Appendix 23.B

East Haul Road Culverts – Hydrologic Analysis and Design

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EAST HAULROAD
25-YR 24-HR STORM

CULVERT CP-407

STATION 167+20

BHP Billiton

GEOMAT Inc.
915 Malta Avenue
Farmingrton, NM 87401

Phone: (505) 327-7928

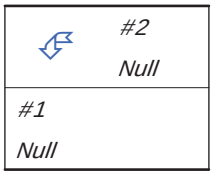
General Information

Storm Information:

Storm Type:	Type II-70
Design Storm:	25 yr - 24 hr
Rainfall Depth:	2.060 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	End	0.000	0.000	CULVERT CP-407
Null	#2	==>	#1	0.000	0.000	CP-407 DROP INLET



Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#2	4.905	4.905	6.60	0.36
#1	443.460	448.365	218.40	21.91

Structure Detail:

Structure #2 (Null)

CP-407 DROP INLET

Structure #1 (Null)

CULVERT CP-407

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#2	1	4.905	0.135	0.000	0.000	89.000	M	6.60	0.358
	Σ	4.905						6.60	0.358
#1	1	443.460	0.662	0.000	0.000	82.900	M	216.89	21.550
	Σ	448.365						218.40	21.908

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	8. Large gullies, diversions, and low flowing streams	1.74	164.21	9,425.68	3.950	0.662
#1	1	Time of Concentration:					0.662
#2	1	8. Large gullies, diversions, and low flowing streams	2.18	46.86	2,152.76	4.420	0.135
#2	1	Time of Concentration:					0.135

HY-8 Culvert Analysis Report
CULVERT CP-407 – STATION 167+20

Culvert Data Summary - Culvert CP-407

Barrel Shape: Circular

Barrel Diameter: 5.00 ft

Barrel Material: Corrugated Steel

Embedment: 0.00 in

Barrel Manning's n: 0.0240

Inlet Type: Conventional

Inlet Edge Condition: Square Edge with Headwall

Inlet Depression: None

Site Data - Culvert CP-407

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 5274.48 ft

Outlet Station: 220.00 ft

Outlet Elevation: 5270.70 ft

Number of Barrels: 2

Table 1 - Culvert Summary Table: Culvert CP-407

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	5274.48	0.000	0.0*	0-NF	0.000	0.000	0.000	0.000	0.000	0.000
21.84	21.84	5275.69	1.210	0.0*	1-S2n	0.785	0.881	0.801	1.460	5.222	3.848
43.68	43.68	5276.22	1.743	0.0*	1-S2n	1.140	1.269	1.159	1.890	6.275	4.516
65.52	65.52	5276.65	2.167	0.0*	1-S2n	1.412	1.581	1.420	2.191	7.106	4.976
87.36	87.36	5277.01	2.530	0.0*	1-S2n	1.641	1.833	1.643	2.432	7.751	5.334
109.20	109.20	5277.36	2.879	0.0*	1-S2n	1.850	2.068	1.858	2.636	8.202	5.632
131.04	131.04	5277.69	3.209	0.0*	1-S2n	2.051	2.269	2.059	2.815	8.591	5.889
152.88	152.88	5278.00	3.523	0.0*	1-S2n	2.232	2.470	2.239	2.976	8.970	6.116
174.72	174.72	5278.31	3.829	0.0*	1-S2n	2.413	2.643	2.413	3.123	9.309	6.320
196.56	196.56	5278.61	4.129	0.0*	1-S2n	2.588	2.811	2.601	3.258	9.526	6.506
218.40	218.40	5278.91	4.430	0.0*	1-S2n	2.760	2.978	2.768	3.403	9.793	6.597

* theoretical depth is impractical. Depth reported is corrected.

****

Inlet Elevation (invert): 5274.48 ft, Outlet Elevation (invert): 5270.70 ft

Culvert Length: 220.00 ft, Culvert Slope: 0.0172

****

Roadway Data for Crossing: Culvert CP-407

Roadway Profile Shape: Irregular Roadway Shape (coordinates)

Irregular Roadway Cross-Section:

Coord No.	Station (ft)	Elevation (ft)
1	0.00	5286.50
2	50.00	5286.30
3	100.00	5286.20
4	150.00	5286.17
5	200.00	5286.23
6	250.00	5286.37
7	300.00	5286.60

Roadway Surface: Gravel

Roadway Top Width: 123.00 ft

Table 2 - Downstream Channel Rating Curve (Crossing: Culvert CP-407)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
0.00	5270.70	0.00	0.00	0.00	0.00
21.84	5272.16	1.46	3.85	1.42	0.80
43.68	5272.59	1.89	4.52	1.84	0.84
65.52	5272.89	2.19	4.98	2.13	0.86
87.36	5273.13	2.43	5.33	2.37	0.87
109.20	5273.33	2.64	5.63	2.57	0.88
131.04	5273.51	2.82	5.89	2.74	0.89
152.88	5273.67	2.98	6.12	2.90	0.90
174.72	5273.82	3.12	6.32	3.04	0.91
196.56	5273.95	3.26	6.51	3.17	0.92
218.40	5274.10	3.40	6.60	3.31	0.92

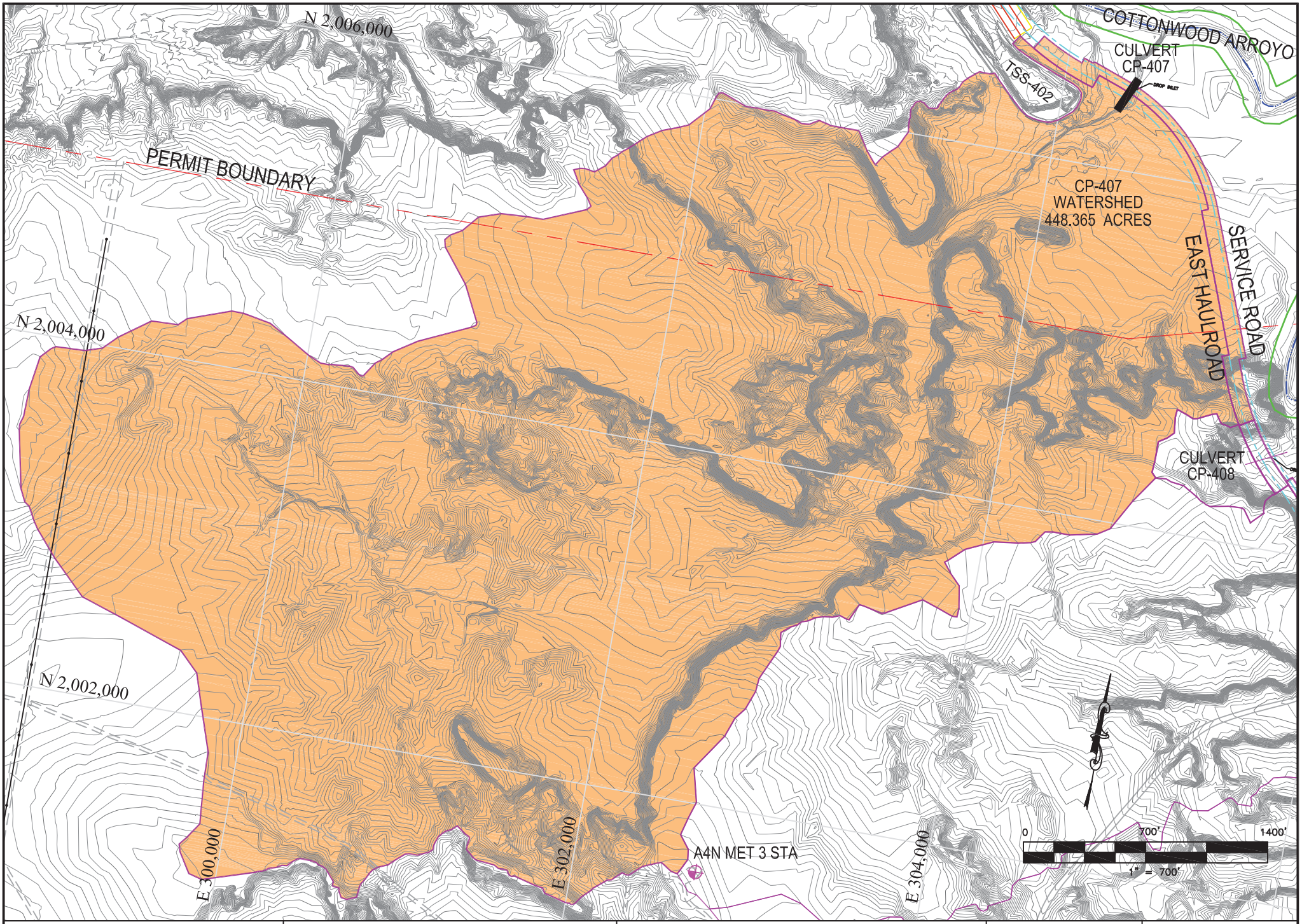
Tailwater Channel Data - Culvert CP-407

Tailwater Channel Option: Irregular Channel

Channel Slope: 0.0156

User Defined Channel Cross-Section:

Coord No.	Station (ft)	Elevation (ft)	Manning's n
1	0.00	5278.00	0.0370
2	81.52	5278.00	0.0370
3	113.44	5278.21	0.0370
4	138.45	5278.00	0.0370
5	145.82	5276.00	0.0370
6	151.19	5274.00	0.0370
7	156.86	5272.00	0.0370
8	160.00	5270.70	0.0370
9	163.79	5272.00	0.0370
10	170.85	5274.00	0.0370
11	189.13	5276.00	0.0370
12	300.00	5276.92	0.0370



GEOMAT INC.
915 Malta Avenue ◆ Farmington, NM 87401 ◆ (505) 327-7928

NAVAJO COAL COMPANY
EAST HAULROAD DESIGN

CULVERT CP-407 WATERSHED
EAST HAULROAD STA 167+20

DRAWN BY: PR & BT	PLATE 3
PREPARED BY: PR & BT	REVISED:
	DATE: JAN. 27, 2012

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EAST HAULROAD
25-YR 24-HR STORM

CULVERT CP-408

STATION 189+89

BHP Billiton

GEOMAT Inc.
915 Malta Avenue
Farmingrton, NM 87401

Phone: (505) 327-7928

Copyright 1998 -2010 Pamela J. Schwab

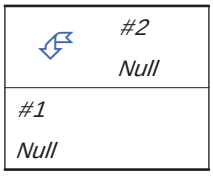
General Information

Storm Information:

Storm Type:	Type II-70
Design Storm:	25 yr - 24 hr
Rainfall Depth:	2.060 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	End	0.000	0.000	CULVERT CP-408
Null	#2	==>	#1	0.000	0.000	CP-408 DROP INLET



Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#2	0.917	0.917	1.89	0.08
#1	5.811	6.728	11.14	0.43

Structure Detail:

Structure #2 (Null)

CP-408 DROP INLET

Structure #1 (Null)

CULVERT CP-408

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#2	1	0.917	0.011	0.000	0.000	89.000	M	1.89	0.078
	Σ	0.917						1.89	0.078
#1	1	5.811	0.019	0.000	0.000	82.900	M	9.25	0.354
	Σ	6.728						11.14	0.432

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	8. Large gullies, diversions, and low flowing streams	10.36	70.06	676.11	9.650	0.019
#1	1	Time of Concentration:					0.019
#2	1	8. Large gullies, diversions, and low flowing streams	6.24	19.70	315.57	7.490	0.011
#2	1	Time of Concentration:					0.011

HY-8 Culvert Analysis Report
CULVERT CP-408 – STATION 189+89

Culvert Data Summary - Culvert CP-408

Barrel Shape: Circular

Barrel Diameter: 2.00 ft

Barrel Material: Corrugated Steel

Embedment: 0.00 in

Barrel Manning's n: 0.0240

Inlet Type: Conventional

Inlet Edge Condition: Square Edge with Headwall

Inlet Depression: None

Site Data - Culvert CP-408

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 5303.63 ft

Outlet Station: 252.00 ft

Outlet Elevation: 5292.87 ft

Number of Barrels: 1

Table 1 - Culvert Summary Table: Culvert CP-408

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	5303.63	0.000	0.0*	0-NF	0.000	0.000	0.000	0.000	0.000	0.000
1.11	1.11	5304.10	0.475	0.0*	1-S2n	0.269	0.354	0.274	0.213	4.141	1.526
2.23	2.23	5304.31	0.684	0.0*	1-S2n	0.400	0.510	0.401	0.276	4.972	1.815
3.34	3.34	5304.48	0.853	0.0*	1-S2n	0.482	0.635	0.484	0.321	5.642	2.009
4.46	4.46	5304.62	0.991	0.0*	1-S2n	0.563	0.736	0.565	0.357	6.078	2.159
5.57	5.57	5304.76	1.132	0.0*	1-S2n	0.634	0.830	0.639	0.389	6.472	2.282
6.68	6.68	5304.89	1.264	0.0*	1-S2n	0.696	0.911	0.701	0.416	6.779	2.389
7.80	7.80	5305.02	1.391	0.0*	1-S2n	0.758	0.993	0.762	0.441	7.087	2.483
8.91	8.91	5305.14	1.514	0.0*	1-S2n	0.818	1.062	0.821	0.464	7.350	2.567
10.03	10.03	5305.27	1.635	0.0*	1-S2n	0.871	1.129	0.878	0.485	7.545	2.644
11.14	11.14	5305.39	1.756	0.0*	1-S2n	0.925	1.197	0.926	0.504	7.826	2.714

* theoretical depth is impractical. Depth reported is corrected.

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Inlet Elevation (invert): 5303.63 ft, Outlet Elevation (invert): 5292.87 ft

Culvert Length: 252.00 ft, Culvert Slope: 0.0427

****

Roadway Data for Crossing: Culvert CP-408

Roadway Profile Shape: Irregular Roadway Shape (coordinates)

Irregular Roadway Cross-Section:

Coord No.	Station (ft)	Elevation (ft)
1	0.00	5317.68
2	50.00	5317.37
3	300.00	5315.49

Roadway Surface: Gravel

Roadway Top Width: 123.00 ft

Table 2 - Downstream Channel Rating Curve (Crossing: Culvert CP-408)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
0.00	5292.87	0.00	0.00	0.00	0.00
1.11	5293.08	0.21	1.53	0.38	0.83
2.23	5293.15	0.28	1.82	0.50	0.86
3.34	5293.19	0.32	2.01	0.58	0.88
4.46	5293.23	0.36	2.16	0.64	0.90
5.57	5293.26	0.39	2.28	0.70	0.91
6.68	5293.29	0.42	2.39	0.75	0.92
7.80	5293.31	0.44	2.48	0.80	0.93
8.91	5293.33	0.46	2.57	0.84	0.94
10.03	5293.35	0.48	2.64	0.87	0.95
11.14	5293.37	0.50	2.71	0.91	0.95

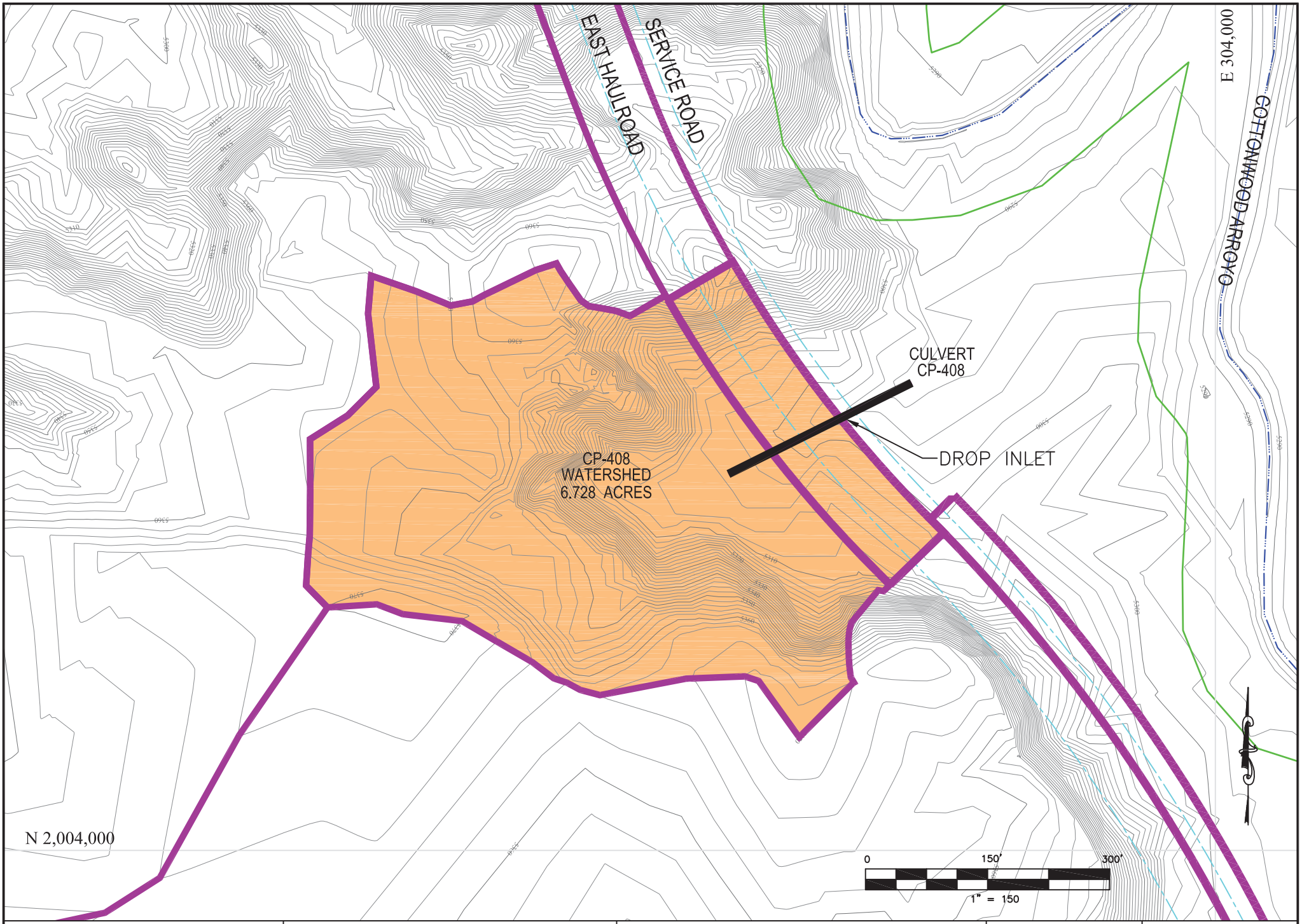
Tailwater Channel Data - Culvert CP-408

Tailwater Channel Option: Irregular Channel

Channel Slope: 0.0289

User Defined Channel Cross-Section:

Coord No.	Station (ft)	Elevation (ft)	Manning's n
1	0.00	5330.00	0.0370
2	66.39	5300.00	0.0370
3	72.66	5298.00	0.0370
4	108.05	5296.00	0.0370
5	146.54	5294.00	0.0370
6	150.00	5292.87	0.0370
7	183.05	5294.00	0.0370
8	231.67	5296.00	0.0370
9	276.81	5298.00	0.0370
10	300.00	5300.00	0.0000



GEOMAT INC.
915 Malta Avenue ◆ Farmington, NM 87401 ◆ (505) 327-7928

NAVAJO COAL COMPANY
EAST HAULROAD DESIGN

CULVERT CP-408 WATERSHED
EAST HAULROAD STA 189+89

DRAWN BY: PR & BT	PLATE 4
PREPARED BY: PR & BT	REVISED:
	DATE: JAN. 27, 2012

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EAST HAULROAD
25-YR 24-HR STORM

CULVERT CP-409

STATION 200+62

BHP Billiton

GEOMAT Inc.
915 Malta Avenue
Farmingrton, NM 87401

Phone: (505) 327-7928

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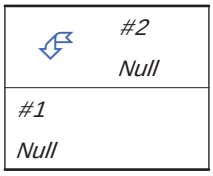
General Information

Storm Information:

Storm Type:	Type II-70
Design Storm:	25 yr - 24 hr
Rainfall Depth:	2.060 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	End	0.000	0.000	CULVERT CP-409
Null	#2	==>	#1	0.000	0.000	CP-409 DROP INLET



Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#2	1.245	1.245	2.57	0.11
#1	146.914	148.159	116.30	7.27

Structure Detail:

Structure #2 (Null)

CP-409 DROP INLET

Structure #1 (Null)

CULVERT CP-409

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#2	1	1.245	0.057	0.000	0.000	89.000	M	2.57	0.112
	Σ	1.245						2.57	0.112
#1	1	146.914	0.286	0.000	0.000	82.900	M	116.15	7.160
	Σ	148.159						116.30	7.272

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	8. Large gullies, diversions, and low flowing streams	2.53	124.72	4,923.45	4.770	0.286
#1	1	Time of Concentration:					0.286
#2	1	8. Large gullies, diversions, and low flowing streams	2.22	20.55	924.87	4.470	0.057
#2	1	Time of Concentration:					0.057

HY-8 Culvert Analysis Report
CULVERT CP-409 – STATION 200+62

Culvert Data Summary - Culvert CP-409

Barrel Shape: Circular

Barrel Diameter: 3.50 ft

Barrel Material: Corrugated Steel

Embedment: 0.00 in

Barrel Manning's n: 0.0240

Inlet Type: Conventional

Inlet Edge Condition: Square Edge with Headwall

Inlet Depression: None

Site Data - Culvert CP-409

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 5301.62 ft

Outlet Station: 227.00 ft

Outlet Elevation: 5296.71 ft

Number of Barrels: 2

Table 1 - Culvert Summary Table: Culvert CP-409

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	5301.62	0.000	0.0*	0-NF	0.000	0.000	0.000	0.000	0.000	0.000
11.63	11.63	5302.60	0.977	0.0*	1-S2n	0.620	0.720	0.629	0.461	4.870	1.842
23.26	23.26	5303.02	1.400	0.0*	1-S2n	0.885	1.031	0.891	0.598	5.972	2.191
34.89	34.89	5303.36	1.737	0.0*	1-S2n	1.103	1.265	1.104	0.696	6.691	2.425
46.52	46.52	5303.67	2.054	0.0*	1-S2n	1.283	1.475	1.285	0.775	7.245	2.605
58.15	58.15	5303.97	2.348	0.0*	1-S2n	1.454	1.658	1.457	0.843	7.668	2.755
69.78	69.78	5304.25	2.628	0.0*	1-S2n	1.609	1.826	1.616	0.903	8.032	2.883
81.41	81.41	5304.52	2.902	0.0*	1-S2n	1.764	1.978	1.764	0.956	8.375	2.997
93.04	93.04	5304.80	3.176	0.0*	1-S2n	1.911	2.126	1.916	1.005	8.634	3.098
104.67	104.67	5305.08	3.456	0.0*	1-S2n	2.059	2.255	2.064	1.051	8.867	3.191
116.30	116.30	5305.37	3.748	0.0*	5-S2n	2.211	2.384	2.213	1.093	9.081	3.276

* theoretical depth is impractical. Depth reported is corrected.

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Inlet Elevation (invert): 5301.62 ft, Outlet Elevation (invert): 5296.71 ft

Culvert Length: 227.00 ft, Culvert Slope: 0.0216

****

Roadway Data for Crossing: Culvert CP-409

Roadway Profile Shape: Irregular Roadway Shape (coordinates)

Irregular Roadway Cross-Section:

Coord No.	Station (ft)	Elevation (ft)
1	0.00	5310.02
2	50.00	5309.83
3	100.00	5309.72
4	150.00	5309.68
5	200.00	5309.72
6	250.00	5309.83
7	300.00	5310.02

Roadway Surface: Gravel

Roadway Top Width: 123.00 ft

Table 2 - Downstream Channel Rating Curve (Crossing: Culvert CP-409)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
0.00	5296.71	0.00	0.00	0.00	0.00
11.63	5297.17	0.46	1.84	0.43	0.68
23.26	5297.31	0.60	2.19	0.56	0.71
34.89	5297.41	0.70	2.42	0.65	0.72
46.52	5297.49	0.78	2.61	0.72	0.74
58.15	5297.55	0.84	2.75	0.78	0.75
69.78	5297.61	0.90	2.88	0.84	0.76
81.41	5297.67	0.96	3.00	0.89	0.76
93.04	5297.72	1.01	3.10	0.93	0.77
104.67	5297.76	1.05	3.19	0.98	0.78
116.30	5297.80	1.09	3.28	1.02	0.78

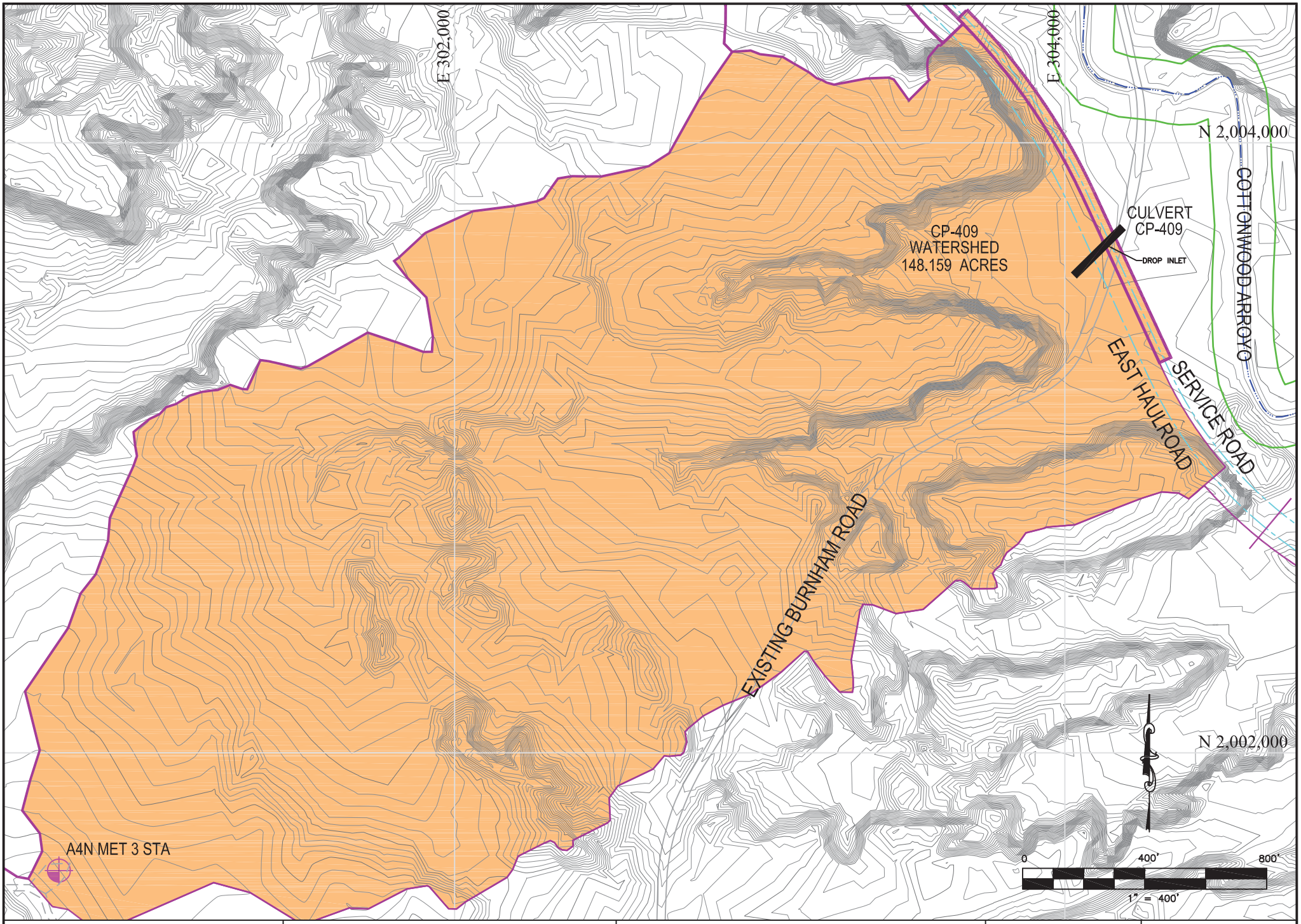
Tailwater Channel Data - Culvert CP-409

Tailwater Channel Option: Irregular Channel

Channel Slope: 0.0149

User Defined Channel Cross-Section:

Coord No.	Station (ft)	Elevation (ft)	Manning's n
1	0.00	5310.00	0.0370
2	34.44	5300.00	0.0370
3	50.00	5298.90	0.0370
4	67.66	5298.00	0.0370
5	110.00	5296.71	0.0370
6	144.29	5298.00	0.0370
7	250.00	5298.97	0.0370
8	265.09	5300.00	0.0370
9	300.00	5310.00	0.0000



GEOMAT INC.
915 Malta Avenue ◆ Farmington, NM 87401 ◆ (505) 327-7928

NAVAJO COAL COMPANY
EAST HAULROAD DESIGN

CULVERT CP-409 WATERSHED
EAST HAULROAD STA 200+62

DRAWN BY: PR & BT	PLATE 5
PREPARED BY: PR & BT	REVISED:
	DATE: JAN. 27, 2012

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EAST HAULROAD
25-YR 24-HR STORM

CULVERT CP-410

STATION 211+31

BHP Billiton

GEOMAT Inc.
915 Malta Avenue
Farmingrton, NM 87401

Phone: (505) 327-7928

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General Information

Storm Information:

Storm Type:	Type II-70
Design Storm:	25 yr - 24 hr
Rainfall Depth:	2.060 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	End	0.000	0.000	CULVERT CP-410

#1
Null

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	248.872	248.872	192.94	12.12

Structure Detail:

Structure #1 (Null)

CULVERT CP-410

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	248.872	0.300	0.000	0.000	82.900	M	192.94	12.123
	Σ	248.872						192.94	12.123

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	8. Large gullies, diversions, and low flowing streams	2.37	118.54	4,992.52	4.620	0.300
#1	1	Time of Concentration:					0.300

HY-8 Culvert Analysis Report
CULVERT CP-410 – STATION 211+31

Culvert Data Summary - Culvert CP-410

Barrel Shape: Circular

Barrel Diameter: 4.00 ft

Barrel Material: Corrugated Steel

Embedment: 0.00 in

Barrel Manning's n: 0.0240

Inlet Type: Conventional

Inlet Edge Condition: Square Edge with Headwall

Inlet Depression: None

Site Data - Culvert CP-410

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 5305.03 ft

Outlet Station: 216.00 ft

Outlet Elevation: 5301.11 ft

Number of Barrels: 3

Table 1 - Culvert Summary Table: Culvert CP-410

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	5305.03	0.000	0.0*	0-NF	0.000	0.000	0.000	0.000	0.000	0.000
19.29	19.29	5306.01	0.983	0.0*	1-S2n	0.642	0.718	0.658	0.424	4.640	1.925
38.59	38.59	5306.44	1.414	0.0*	1-S2n	0.929	1.031	0.930	0.550	5.750	2.290
57.88	57.88	5306.79	1.758	0.0*	1-S2n	1.155	1.283	1.162	0.640	6.351	2.534
77.18	77.18	5307.09	2.055	0.0*	1-S2n	1.339	1.490	1.340	0.713	6.948	2.723
96.47	96.47	5307.37	2.340	0.0*	1-S2n	1.513	1.677	1.516	0.775	7.349	2.879
115.76	115.76	5307.64	2.609	0.0*	1-S2n	1.675	1.843	1.682	0.830	7.687	3.014
135.06	135.06	5307.90	2.867	0.0*	1-S2n	1.825	2.007	1.827	0.879	8.044	3.132
154.35	154.35	5308.15	3.117	0.0*	1-S2n	1.975	2.145	1.975	0.920	8.319	3.271
173.65	173.65	5308.39	3.364	0.0*	1-S2n	2.119	2.283	2.122	0.957	8.551	3.406
192.94	192.94	5308.64	3.612	0.0*	1-S2n	2.261	2.418	2.267	0.993	8.757	3.531

* theoretical depth is impractical. Depth reported is corrected.

****

Inlet Elevation (invert): 5305.03 ft, Outlet Elevation (invert): 5301.11 ft

Culvert Length: 216.00 ft, Culvert Slope: 0.0181

****

Roadway Data for Crossing: Culvert CP-410

Roadway Profile Shape: Irregular Roadway Shape (coordinates)

Irregular Roadway Cross-Section:

Coord No.	Station (ft)	Elevation (ft)
1	0.00	5313.96
2	50.00	5313.74
3	300.00	5312.49

Roadway Surface: Gravel

Roadway Top Width: 40.00 ft

Table 2 - Downstream Channel Rating Curve (Crossing: Culvert CP-410)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
0.00	5301.11	0.00	0.00	0.00	0.00
19.29	5301.54	0.42	1.93	0.48	0.74
38.59	5301.66	0.55	2.29	0.62	0.77
57.88	5301.75	0.64	2.53	0.73	0.79
77.18	5301.82	0.71	2.72	0.81	0.80
96.47	5301.89	0.77	2.88	0.88	0.82
115.76	5301.94	0.83	3.01	0.94	0.82
135.06	5301.99	0.88	3.13	1.00	0.83
154.35	5302.03	0.92	3.27	1.04	0.84
173.65	5302.07	0.96	3.41	1.09	0.85
192.94	5302.10	0.99	3.53	1.13	0.86

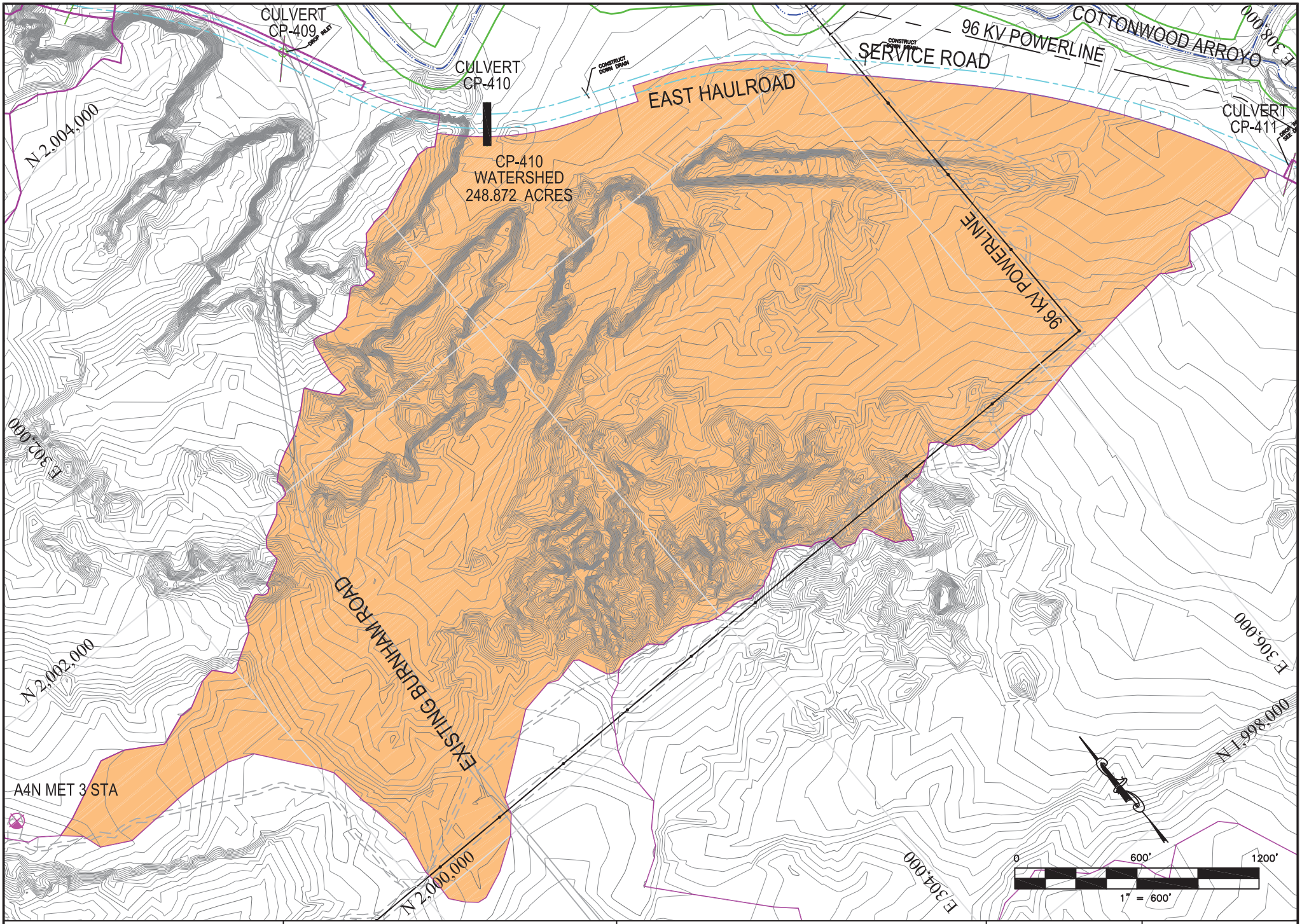
Tailwater Channel Data - Culvert CP-410

Tailwater Channel Option: Irregular Channel

Channel Slope: 0.0182

User Defined Channel Cross-Section:

Coord No.	Station (ft)	Elevation (ft)	Manning's n
1	0.00	5314.00	0.0370
2	4.14	5314.00	0.0370
3	17.39	5312.00	0.0370
4	28.14	5310.00	0.0370
5	38.70	5308.00	0.0370
6	49.14	5306.00	0.0370
7	60.10	5304.00	0.0370
8	69.26	5302.00	0.0370
9	100.00	5301.11	0.0370
10	168.36	5302.00	0.0370
11	250.00	5304.00	0.0000



GEOMAT INC.
915 Malta Avenue ◆ Farmington, NM 87401 ◆ (505) 327-7928

NAVAJO COAL COMPANY
EAST HAULROAD DESIGN

CULVERT CP-410 WATERSHED
EAST HAULROAD STA 211+31

DRAWN BY: PR & BT	PLATE 6
PREPARED BY: PR & BT	REVISED:
	DATE: JAN. 27, 2012

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EAST HAULROAD
25-YR 24-HR STORM

CULVERT CP-411

STATION 251+84

BHP Billiton

GEOMAT Inc.
915 Malta Avenue
Farmingrton, NM 87401

Phone: (505) 327-7928

Copyright 1998 -2010 Pamela J. Schwab

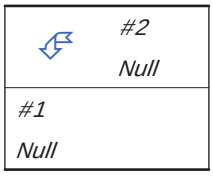
General Information

Storm Information:

Storm Type:	Type II-70
Design Storm:	25 yr - 24 hr
Rainfall Depth:	2.060 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	End	0.000	0.000	CULVERT CP-411
Null	#2	==>	#1	0.000	0.000	CP-411 DROP INLET



Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#2	1.541	1.541	3.18	0.14
#1	265.199	266.740	176.20	13.06

Structure Detail:

Structure #2 (Null)

CP-411 DROP INLET

Structure #1 (Null)

CULVERT CP-411

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#2	1	1.541	0.064	0.000	0.000	89.000	M	3.18	0.138
	Σ	1.541						3.18	0.138
#1	1	265.199	0.412	0.000	0.000	82.900	M	176.01	12.923
	Σ	266.740						176.20	13.061

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	8. Large gullies, diversions, and low flowing streams	1.69	98.05	5,792.98	3.900	0.412
#1	1	Time of Concentration:					0.412
#2	1	8. Large gullies, diversions, and low flowing streams	2.04	20.35	996.52	4.280	0.064
#2	1	Time of Concentration:					0.064

HY-8 Culvert Analysis Report
CULVERT CP-411 – STATION 251+84

Culvert Data Summary - Culvert CP-411

Barrel Shape: Circular

Barrel Diameter: 4.00 ft

Barrel Material: Corrugated Steel

Embedment: 0.00 in

Barrel Manning's n: 0.0240

Inlet Type: Conventional

Inlet Edge Condition: Square Edge with Headwall

Inlet Depression: None

Site Data - Culvert CP-411

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 5323.96 ft

Outlet Station: 217.00 ft

Outlet Elevation: 5321.71 ft

Number of Barrels: 3

Table 1 - Culvert Summary Table: Culvert CP-411

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	5323.96	0.000	0.0*	0-NF	0.000	0.000	0.000	0.000	0.000	0.000
17.62	17.62	5325.01	0.942	1.047	2-M2c	0.719	0.678	0.702	0.234	3.962	1.340
35.24	35.24	5325.46	1.358	1.503	2-M2c	1.023	0.982	1.000	0.302	4.780	1.619
52.86	52.86	5325.84	1.691	1.878	2-M2c	1.274	1.229	1.232	0.347	5.357	1.875
70.48	70.48	5326.15	1.967	2.188	2-M2c	1.484	1.418	1.430	0.386	5.822	2.077
88.10	88.10	5326.43	2.234	2.474	2-M2c	1.681	1.606	1.606	0.421	6.224	2.245
105.72	105.72	5326.70	2.487	2.740	2-M2c	1.862	1.757	1.766	0.452	6.586	2.392
123.34	123.34	5326.95	2.727	2.988	2-M2c	2.042	1.908	1.915	0.482	6.919	2.521
140.96	140.96	5327.18	2.959	3.221	2-M2c	2.214	2.049	2.053	0.510	7.233	2.638
158.58	158.58	5327.41	3.187	3.451	2-M2c	2.386	2.176	2.184	0.536	7.532	2.744
176.20	176.20	5327.64	3.412	3.678	2-M2c	2.564	2.302	2.308	0.560	7.822	2.842

* theoretical depth is impractical. Depth reported is corrected.

****

Inlet Elevation (invert): 5323.96 ft, Outlet Elevation (invert): 5321.71 ft

Culvert Length: 217.00 ft, Culvert Slope: 0.0104

****

Roadway Data for Crossing: Culvert CP-411

Roadway Profile Shape: Irregular Roadway Shape (coordinates)

Irregular Roadway Cross-Section:

Coord No.	Station (ft)	Elevation (ft)
1	0.00	5332.17
2	175.00	5333.04
3	350.00	5333.92

Roadway Surface: Gravel

Roadway Top Width: 123.00 ft

Table 2 - Downstream Channel Rating Curve (Crossing: Culvert CP-411)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
0.00	5321.71	0.00	0.00	0.00	0.00
17.62	5321.95	0.23	1.34	0.28	0.69
35.24	5322.01	0.30	1.62	0.37	0.72
52.86	5322.06	0.35	1.87	0.42	0.75
70.48	5322.10	0.39	2.08	0.47	0.77
88.10	5322.13	0.42	2.25	0.51	0.78
105.72	5322.16	0.45	2.39	0.55	0.80
123.34	5322.19	0.48	2.52	0.58	0.81
140.96	5322.22	0.51	2.64	0.62	0.82
158.58	5322.25	0.54	2.74	0.65	0.82
176.20	5322.27	0.56	2.84	0.68	0.83

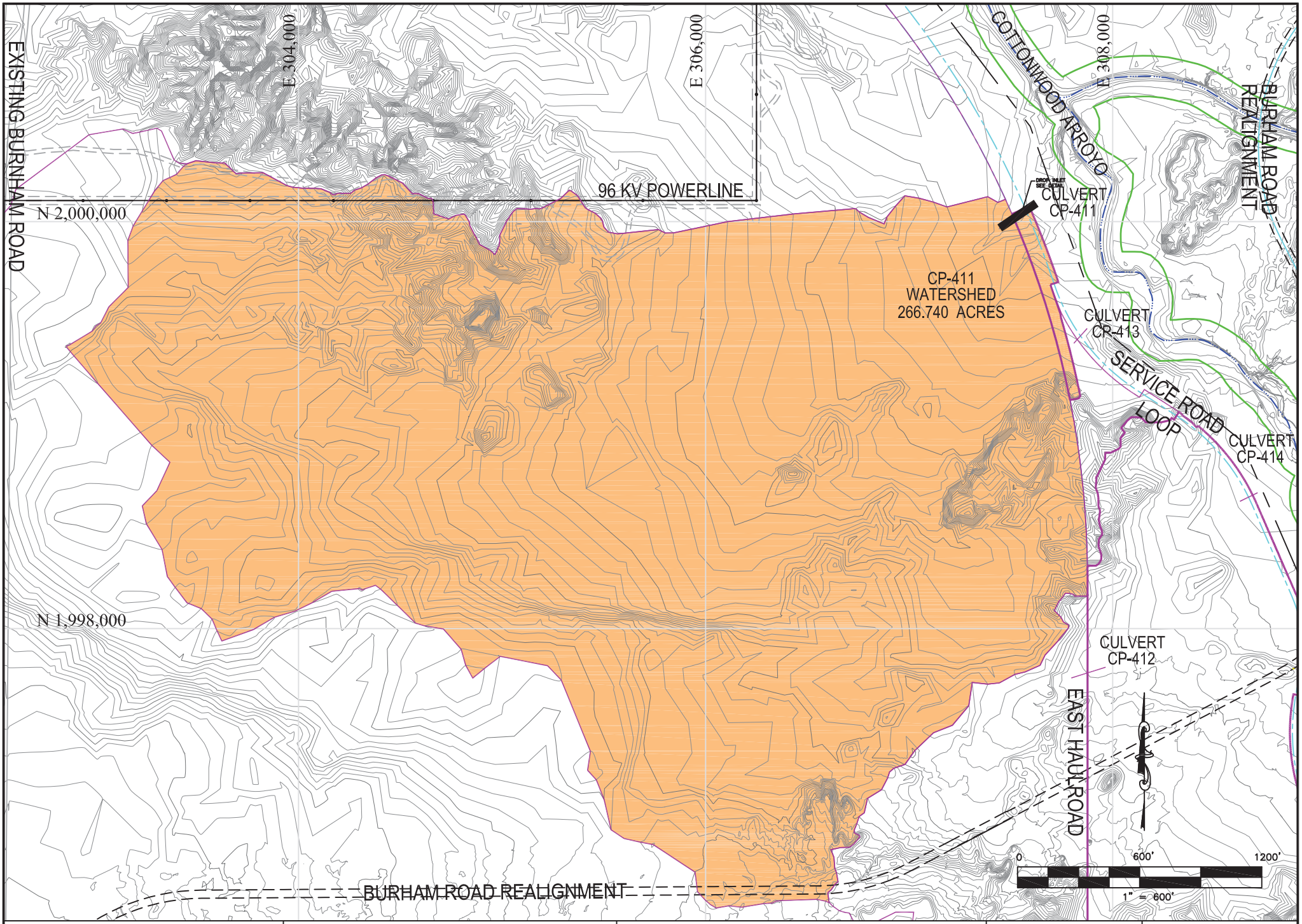
Tailwater Channel Data - Culvert CP-411

Tailwater Channel Option: Irregular Channel

Channel Slope: 0.0194

User Defined Channel Cross-Section:

Coord No.	Station (ft)	Elevation (ft)	Manning's n
1	0.00	5323.04	0.0370
2	75.64	5322.00	0.0370
3	200.00	5321.71	0.0370
4	310.81	5324.00	0.0370
5	350.00	5324.00	0.0370



GEOMAT INC.
915 Malta Avenue ◆ Farmington, NM 87401 ◆ (505) 327-7928

NAVAJO COAL COMPANY
EAST HAULROAD DESIGN

CULVERT CP-411 WATERSHED
EAST HAULROAD STA 251+84

DRAWN BY: PR & BT	PLATE 7
PREPARED BY: PR & BT	REVISED:
	DATE: JAN. 27, 2012

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EAST HAULROAD
25-YR 24-HR STORM

CULVERT CP-412

STATION 274+66

BHP Billiton

GEOMAT Inc.
915 Malta Avenue
Farmingrton, NM 87401

Phone: (505) 327-7928

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General Information

Storm Information:

Storm Type:	Type II-70
Design Storm:	25 yr - 24 hr
Rainfall Depth:	2.060 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	End	0.000	0.000	CULVERT CP-412

#1
Null

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	76.550	76.550	52.00	3.73

Structure Detail:

Structure #1 (Null)

CULVERT CP-412

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	76.550	0.395	0.000	0.000	82.900	M	52.00	3.726
	Σ	76.550						52.00	3.726

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	8. Large gullies, diversions, and low flowing streams	1.53	80.82	5,281.84	3.710	0.395
#1	1	Time of Concentration:					0.395

HY-8 Culvert Analysis Report
CULVERT CP-412 – STATION 274+66

Culvert Data Summary - Culvert CP-412

Barrel Shape: Circular

Barrel Diameter: 3.00 ft

Barrel Material: Corrugated Steel

Embedment: 0.00 in

Barrel Manning's n: 0.0240

Inlet Type: Conventional

Inlet Edge Condition: Square Edge with Headwall

Inlet Depression: None

Site Data - Culvert CP-412

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 5352.89 ft

Outlet Station: 177.00 ft

Outlet Elevation: 5351.39 ft

Number of Barrels: 2

Table 1 - Culvert Summary Table: Culvert CP-412

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	5352.89	0.000	0.0*	0-NF	0.000	0.000	0.000	0.000	0.000	0.000
5.20	5.20	5353.64	0.672	0.750	2-M2c	0.557	0.480	0.501	0.243	3.345	1.275
10.40	10.40	5353.96	0.971	1.071	2-M2c	0.790	0.701	0.714	0.315	4.032	1.516
15.60	15.60	5354.22	1.205	1.330	2-M2c	0.981	0.876	0.880	0.367	4.515	1.678
20.80	20.80	5354.44	1.404	1.554	2-M2c	1.147	1.012	1.021	0.407	4.903	1.819
26.00	26.00	5354.65	1.589	1.761	2-M2c	1.298	1.140	1.146	0.440	5.237	1.955
31.20	31.20	5354.84	1.766	1.945	2-M2c	1.441	1.255	1.260	0.470	5.538	2.072
36.40	36.40	5355.01	1.934	2.123	2-M2c	1.581	1.359	1.366	0.497	5.810	2.175
41.60	41.60	5355.18	2.096	2.294	2-M2c	1.717	1.462	1.465	0.523	6.067	2.268
46.80	46.80	5355.35	2.253	2.462	2-M2c	1.855	1.554	1.558	0.547	6.312	2.352
52.00	52.00	5355.52	2.408	2.630	2-M2c	1.996	1.640	1.646	0.570	6.545	2.428

* theoretical depth is impractical. Depth reported is corrected.

****

Inlet Elevation (invert): 5352.89 ft, Outlet Elevation (invert): 5351.39 ft

Culvert Length: 177.00 ft, Culvert Slope: 0.0085

****

Roadway Data for Crossing: Culvert CP-412

Roadway Profile Shape: Irregular Roadway Shape (coordinates)

Irregular Roadway Cross-Section:

Coord No.	Station (ft)	Elevation (ft)
1	0.00	5362.37
2	150.00	5360.49
3	200.00	5359.97
4	250.00	5359.64
5	300.00	5359.50

Roadway Surface: Gravel

Roadway Top Width: 40.00 ft

Table 2 - Downstream Channel Rating Curve (Crossing: Culvert CP-412)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
0.00	5351.00	0.00	0.00	0.00	0.00
5.20	5351.24	0.24	1.28	0.25	0.64
10.40	5351.31	0.31	1.52	0.33	0.67
15.60	5351.37	0.37	1.68	0.38	0.69
20.80	5351.41	0.41	1.82	0.43	0.70
26.00	5351.44	0.44	1.96	0.46	0.72
31.20	5351.47	0.47	2.07	0.49	0.73
36.40	5351.50	0.50	2.18	0.52	0.74
41.60	5351.52	0.52	2.27	0.55	0.74
46.80	5351.55	0.55	2.35	0.57	0.75
52.00	5351.57	0.57	2.43	0.60	0.76

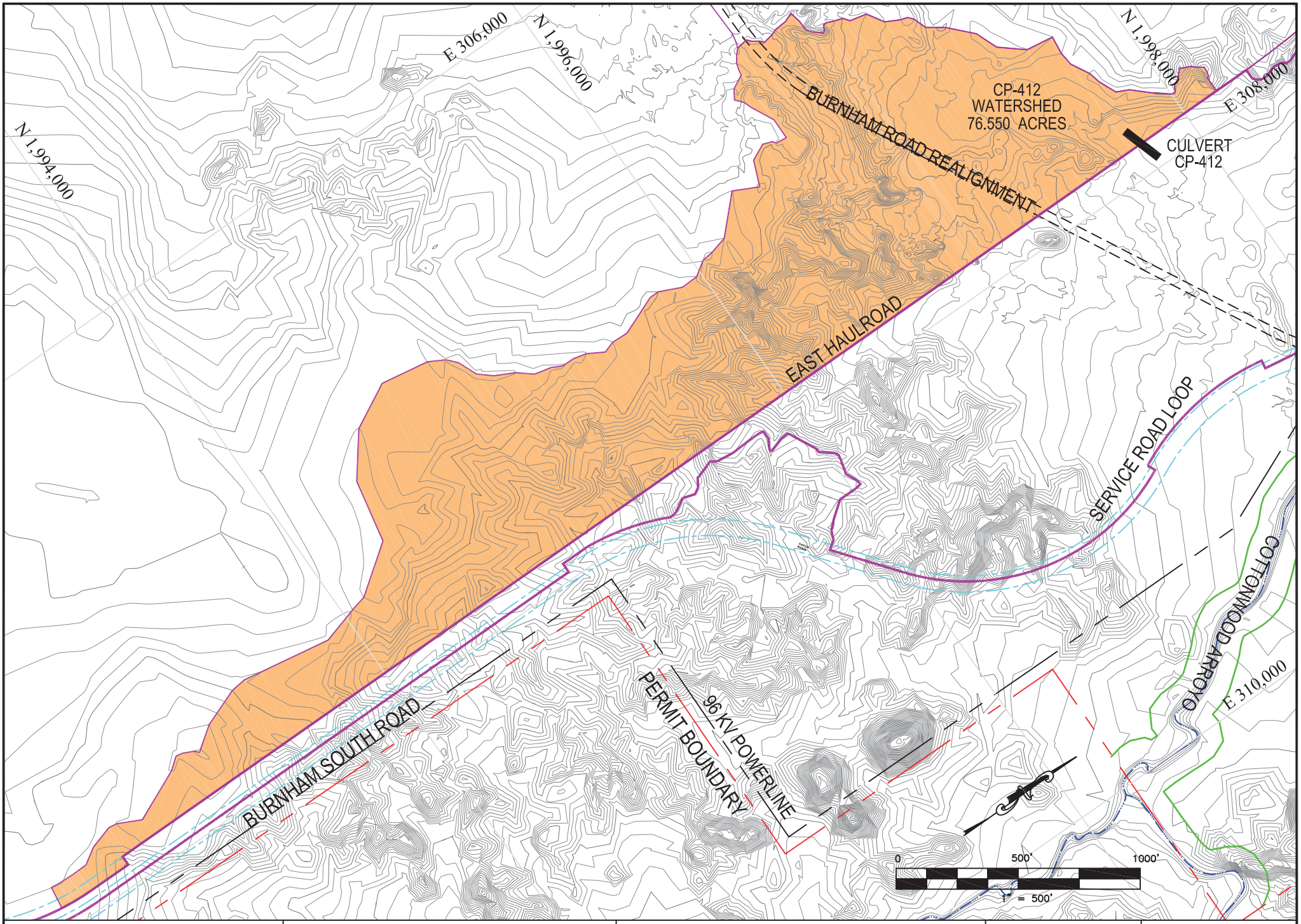
Tailwater Channel Data - Culvert CP-412

Tailwater Channel Option: Irregular Channel

Channel Slope: 0.0168

User Defined Channel Cross-Section:

Coord No.	Station (ft)	Elevation (ft)	Manning's n
1	0.00	5366.00	0.0370
2	36.74	5351.00	0.0370
3	90.00	5351.39	0.0370
4	132.50	5352.00	0.0370
5	167.20	5352.61	0.0370
6	206.10	5352.00	0.0370
7	232.50	5352.00	0.0370
8	300.00	5353.53	0.0000



GEOMAT INC.
915 Malta Avenue ◆ Farmington, NM 87401 ◆ (505) 327-7928

NAVAJO COAL COMPANY
EAST HAULROAD DESIGN

CULVERT CP-412 WATERSHED
EAST HAULROAD STA 274+66

DRAWN BY: PR & BT	PLATE 8
PREPARED BY: PR & BT	REVISED:
	DATE: JAN. 27, 2012

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EAST HAULROAD SERVICE ROAD LOOP 25-YR 24-HR STORM

CULVERT CP-413

STATION 3+40

BHP Billiton

GEOMAT Inc.
915 Malta Avenue
Farmingrton, NM 87401

Phone: (505) 327-7928

General Information

Storm Information:

Storm Type:	Type II-70
Design Storm:	25 yr - 24 hr
Rainfall Depth:	2.060 inches

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Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	End	0.000	0.000	CULVERT CP-413

#1
Null

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	4.112	4.112	6.54	0.25

Structure Detail:

Structure #1 (Null)

CULVERT CP-413

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	4.112	0.068	0.000	0.000	82.900	M	6.54	0.250
	Σ	4.112						6.54	0.250

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	8. Large gullies, diversions, and low flowing streams	2.65	31.95	1,207.13	4.880	0.068
#1	1	Time of Concentration:					0.068

HY-8 Culvert Analysis Report
CULVERT CP-413 – STATION 3+40

Culvert Data Summary - Culvert CP-413

Barrel Shape: Circular

Barrel Diameter: 2.00 ft

Barrel Material: Corrugated Steel

Embedment: 0.00 in

Barrel Manning's n: 0.0240

Inlet Type: Conventional

Inlet Edge Condition: Square Edge with Headwall

Inlet Depression: None

Site Data - Culvert CP-413

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 5332.33 ft

Outlet Station: 98.00 ft

Outlet Elevation: 5331.06 ft

Number of Barrels: 1

Table 1 - Culvert Summary Table: Culvert CP-413

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	5332.33	0.000	0.0*	0-NF	0.000	0.000	0.000	0.000	0.000	0.000
0.65	0.65	5332.74	0.369	0.407	2-M2c	0.278	0.262	0.277	0.171	2.480	0.976
1.31	1.31	5332.93	0.534	0.597	2-M2c	0.411	0.393	0.395	0.222	2.980	1.161
1.96	1.96	5333.06	0.657	0.731	2-M2c	0.498	0.477	0.486	0.258	3.327	1.284
2.62	2.62	5333.19	0.766	0.856	2-M2c	0.584	0.558	0.563	0.288	3.606	1.380
3.27	3.27	5333.29	0.867	0.963	2-M2c	0.654	0.628	0.632	0.313	3.841	1.459
3.92	3.92	5333.39	0.952	1.062	2-M2c	0.720	0.688	0.694	0.335	4.049	1.527
4.58	4.58	5333.49	1.037	1.157	2-M2c	0.787	0.748	0.752	0.355	4.238	1.587
5.23	5.23	5333.58	1.120	1.247	2-M2c	0.846	0.806	0.806	0.373	4.415	1.641
5.89	5.89	5333.66	1.200	1.327	2-M2c	0.903	0.853	0.857	0.390	4.576	1.690
6.54	6.54	5333.73	1.277	1.404	2-M2c	0.961	0.901	0.906	0.405	4.729	1.735

* theoretical depth is impractical. Depth reported is corrected.

****

Inlet Elevation (invert): 5332.33 ft, Outlet Elevation (invert): 5331.06 ft

Culvert Length: 98.00 ft, Culvert Slope: 0.0130

****

Roadway Data for Crossing: Culvert CP-413

Roadway Profile Shape: Irregular Roadway Shape (coordinates)

Irregular Roadway Cross-Section:

Coord No.	Station (ft)	Elevation (ft)
1	0.00	5336.10
2	25.00	5336.35
3	50.00	5336.61
4	75.00	5336.90
5	100.00	5337.19

Roadway Surface: Gravel

Roadway Top Width: 50.00 ft

Table 2 - Downstream Channel Rating Curve (Crossing: Culvert CP-413)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
0.00	5331.06	0.00	0.00	0.00	0.00
0.65	5331.23	0.17	0.98	0.17	0.59
1.31	5331.28	0.22	1.16	0.22	0.61
1.96	5331.32	0.26	1.28	0.25	0.63
2.62	5331.35	0.29	1.38	0.28	0.64
3.27	5331.37	0.31	1.46	0.31	0.65
3.92	5331.39	0.33	1.53	0.33	0.66
4.58	5331.41	0.35	1.59	0.35	0.66
5.23	5331.43	0.37	1.64	0.37	0.67
5.89	5331.45	0.39	1.69	0.38	0.67
6.54	5331.46	0.41	1.74	0.40	0.68

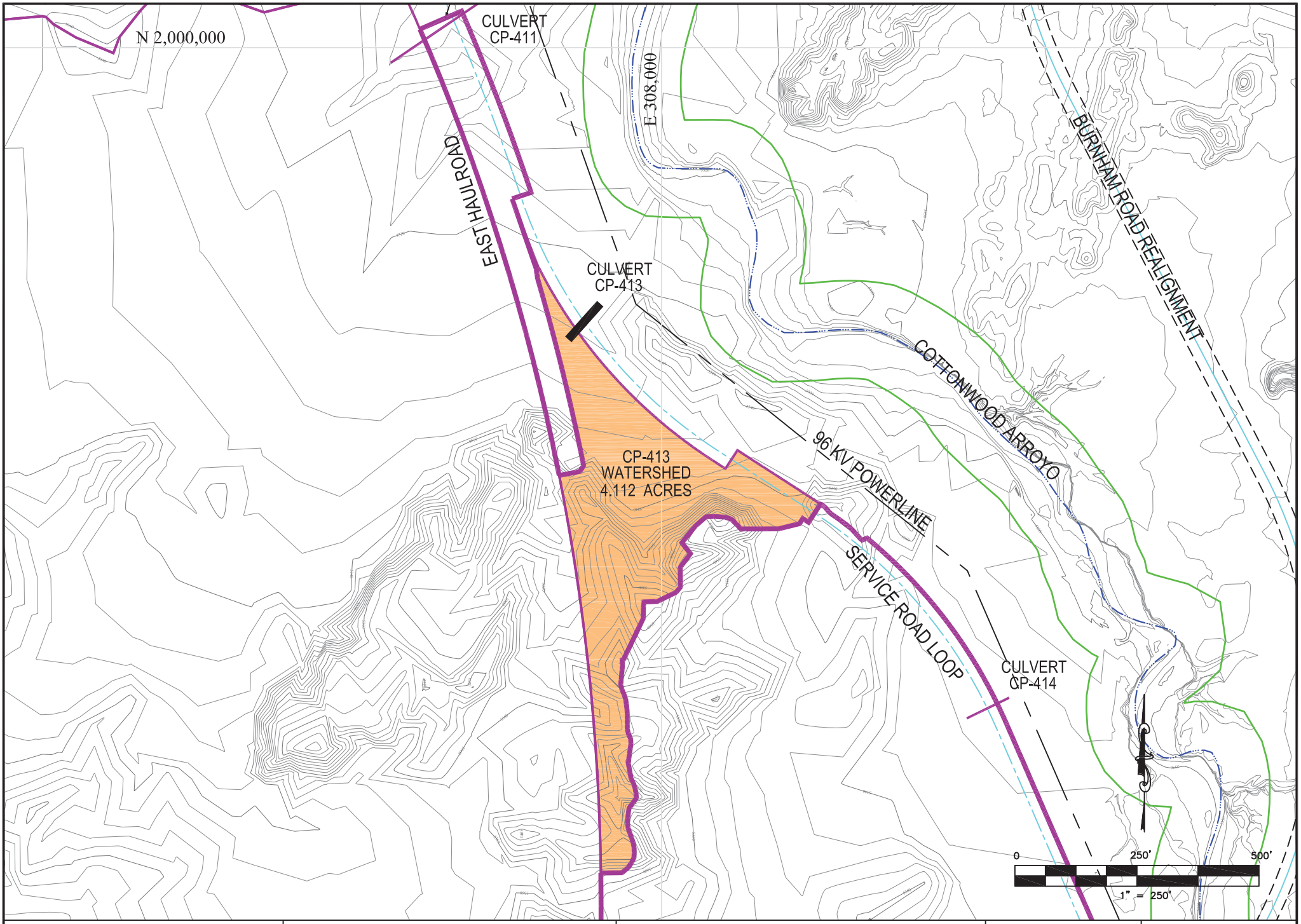
Tailwater Channel Data - Culvert CP-413

Tailwater Channel Option: Irregular Channel

Channel Slope: 0.0157

User Defined Channel Cross-Section:

Coord No.	Station (ft)	Elevation (ft)	Manning's n
1	0.00	5336.00	0.0370
2	26.35	5332.00	0.0370
3	50.00	5331.06	0.0370
4	69.54	5332.00	0.0370
5	89.31	5334.00	0.0370
6	100.00	5335.09	0.0370



GEOMAT INC.
915 Malta Avenue ◆ Farmington, NM 87401 ◆ (505) 327-7928

NAVAJO COAL COMPANY
EAST HAULROAD DESIGN

CULVERT CP-413 WATERSHED
SERVICE ROAD LOOP STA 3+40

DRAWN BY: PR & BT	PLATE 9
PREPARED BY: PR & BT	REVISED:
	DATE: JAN. 27, 2012

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EAST HAULROAD SERVICE ROAD LOOP 25-YR 24-HR STORM

CULVERT CP-414

STATION 15+00

BHP Billiton

GEOMAT Inc.
915 Malta Avenue
Farmingrton, NM 87401

Phone: (505) 327-7928

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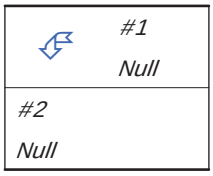
General Information

Storm Information:

Storm Type:	Type II-70
Design Storm:	25 yr - 24 hr
Rainfall Depth:	2.060 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	#2	0.117	0.330	CULVERT CP-412
Null	#2	==>	End	0.000	0.000	CULVERT CP-414



Structure Routing Details:

Stru #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	8. Large gullies, diversions, and low flowing streams	1.21	16.78	1,388.63	3.29	0.117
#1	Muskingum K:					0.117

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	76.550	76.550	52.00	3.73
#2	79.526	156.076	90.31	7.59

Structure Detail:

Structure #1 (Null)

CULVERT CP-412

Structure #2 (Null)

CULVERT CP-414

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	76.550	0.395	0.000	0.000	82.900	M	52.00	3.726
	Σ	76.550						52.00	3.726
#2	1	79.526	0.636	0.000	0.000	82.900	M	40.01	3.861
	Σ	156.076						90.31	7.587

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	8. Large gullies, diversions, and low flowing streams	1.53	80.82	5,281.84	3.710	0.395
#1	1	Time of Concentration:					0.395
#2	1	8. Large gullies, diversions, and low flowing streams	1.46	121.29	8,297.59	3.620	0.636
#2	1	Time of Concentration:					0.636

HY-8 Culvert Analysis Report
CULVERT CP-414 – STATION 15+00

Culvert Data Summary - Culvert CP-414

Barrel Shape: Circular

Barrel Diameter: 3.00 ft

Barrel Material: Corrugated Steel

Embedment: 0.00 in

Barrel Manning's n: 0.0240

Inlet Type: Conventional

Inlet Edge Condition: Square Edge with Headwall

Inlet Depression: None

Site Data - Culvert CP-414

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 5335.84 ft

Outlet Station: 97.00 ft

Outlet Elevation: 5334.94 ft

Number of Barrels: 3

Table 1 - Culvert Summary Table: Culvert CP-414

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	5335.84	0.000	0.0*	0-NF	0.000	0.000	0.000	0.000	0.000	0.000
9.03	9.03	5336.65	0.727	0.813	2-M2c	0.594	0.525	0.540	0.217	3.478	1.024
18.06	18.06	5337.00	1.047	1.159	2-M2c	0.836	0.756	0.770	0.262	4.198	1.344
27.09	27.09	5337.28	1.306	1.438	2-M2c	1.034	0.944	0.949	0.297	4.707	1.575
36.12	36.12	5337.52	1.520	1.684	2-M2c	1.215	1.093	1.101	0.329	5.118	1.761
45.16	45.16	5337.74	1.728	1.903	2-M2c	1.374	1.234	1.237	0.357	5.475	1.919
54.19	54.19	5337.95	1.924	2.110	2-M2c	1.531	1.353	1.360	0.383	5.796	2.059
63.22	63.22	5338.14	2.111	2.305	2-M2c	1.682	1.472	1.475	0.407	6.093	2.184
72.25	72.25	5338.33	2.292	2.492	2-M2c	1.834	1.577	1.581	0.430	6.375	2.298
81.28	81.28	5338.52	2.471	2.682	2-M2c	1.991	1.676	1.682	0.451	6.642	2.403
90.31	90.31	5338.70	2.649	2.861	2-M2c	2.156	1.776	1.777	0.472	6.902	2.501

* theoretical depth is impractical. Depth reported is corrected.

****

Inlet Elevation (invert): 5335.84 ft, Outlet Elevation (invert): 5334.94 ft

Culvert Length: 97.00 ft, Culvert Slope: 0.0093

****

Roadway Data for Crossing: Culvert CP-414

Roadway Profile Shape: Irregular Roadway Shape (coordinates)

Irregular Roadway Cross-Section:

Coord No.	Station (ft)	Elevation (ft)
1	0.00	5341.29
2	50.00	5341.01
3	100.00	5340.78
4	150.00	5340.63
5	200.00	5340.57

Roadway Surface: Gravel

Roadway Top Width: 50.00 ft

Table 2 - Downstream Channel Rating Curve (Crossing: Culvert CP-414)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
0.00	5334.76	0.00	0.00	0.00	0.00
9.03	5334.98	0.22	1.02	0.23	0.62
18.06	5335.02	0.26	1.34	0.28	0.66
27.09	5335.06	0.30	1.57	0.32	0.69
36.12	5335.09	0.33	1.76	0.35	0.71
45.16	5335.12	0.36	1.92	0.39	0.72
54.19	5335.14	0.38	2.06	0.41	0.74
63.22	5335.17	0.41	2.18	0.44	0.75
72.25	5335.19	0.43	2.30	0.46	0.76
81.28	5335.21	0.45	2.40	0.49	0.76
90.31	5335.23	0.47	2.50	0.51	0.77

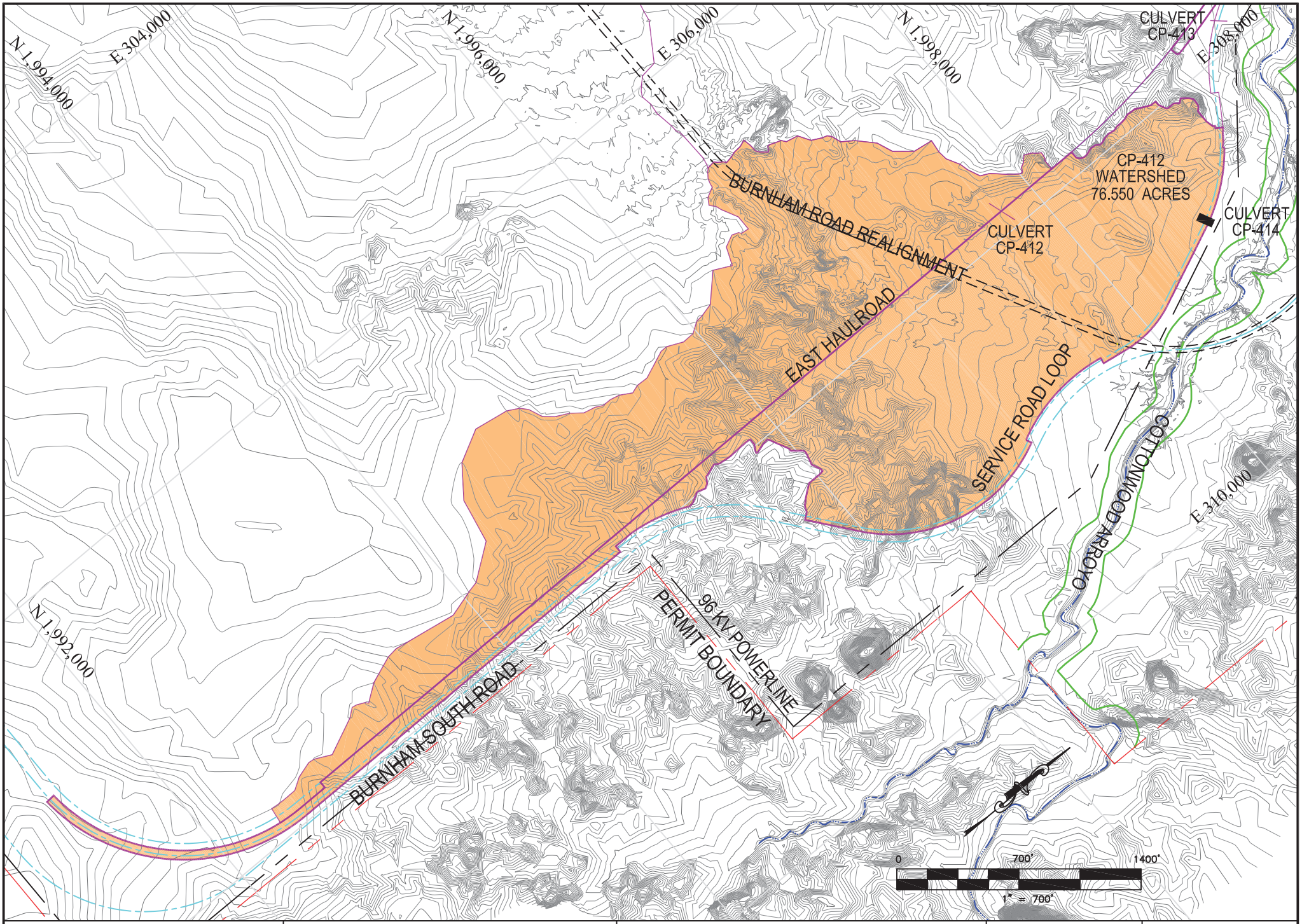
Tailwater Channel Data - Culvert CP-414

Tailwater Channel Option: Irregular Channel

Channel Slope: 0.0173

User Defined Channel Cross-Section:

Coord No.	Station (ft)	Elevation (ft)	Manning's n
1	0.00	5344.00	0.0370
2	34.66	5336.00	0.0370
3	50.00	5334.76	0.0370
4	100.00	5334.94	0.0370
5	150.00	5334.94	0.0370
6	167.78	5336.00	0.0370
7	200.00	5344.00	0.0370



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CULVERT CP-414 WATERSHED
SERVICE ROAD LOOP STA 15+00

DRAWN BY: PR & BT	PLATE 10
PREPARED BY: PR & BT	REVISED:
	DATE: JAN. 27, 2012