENDIX C-2c. WATER QUALITY - MBR5
CHEVRON MINING, INC., MCKINLEY MINE
NEAR GALLUP, NEW MEXICO



APPENDIX C-2d. WATER QUALITY - MBR5
CHEVRON MINING, INC., MCKINLEY MINE
NEAR GALLUP, NEW MEXICO



APPENDIX C-2e. WATER QUALITY - MBR5
CHEVRON MINING, INC., MCKINLEY MINE
NEAR GALLUP, NEW MEXICO



Exhibits

Exhibit A: Area 9S Bond Release – Bond Release Location

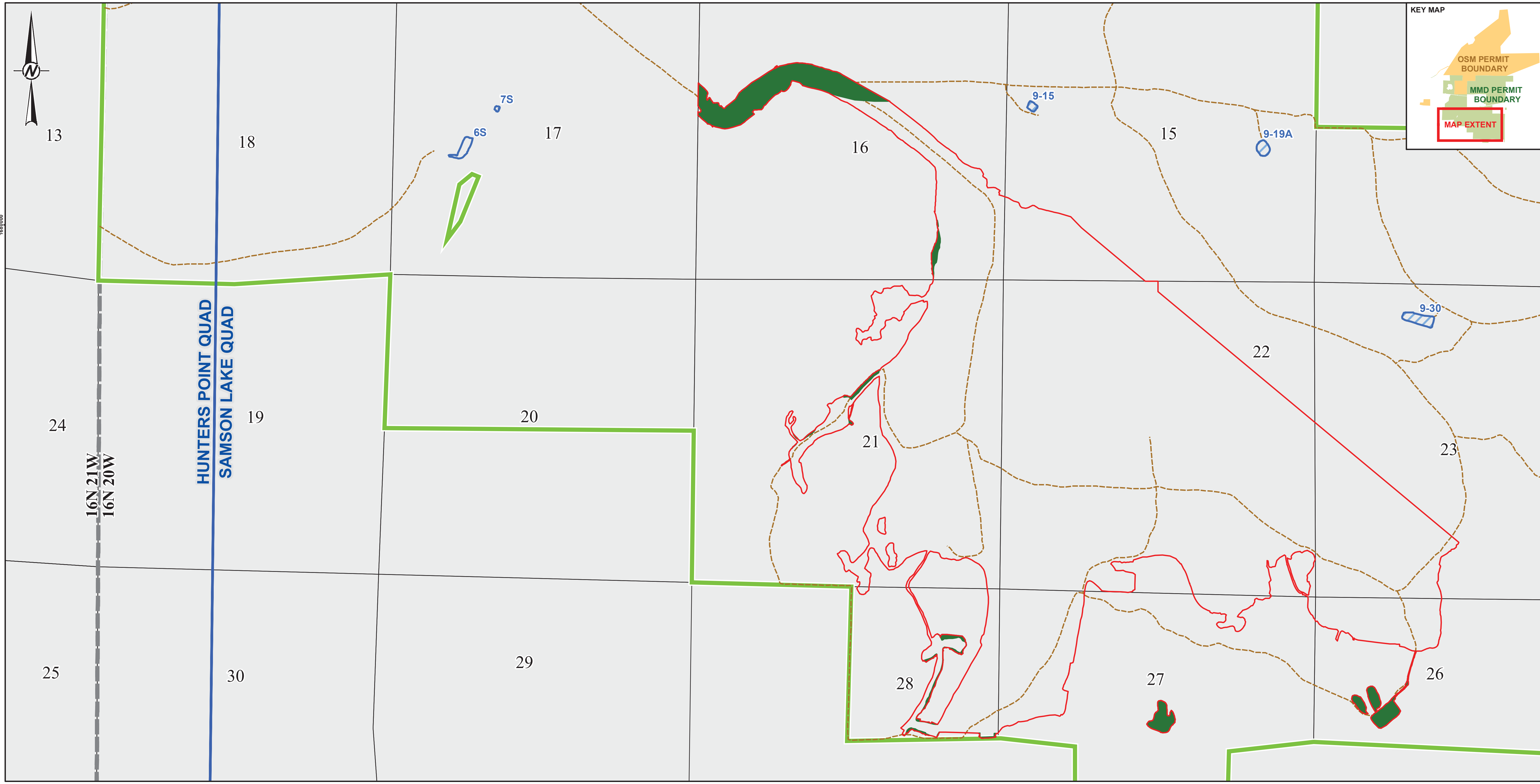
Exhibit B: Area 9S Bond Release – USGS Quadrangle

Exhibit C: Area 9S Bond Release – Postmining Topography

Exhibit D: Area 9S Bond Release – Seeding Map

Exhibit E: Area 9S Bond Release – Aerial

Exhibit F: Area 9S Bond Release – Land Inventory - Surface & Coal



LEGEND

- Phase I Area 9S Bond Release Boundary (42 acs)
- Phase II and Phase III Area 9S Bond Release Boundary (1,193 acs)
- MMD Permit Boundary
- OSM Permit Boundary
- Post-Mining Two-Track Trails
- Permanent Pond
- Pond
- Township and Range
- Section
- USGS 24k Topo Map Boundaries

0 2,000 4,000
Feet

NOTE(S)
1.

REFERENCE(S)
1. COORDINATE SYSTEM: NAD 1983 STATEPLANE NEW MEXICO WEST FIPS 3003 FEET

CLIENT
Chevron Mining Inc.
McKINLEY MINE

PROJECT
CHEVRON MCKINLEY MINE

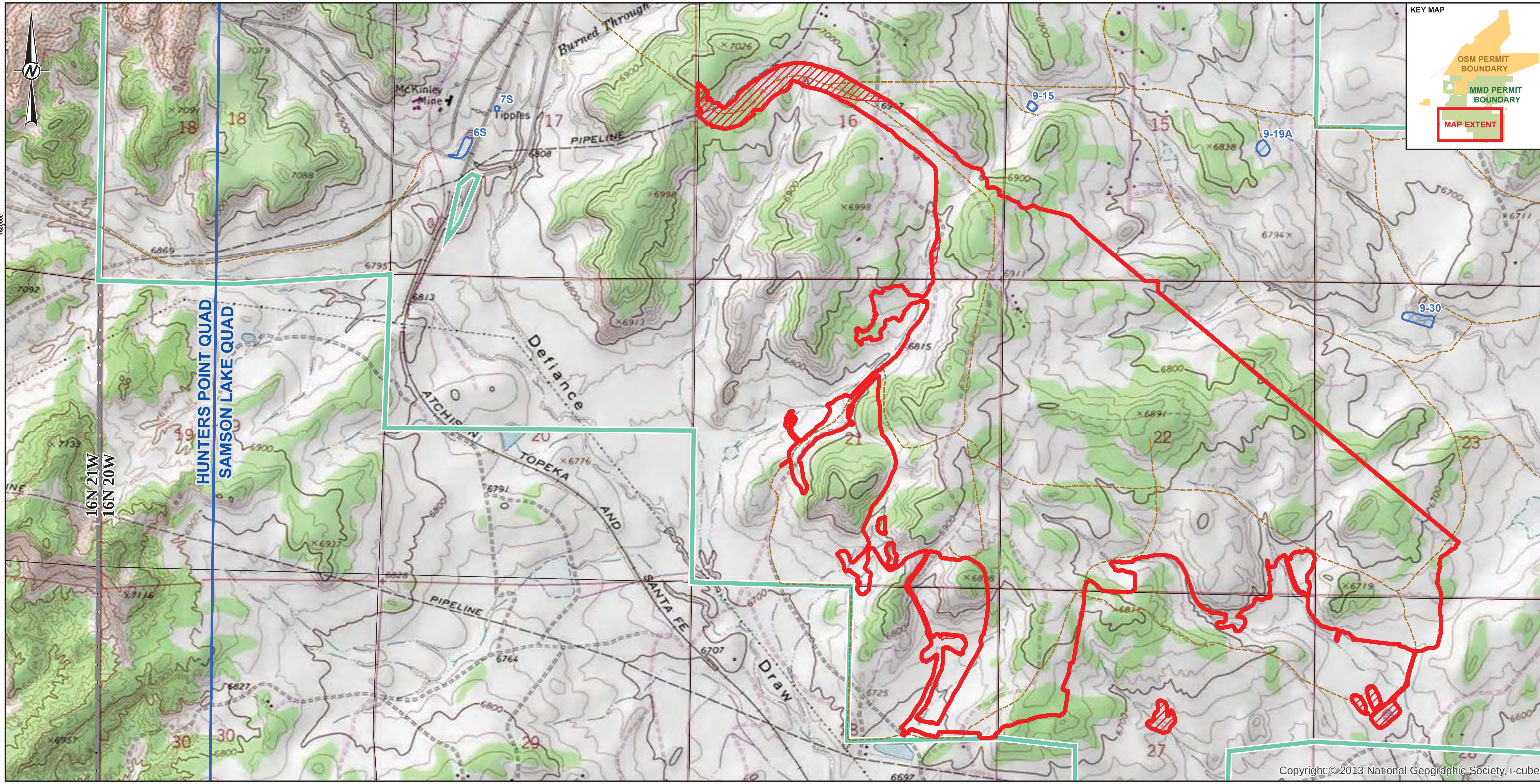
CONSULTANT
WSP GOLDER

YYYY-MM-DD	2022-08-12
DESIGNED	-
PREPARED	HJ
REVIEWED	KK
APPROVED	MS

TITLE
AREA 9S BOND RELEASE – BOND RELEASE LOCATION

PROJECT NO.	PHASE	REV.	FIGURE
1338105302	0003	B	EXHIBIT A

1 in IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B



LEGEND

- Phase I Area 9S Bond Release Boundary (42 acs)
- Phase II and III Area 9S Bond Release Boundary (1,193 acs)
- MMD Permit Boundary
- OSM Permit Boundary
- Post-Mining Two-Track Trails
- Permanent Pond
- Pond
- Township and Range
- Section
- USGS 24k Topo Map Boundaries

0 2,000 4,000
Feet

NOTE(S)
1.

REFERENCE(S)
1. COORDINATE SYSTEM: NAD 1983 STATEPLANE NEW MEXICO WEST FIPS 3003 FEET

CLIENT
Chevron Mining Inc.
McKINLEY MINE

PROJECT
CHEVRON MCKINLEY MINE

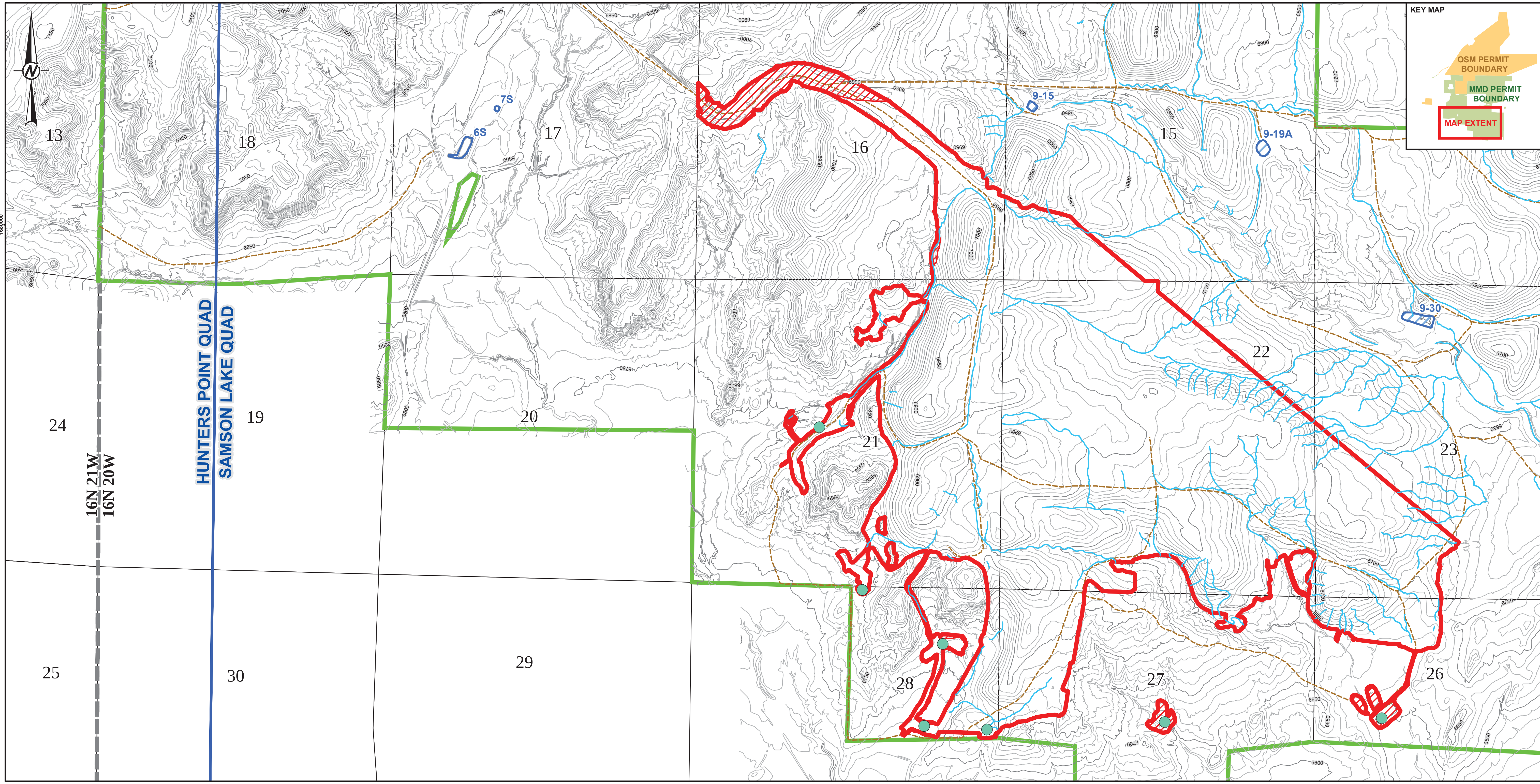
CONSULTANT
WSP GOLDER

YYYY-MM-DD	2022-08-12
DESIGNED	-
PREPARED	HJ
REVIEWED	KK
APPROVED	MS

TITLE
AREA 9S BOND RELEASE – USGS TOPOGRAPHIC MAP

PROJECT NO.	PHASE	REV.	FIGURE
1338105302	0003	B	EXHIBIT B

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B



LEGEND

- Small Depression Location
- Major Surface Contour (25 ft. Interval)
- Minor Surface Contour (5 ft. Interval)
- Surface Drainage
- Phase I Area 9S Bond Release Boundary (42 acs)
- Phase II and III Area 9S Bond Release Boundary (1,193 acs)
- MMD Permit Boundary
- OSM Permit Boundary
- Post-Mining Two-Track Trails
- Permanent Pond
- Pond
- Township and Range
- Section
- USGS 24k Topo Map Boundaries

0 2,000 4,000
Feet

NOTE(S)
1.

REFERENCE(S)
1. COORDINATE SYSTEM: NAD 1983 STATEPLANE NEW MEXICO WEST FIPS 3003 FEET

CLIENT
Chevron Mining Inc.
McKINLEY MINE

CONSULTANT
WSP GOLDER

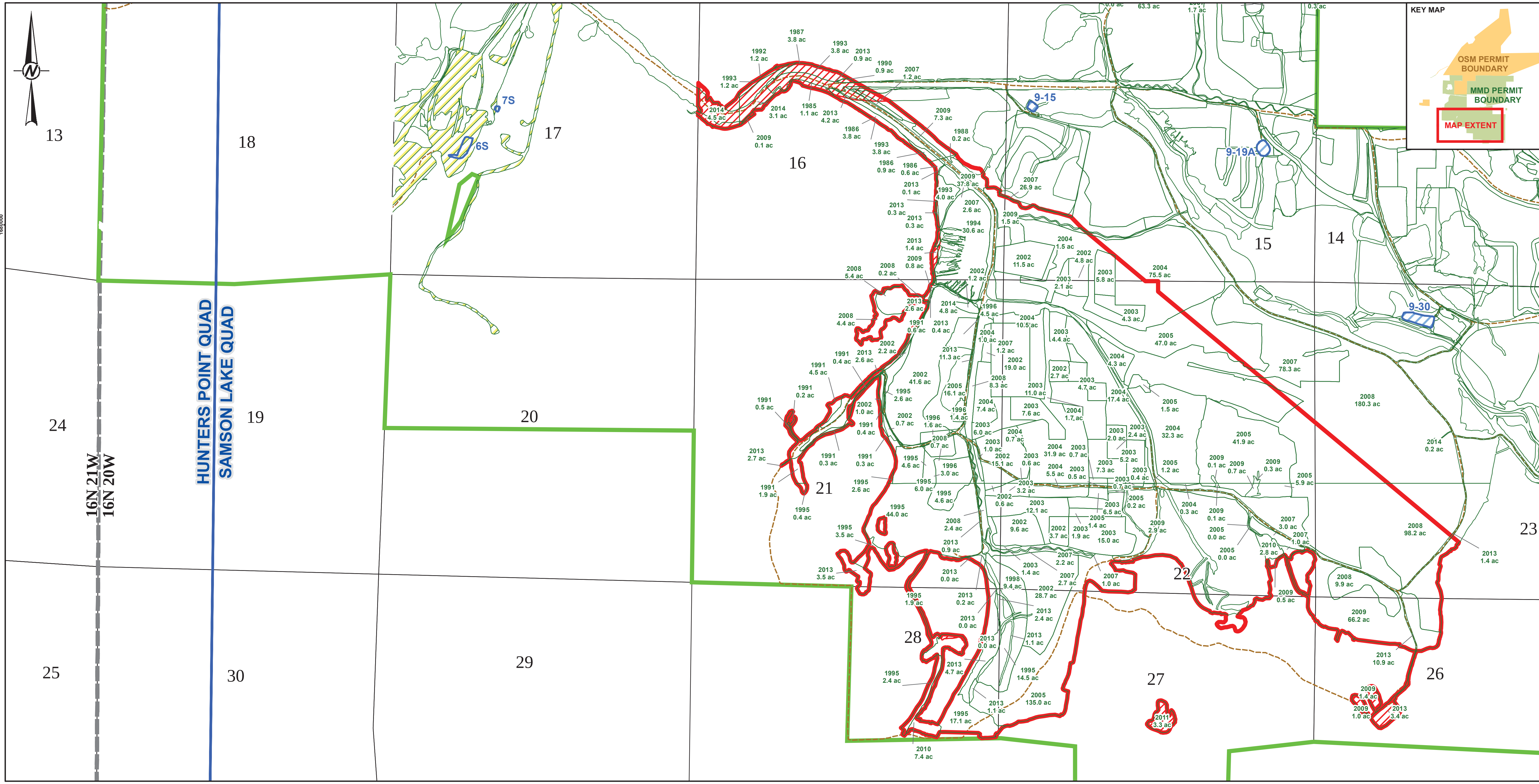
YYYY-MM-DD	2022-08-12
DESIGNED	-
PREPARED	HJ
REVIEWED	KK
APPROVED	MS

PROJECT
CHEVRON MCKINLEY MINE

TITLE
AREA 9S BOND RELEASE – POST-MINING TOPOGRAPHY

PROJECT NO.	PHASE	REV.	FIGURE
1338105302	0003	B	**EXHIBIT C**

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B



LEGEND

- Phase I Area 9S Bond Release Boundary (42 acs)
- Phase II and III Area 9S Bond Release Boundary (1,193 acs)
- Seeding Area (Year Seeded or Reseeded and Acreage)
- Long-term Facility
- MMD Permit Boundary
- OSM Permit Boundary
- Post-Mining Two-Track Trails
- Permanent Pond
- Pond
- Township and Range
- Section
- USGS 24k Topo Map Boundaries

0 2,000 4,000
Feet

NOTE(S)
1.

REFERENCE(S)
1. COORDINATE SYSTEM: NAD 1983 STATEPLANE NEW MEXICO WEST FIPS 3003 FEET

CLIENT
Chevron Mining Inc.
McKINLEY MINE

PROJECT
CHEVRON MCKINLEY MINE

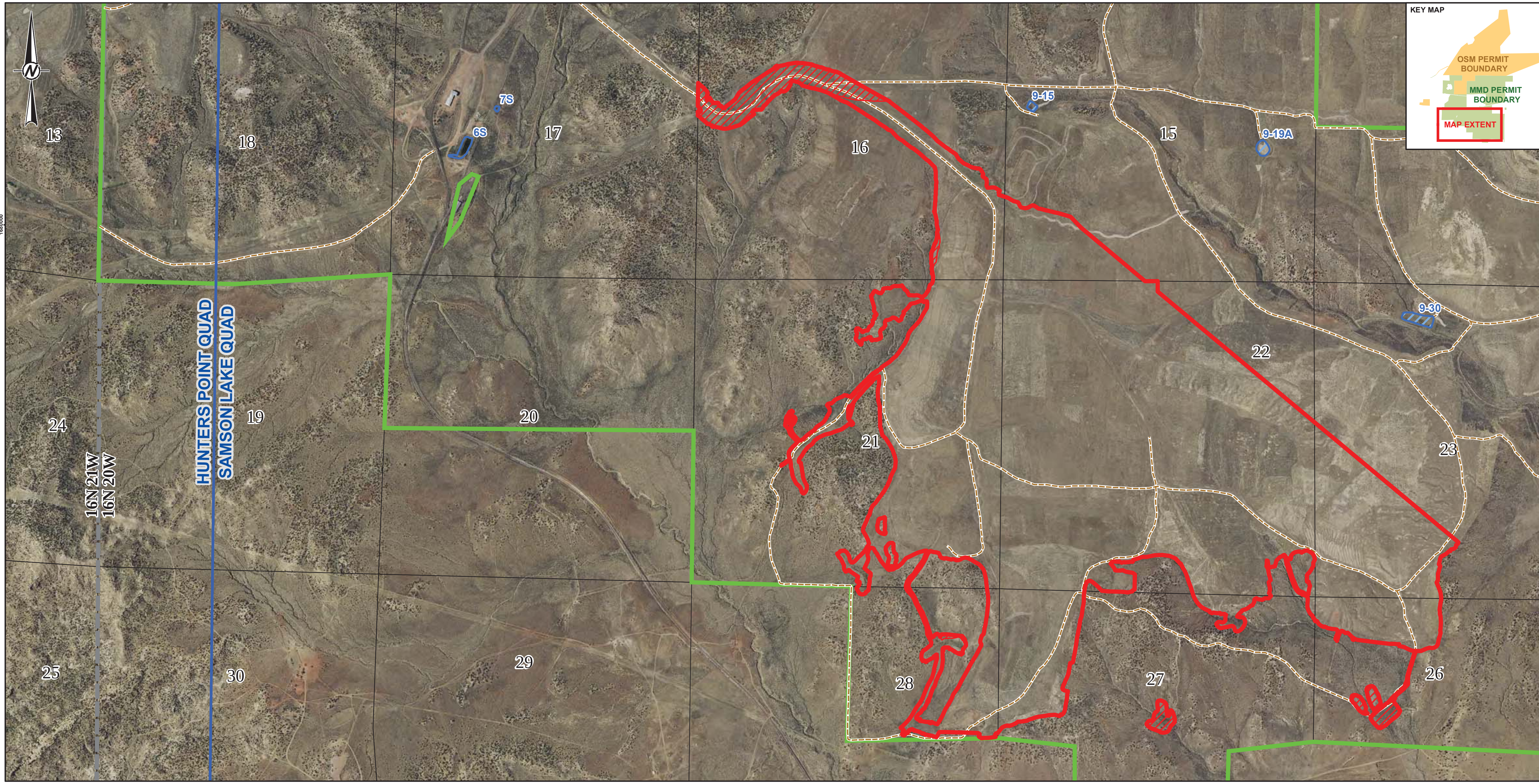
CONSULTANT
WSP GOLDER

YYYY-MM-DD	2022-08-12
DESIGNED	-
PREPARED	HJ
REVIEWED	KK
APPROVED	MS

TITLE
AREA 9S BOND RELEASE – SEEDING MAP

PROJECT NO.	PHASE	REV.	FIGURE
1338105302	0003	B	EXHIBIT D

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B



LEGEND

- Phase I Area 9S Bond Release Boundary (42 acs)
- Phase II and III Area 9S Bond Release Boundary (1,193 acs)
- MMD Permit Boundary
- OSM Permit Boundary
- Post-Mining Two-Track Trails
- Permanent Pond
- Pond
- Township and Range
- Section
- USGS 24k Topo Map Boundaries

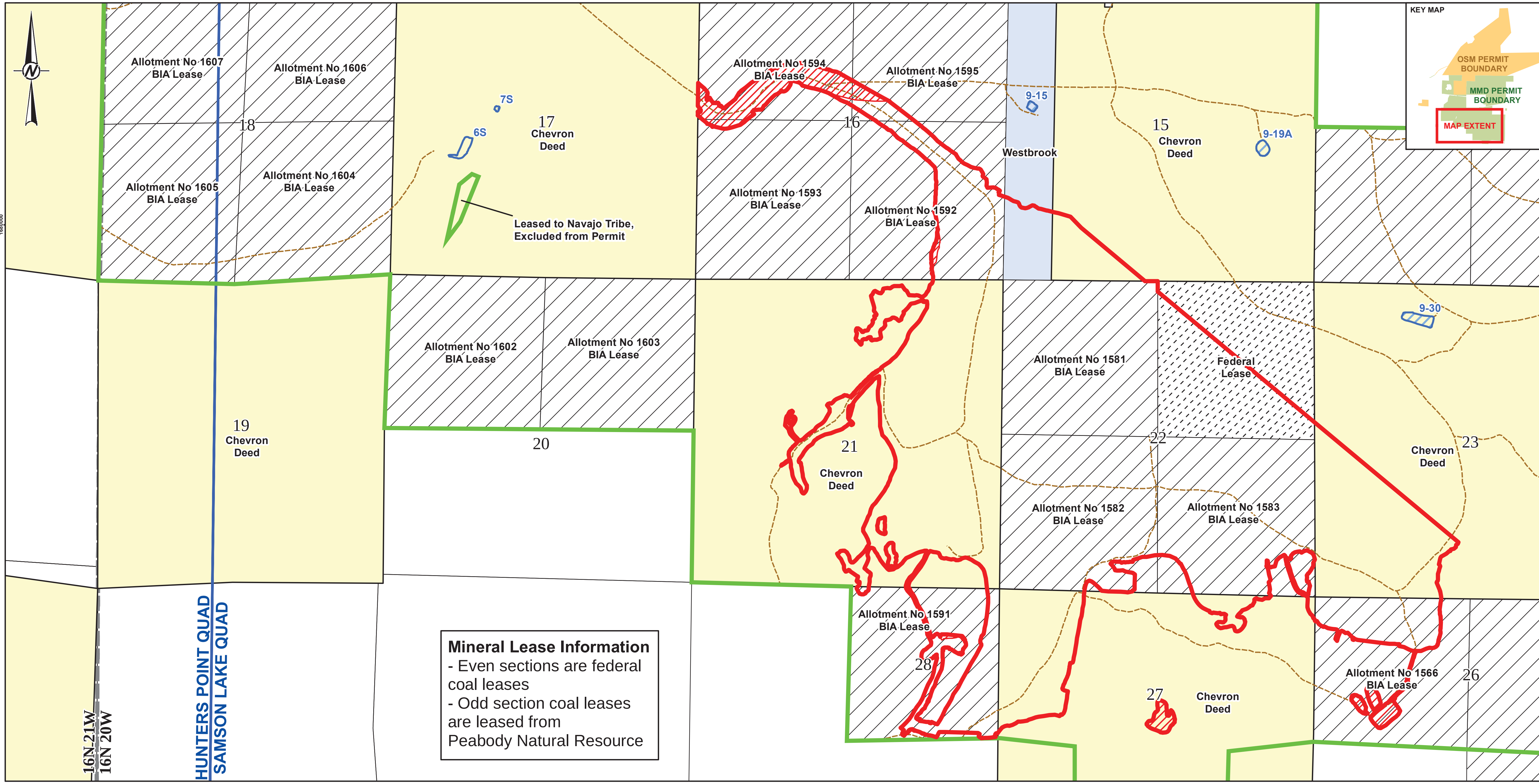
0 2,000 4,000
Feet

NOTE(S)
1.

REFERENCE(S)
1. AERIAL IMAGERY: NAIP 2020.
2. COORDINATE SYSTEM: NAD 1983 STATEPLANE NEW MEXICO WEST FIPS 3003 FEET

CLIENT	Chevron Mining Inc. McKINLEY MINE
PROJECT	CHEVRON MCKINLEY MINE
CONSULTANT	WSP GOLDER
YYYY-MM-DD	2022-08-12
DESIGNED	-
PREPARED	HJ
REVIEWED	KK
APPROVED	MS
TITLE	AREA 9S BOND RELEASE – AERIAL
PROJECT NO.	1338105302
PHASE	0003
REV.	B
FIGURE	EXHIBIT E

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B



LEGEND

- Phase I Area 9S Bond Release Boundary (42 acs)
- Phase II and III Area 9S Bond Release Boundary (1,193 acs)
- MMD Permit Boundary
- OSM Permit Boundary
- Post-Mining Two-Track Trails
- Permanent Pond
- Pond
- Township and Range
- Section
- USGS 24k Topo Map Boundaries

SURFACE INFORMATION

- BIA Allotment Surface Lease
- Chevron Fee Surface
- Federal Surface Lease
- Private Lease to Chevron

NOTE(S)

1.

REFERENCE(S)

1. COORDINATE SYSTEM: NAD 1983 STATEPLANE NEW MEXICO WEST FIPS 3003 FEET

CLIENT

Chevron Mining Inc.
McKINLEY MINE

CONSULTANT

WSP GOLDER

YYYY-MM-DD	2022-08-12
DESIGNED	-
PREPARED	HJ
REVIEWED	KK
APPROVED	MS

PROJECT

CHEVRON MCKINLEY MINE

TITLE

AREA 9S BOND RELEASE – LAND INVENTORY - SURFACE & COAL

PROJECT NO.	PHASE	REV.	FIGURE
1338105302	0003	A	**EXHIBIT F**