ARCADIS

Tables

Table 1

General Chemistry
Water Quality Monitoring Results

Former Universal Propulsion Company, Inc. Facility
Phoenix, Arizona

Parameter	MW-1 1/26/2012	MW-2 1/25/2012	MW-4 1/26/2012	MW-5 1/25/2012	MW-13 1/24/2020	MW-19 1/26/2012	MW-20 2/6/2012	MW-21 2/9/2012
General Chemistry (mg/L)								
Alkalinity as $CaCO_3$	150	160	180	160	200	140	160	160
Alkalinity, Phenolphthalein	<6.0	<6.0	<6.0	<6.0	<6.0	<6.0	<6.0	<6.0
Bicarbonate Alkalinity as $CaCO_3$	150	160	180	160	200	140	160	160
Biochemical Oxygen Demand	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Carbonate Alkalinity as $CaCO_3$	<6.0	<6.0	<6.0	<6.0	<6.0	<6.0	<6.0	<6.0
Chemical Oxygen Demand	<20	<20	<20	<20	<20	<20	NA	<20
Chloride	21	24	21	13	15	24	44	12
Hardness, Total	150	130	130	99	140	150	NA	NA
Hydroxide Alkalinity as $CaCO_3$	<6.0	<6.0	<6.0	<6.0	<6.0	<6.0	<6.0	<6.0
Nitrate-N	1.8	3.8	1.5	1.8	1.2	6.7	7	2
Perchlorate (µg/L)	68	91	<2.0	25	11	35000	430	6.2
Sulfate	13	7.1	6.2	5.1	10	11	15	4.9
Total Dissolved Solids	280	280	280	250	260	360	330	240
Total Organic Carbon	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Dissolved Oxygen (mg/L)*	4.45	4.46	3.14	4.54	2.43	5.36	NM	5.43

Notes:

* = dissolved oxygen measured as a field parameter
< = less than
$CaCO_3$ = calcium carbonate
mg/L = milligrams per liter
NA = not analyzed
Nitrate-N = nitrate reported as nitrogen
NM = not measured
µg/L = micrograms per liter

Table 2

UPCO Well Information

Former Universal Propulsion Company, Inc. Facility
Phoenix, Arizona

WellID	Easting	Northing	ADWR Number	Total Casing Depth (feet bgs)	Screened Interval (feet bgs)	Measuring Point Elevation (feet amsl)
MW-1	653227.14	987065.13	55-201495	240	190-240	1560.43
MW-2	653289.68	987649.25	55-201494	250	200-250	1571.22
MW-3	652625.62	988671.09	55-204197	271	221-271	1583.59
MW-4	654284.93	988971.85	55-204196	300	245-295	1620.34
MW-5	653971.17	988127.33	55-204195	285	230-280	1594.08
MW-6	652259.53	987361.63	55-204194	210	155-205	1551.65
MW-7	652125.72	986534.14	55-205001	210	155-205	1541.35
MW-8	653422.61	986160.23	55-205002	235	180-230	1542.18
MW-9	654356.82	986138.65	55-901548	255	200-250	1565.60
MW-10	651342.65	987055.87	55-901549	205	150-200	1536.11
MW-11	654182.70	987795.50	55-903736	315	260-310	1606.14
MW-12	653210.97	987117.21	55-903737	480	450-480	1560.91
MW-13	654137.59	988274.92	55-217221	490.5	440-490	1599.52
MW-14	653239.01	989362.53	55-217222	500	445-495	1602.48
MW-15	653225.43	989314.03	55-217223	325	270-320	1600.48
MW-16	652624.02	988727.69	55-913047	500	445-495	1585.36
MW-17	652108.14	987746.04	55-913046	260	205-255	1560.72
MW-18	652551.52	986026.10	55-911047	230	175-225	1533.53
MW-19	654123.16	988257.79	55-913045	305	250-300	1599.51
MW-20	653603.36	987861.04	55-914005	290	235-285	1580.87
MW-21	653452.17	987298.28	55-914006	270	215-265	1565.28
MW-22	653986.82	988397.29	55-222509	280	210-280	1598.46
PW-1	652363.12	987457.36	55-500290	500	420-480	1554.46
EW-1	654072.86	988197.93	55-222510	300	250-300	1594.88
EW-2	653202.70	987087.51	55-222511	305	210-305	1560.92
IW-1	654207.54	988310.57	55-222512	335	250-335	1595.52
IW-2	653918.36	988425.16	55-222513	285	210-285	1593.68
IW-3	653358.52	987678.13	55-222514	255	180-255	1568.96
RW-1	654327.57	988477.20	55-223676	340	265-340	1605.41
RW-2	654020.89	988671.20	55-223677	332	252-332	1605.31
SVMW-1	652901.10	987613.08	55-909947	200	30-40 90-100 140-150 190-200	NA

Notes:
Coordinates are expressed in North American Datum 83 State Plane Arizona Central (international feet).
ADWR = Arizona Department of Water Resources
bgs = below ground surface
amsl = above mean sea level
NA = not applicable

Table 3

Highest Detected Concentrations of Perchlorate in Soil

Former Universal Propulsion Company, Inc. Facility
Phoenix, Arizona

Area:	B-Complex						C-Complex										
Depth (ft bgs)	0-3	4-10	11-20	21-30	31-40	41-50	0-1	2-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100
Perchlorate (mg/kg)	0.4	<0.04	<0.04	<0.04	<0.04	<0.04	330	23	83	1.3	0.12	0.074	0.23	<0.04	<0.04	<0.04	<0.04

	D-Complex																													
Area:	Old Burn Area					Thermal Treatment Unit Area							Waterbore Area																	
Depth (ft bgs)	0-1	2-5	6-10	11-20	21-30	0-1	2-5	6-10	11-20	21-30	31-40	41-50	0-1	2-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100	101-125	126-150	151-165	166-175	176-200	201-216
Perchlorate (mg/kg)	0.8	0.16	0.06	<0.04	<0.04	4.9	11	16	0.63	0.12	0.63	1.2	1800	236	369	255	150	51	84	98	85	93	61	35	8.9	<0.04	32	<0.04	0.14

	E-Complex				Open Burn Unit								F-Complex					
Area:	Storage Magazine Area				New Burn Area													
Depth (ft bgs)	0-1	2-5	6-10	11-20	0-1	2-5	6-10	11-20	21-30	31-40	41-50	51-60	0-10	11-20	21-30	31-40	41-50	51-60
Perchlorate (mg/kg)	124	6.2	1.6	0.64	27	61	38	15	12	15	2.3	4	6.5	0.71	1.2	0.74	1.8	0.47

Notes:
< = less than
ft bgs = feet below ground surface
mg/kg = milligrams per kilogram

Table 4

Highest Detected Concentrations of Metals in Soil

Former Universal Propulsion Company, Inc. Facility
Phoenix, Arizona

Area:	B-Complex						C-Complex										
Depth (ft bgs)	0-3	4-10	11-20	21-30	31-40	41-50	0-1	2-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100
Arsenic (mg/kg)	12.0	10.0	9.8	8.6	6.8	9.9	8.3	7.0	6.5	7.3	5.8	7.0	6.1	6.2	5.9	5.5	<5
Lead (mg/kg)	17.0	11.0	7.6	12.0	7.4	11.0	61.0	6.0	12.0	8.3	9.3	9.2	8.2	7.1	6.8	7.5	5.9

Area:	D-Complex																										
	Old Burn Area					Thermal Treatment Unit Area							Waterbore Area														
Depth (ft bgs)	0-1	2-5	6-10	11-20	21-30	0-1	2-5	6-10	11-20	21-30	31-40	41-50	0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100	101-125	126-150	151-165	166-175	176-200	201-216
Arsenic (mg/kg)	11.0	7.0	7.9	NA	NA	9.7	NA	NA	NA	NA	NA	NA	5.8	7.8	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Lead (mg/kg)	4800.0	44.0	<5	NA	NA	22.0	NA	NA	NA	NA	NA	NA	31.0	9.9	9.1	11.0	9.0	10.0	8.5	8.9	9.9	8.8	8.9	9.1	5.6	11	5.8	<5

Area:	E-Complex				Open Burn Unit								F-Complex				
	Storage Magazine Area				New Burn Area												
Depth (ft bgs)	0-1	2-5	6-10	11-20	0-1	2-5	6-10	11-20	21-30	31-40	41-50	51-60	0-10	11-20	21-30	31-40	41-50
Arsenic (mg/kg)	NA	NA	NA	NA	15.0	6.3	7.8	7.7	6.9	NA	NA	NA	9.9	12	10	6.8	10
Lead (mg/kg)	35.0	17.0	5.3	NA	650.0	21.0	11.0	9.6	15.0	NA	NA	NA	54	11	11	12	7.5

Notes:
< = less than
ft bgs = feet below ground surface
mg/kg = milligrams per kilogram
NA = not analyzed

Table 5

Groundwater Analytical Summary

Former Universal Propulsion Company, Inc. Facility
Phoenix, Arizona

Sample ID	Date	Perchlorate (µg/L)		1,1-Dichloroethene (µg/L)	1,4-Dioxane (µg/L)
		USEPA 314.0	USEPA 332.0		
Remedial Goal (µg/L)		**14.0**		**7.0**	**3.5**
EW-1	4/4/2014	**57.0**		<0.50	<2.0
EW-1	7/17/2014	**941**	**970**	<0.50	<2.0
EW-1	10/14/2014	**265**			
EW-2	4/7/2014	**36.8**		<0.50	<2.0
EW-2	7/11/2014	**62.0**		<0.50	2.3
EW-2	7/14/2014		**58**		
EW-2	10/13/2014	**52.5**			
IW-1	4/4/2014	**35000**		<0.50	<2.0
IW-1	7/17/2014	**44000**	**39000**	<0.50	<2.0
IW-1	10/15/2014	**47600**			
IW-2	4/7/2014	4.5		<0.50	<2.0
IW-2	7/15/2014	<3.0	0.24	<0.50	<2.0
IW-2	10/10/2014		0.16		
IW-3	4/3/2014	**62.3**		<0.50	<2.0
IW-3	7/16/2014	10.6	11	<0.50	<2.0
IW-3	10/10/2014	**36.0**			
MW-1	2/13/2004	**130**			
MW-1	3/19/2004	**120**			
MW-1	4/16/2004	**88**		<5	
MW-1	9/7/2004	**94**		<5	
MW-1	11/4/2004	**89**		<5	
MW-1	12/9/2004	**89**		<5	
MW-1	1/17/2005	**77**		<5	1.4
MW-1	2/21/2005			<5	
MW-1	3/21/2005			<5	
MW-1	4/25/2005	**65**		<5	1.3
MW-1	5/19/2005			<5	
MW-1	6/27/2005			<5	
MW-1	7/18/2005	**58**		<5	1.4
MW-1	9/23/2005			<2	
MW-1	10/24/2005	**47**		<2	1.3
MW-1	3/21/2006	**49**		<2	1.5
MW-1	5/22/2006	**52**		<2	1.5
MW-1	8/28/2006	**61**		<2.0	<1.0
MW-1	11/13/2006	**64**		<2.0	1.3
MW-1	2/13/2007	**76**		<2.0	1.1
MW-1	4/9/2007	**71**		<2.0	<1.0
MW-1	7/31/2007	**71**		<2.0	1.3
MW-1	10/16/2007	**70**	**75**	< 2.0	1.0
MW-1	1/15/2008	**74**		<2.0	<1.0
MW-1	3/31/2008	**76**			
MW-1	10/17/2008	**73**		<0.50	<1.0
MW-1	1/23/2009	**76**		<0.50	<2.0
MW-1	4/15/2009	**76**			

Table 5

Groundwater Analytical Summary

Former Universal Propulsion Company, Inc. Facility
Phoenix, Arizona

Sample ID	Date	Perchlorate (µg/L)		1,1-Dichloroethene (µg/L)	1,4-Dioxane (µg/L)
		USEPA 314.0	USEPA 332.0		
Remedial Goal (µg/L)		**14.0**		**7.0**	**3.5**
MW-1	8/14/2009	**83**		<0.50	<2.0
MW-1	11/2/2009	**70**			
MW-1	1/25/2010	**69**		<0.50	<1.0
MW-1	6/14/2010	**78**			
MW-1	3/2/2011	**67**		<0.50	<1.0
MW-1	4/26/2011	**70**			
MW-1	10/27/2011	**73**		<0.50	<2.0
MW-1	1/26/2012	**68**		<0.50	<2.0
MW-1	5/9/2012	**71**			
MW-1	8/19/2012	**81**		<0.50	<2.0
MW-1	3/6/2013	**67.7**		<0.50	<2.0
MW-1	5/2/2013	**63.2**			
MW-1	7/24/2013	**63.5**		<0.50	<2.0
MW-1	10/9/2013	**62.2**			
MW-1	1/22/2014	**59.8**		<0.50	<2.0
MW-1	4/2/2014	**53.7**			
MW-1	7/15/2014	**57.9**		<0.50	<2.0
MW-1	10/13/2014	**55.1**			
MW-2	2/13/2004	**47**			
MW-2	3/19/2004	**39**			
MW-2	4/16/2004	**40**		<5	
MW-2	9/7/2004	**50**		<5	
MW-2	11/5/2004	**54**		<5	
MW-2	12/9/2004	**56**		<5	
MW-2	1/17/2005	**55**		<5	2.1
MW-2	4/25/2005	**64**		<5	2
MW-2	7/18/2005	**61**		<5	2.4
MW-2	10/24/2005	**71**		<2	1.8
MW-2	3/22/2006	**69**		<2	2.2
MW-2	5/23/2006	**75**		<2	2.1
MW-2	8/28/2006	**77**		<2.0	2.1
MW-2	11/13/2006	**78**		<2.0	2.5
MW-2	2/13/2007	**87**		<2.0	2.7
MW-2	4/9/2007	**83**		<2.0	2.6
MW-2	7/31/2007	**84**		<2.0	3.0
MW-2	10/16/2007	**80**	**83**	< 2.0	2.7
MW-2	1/19/2008	**84**		<2.0	2.7
MW-2	3/31/2008	**86**			
MW-2	7/30/2008	**88**		<0.50	2.6 J
MW-2	10/17/2008	**78**			
MW-2	1/23/2009	**92**		<0.50	2.4
MW-2	4/15/2009	**88**			
MW-2	8/14/2009	**96**		<0.50	2.8
MW-2	11/2/2009	**83**			

Table 5

Groundwater Analytical Summary

Former Universal Propulsion Company, Inc. Facility
Phoenix, Arizona

Sample ID	Date	Perchlorate (µg/L)		1,1-Dichloroethene (µg/L)	1,4-Dioxane (µg/L)
		USEPA 314.0	USEPA 332.0		
Remedial Goal (µg/L)		**14.0**		**7.0**	**3.5**
MW-2	1/25/2010	**90**		<0.50	2.7
MW-2	6/14/2010	**94**			
MW-2	3/2/2011	**87**		<0.50	2.6
MW-2	4/26/2011	**87**			
MW-2	10/27/2011	**90**		<0.50	2.8
MW-2	1/25/2012	**91**		<0.50	2.8
MW-2	5/10/2012	**88**			
MW-2	8/19/2012	**82**		<0.50	2.9
MW-2	3/7/2013	**92.5**		<0.50	2.5 J
MW-2	5/1/2013	**89.7**			
MW-2	7/23/2013	**89.7**		<0.50	3.2
MW-2	10/9/2013	**88.9**			
MW-2	1/23/2014	**87.4**		<0.50	2.7
MW-2	4/2/2014	**81.1**			
MW-2	7/15/2014	**83.9**		<0.50	3.2
MW-2	10/13/2014	**81.2**			
MW-3	9/8/2004	<2		<5	
MW-3	11/5/2004	<2		<5	
MW-3	12/9/2004	<2		<5	
MW-3	1/18/2005	<2		<5	<1
MW-3	4/26/2005	<2		<5	<1
MW-3	7/20/2005	<2		<5	<1
MW-3	10/26/2005	<2		<2	<1
MW-3	3/21/2006	<2		<2	<1
MW-3	8/30/2006	<2.0		<2.0	<1.0
MW-3	11/15/2006		0.59		
MW-3	2/15/2007	<2.0	0.54	<2.0	<1.0
MW-3	8/2/2007	<2	1.0	<2.0	<1.0
MW-3	1/18/2008	<2.0	0.46	<2.0	<2.0
MW-3	7/30/2008	<2.0	0.69		
MW-3	1/14/2009	<2.0	0.73	<0.50	<2.0
MW-3	8/18/2009	<2.0	0.64 J		
MW-3	1/20/2010	<2.0	0.47 J	<0.50	<1.0
MW-3	2/25/2011	<2.0	0.53	<0.50	<1.0
MW-3	7/28/2011	<2.0	0.59		
MW-3	2/1/2012	<2.0	0.51	<0.50	<2.0
MW-3	8/8/2012	<2.0 UJ	0.62		
MW-3	3/1/2013	<3.0		<0.50	2.8
MW-3	7/24/2013	<3.0	0.48		
MW-3	1/15/2014	<3.0	0.47	<0.50	<2.0
MW-3	7/10/2014	<3.0	0.43 J		
MW-4	9/8/2004	<2		<5	
MW-4	11/5/2004	<2		<5	
MW-4	12/9/2004	<2		<5	

Table 5

Groundwater Analytical Summary

Former Universal Propulsion Company, Inc. Facility
Phoenix, Arizona

Sample ID	Date	Perchlorate (µg/L)		1,1-Dichloroethene (µg/L)	1,4-Dioxane (µg/L)
		USEPA 314.0	USEPA 332.0		
Remedial Goal (µg/L)		**14.0**		**7.0**	**3.5**
MW-4	1/18/2005	<2		<5	<1
MW-4	4/26/2005	<2		<5	<1
MW-4	7/18/2005	<2		<5	<1
MW-4	10/26/2005	<2		<2	<1
MW-4	3/23/2006	<2		<2	<1
MW-4	8/30/2006	<2.0		<2.0	<1.0
MW-4	11/15/2006		0.61		
MW-4	2/15/2007	<2.0	0.62	<2.0	<1.0
MW-4	8/2/2007	<2	0.97	<2.0	<1.0
MW-4	1/19/2008	<2.0	0.53	<2.0	<1.0
MW-4	7/30/2008	<2.0	0.74		
MW-4	1/14/2009	<2.0	0.72	<0.50	<2.0
MW-4	8/18/2009	<2.0	0.71 J		
MW-4	1/20/2010	<2.0	0.49 J	<0.50	<1.0
MW-4	2/25/2011	<2.0	0.61	<0.50	<1.0
MW-4	7/29/2011	<2.0	0.61		
MW-4	1/26/2012	<2.0		<0.50	<2.0
MW-4	8/8/2012	<2.0 UJ	0.84 J		
MW-4	3/5/2013	<3.0	0.77	<0.50	<2.0
MW-4	7/24/2013	<3.0	0.67		
MW-4	1/18/2014	<3.0	0.61	<0.50	<2.0
MW-4	7/15/2014	<3.0	0.59		
MW-5	9/8/2004	6.4		<5	
MW-5	11/4/2004	7.7		<5	
MW-5	12/8/2004	9.6		<5	
MW-5	1/18/2005	9		<5	<1
MW-5	4/26/2005	11		<5	<1
MW-5	7/18/2005	12		<5	<1
MW-5	10/25/2005	**15**		<2	<1
MW-5	3/22/2006	**16**		<2	<1
MW-5	5/23/2006	**17**			
MW-5	8/30/2006	**18**		<2.0	<1.0
MW-5	11/14/2006	**18**			
MW-5	2/13/2007	**21**		<2.0	<1.0
MW-5	4/10/2007	**19**			
MW-5	7/31/2007	**19**		<2.0	<1.0
MW-5	10/17/2007	**22**			
MW-5	1/16/2008	**25**		<2.0	<1.0
MW-5	3/31/2008	**23**			
MW-5	7/30/2008	**24**			
MW-5	10/17/2008	**22**			
MW-5	1/16/2009	**24**		<0.50	<2.0
MW-5	4/15/2009	**23**			
MW-5	8/17/2009	**27**			

Table 5

Groundwater Analytical Summary

Former Universal Propulsion Company, Inc. Facility
Phoenix, Arizona

Sample ID	Date	Perchlorate (µg/L)		1,1-Dichloroethene (µg/L)	1,4-Dioxane (µg/L)
		USEPA 314.0	USEPA 332.0		
Remedial Goal (µg/L)		**14.0**		**7.0**	**3.5**
MW-5	10/28/2009	**26**			
MW-5	1/25/2010	**32**		<0.50	<1.0
MW-5	6/14/2010	**27**			
MW-5	3/2/2011	**20**		<0.50	<1.0
MW-5	4/26/2011	**23**			
MW-5	7/29/2011	**22**			
MW-5	10/26/2011	**25**			
MW-5	1/25/2012	**25**		<0.50	<2.0
MW-5	5/10/2012	**24**			
MW-5	8/19/2012	**26**			
MW-5	3/6/2013	**24.6**		<0.50	<2.0
MW-5	5/1/2013	**27.6**			
MW-5	7/19/2013	**28.9**			
MW-5	10/9/2013	**30.5**			
MW-5	1/22/2014	**27.7**		<0.50	<2.0
MW-5	4/1/2014	**27.3**			
MW-5	7/11/2014	**21.2**			
MW-5	10/10/2014	**24.5**			
MW-6	9/8/2004	**18**		<5	
MW-6	11/5/2004	**19**		<5	
MW-6	12/9/2004	**18**		<5	
MW-6	1/18/2005	**15**		<5	<1
MW-6	4/27/2005	**18**		<5	<1
MW-6	7/20/2005	**20**		<5	<1
MW-6	10/26/2005	**18**		<2	<1
MW-6	3/23/2006	**16**		<2	<1
MW-6	5/23/2006	**17**			
MW-6	8/30/2006	**17**		<2.0	<1.0
MW-6	11/15/2006	**16**			
MW-6	2/15/2007	**18**		<2.0	<1.0
MW-6	4/10/2007	**17**			
MW-6	8/2/2007	**17**			
MW-6	8/2/2007			<2.0	<1.0
MW-6	10/17/2007	**15**			
MW-6	1/17/2008	**18**		<2.0	<1.0
MW-6	3/31/2008	**17**			
MW-6	7/30/2008	**17**			
MW-6	10/17/2008	**15**			
MW-6	1/14/2009	**18**		<0.50	<2.0
MW-6	4/15/2009	**17**			
MW-6	8/18/2009	**19**			
MW-6	10/30/2009	**15**			
MW-6	1/20/2010	**16**		<0.50	<1.0
MW-6	6/15/2010	**19**			

Table 5

Groundwater Analytical Summary

Former Universal Propulsion Company, Inc. Facility
Phoenix, Arizona

Sample ID	Date	Perchlorate (µg/L)		1,1-Dichloroethene (µg/L)	1,4-Dioxane (µg/L)
		USEPA 314.0	USEPA 332.0		
Remedial Goal (µg/L)		**14.0**		**7.0**	**3.5**
MW-6	2/25/2011	**17**		<0.50	<1.0
MW-6	4/27/2011	**18**			
MW-6	7/28/2011	14			
MW-6	10/27/2011	**18**			
MW-6	2/1/2012	**20**	14 J	<0.50	<2.0
MW-6	5/10/2012	**18**			
MW-6	8/19/2012	**20**			
MW-6	3/6/2013	**19.4**		<0.50	<2.0
MW-6	5/3/2013	**18.7**			
MW-6	7/24/2013	**17.8**			
MW-6	10/9/2013	**19.0**			
MW-6	1/23/2014	**17.1**		<0.50	<2.0
MW-6	4/2/2014	**15.8**			
MW-6	7/15/2014	**17.8**		<0.50	<2.0
MW-6	10/15/2014	<3.0			
MW-7	11/5/2004	<2		<5	
MW-7	12/8/2004	<2		<5	
MW-7	1/18/2005	<2		<5	<1
MW-7	4/26/2005	<2		<5	<1
MW-7	7/20/2005	<2		<5	<1
MW-7	10/25/2005	<2		<2	<1
MW-7	3/22/2006	<2		<2	<1
MW-7	8/30/2006	<2.0		<2.0	<1.0
MW-7	11/15/2006		0.60		
MW-7	2/14/2007	<2.0	0.60	<2.0	<1.0
MW-7	8/1/2007	<2	0.58 J	<2.0	<1.0
MW-7	1/17/2008	<2.0	0.49	<2.0	<1.0
MW-7	8/1/2008	<2.0	0.73		
MW-7	1/15/2009	<2.0	0.62	<0.50	<2.0
MW-7	8/18/2009	<2.0	0.70 J		
MW-7	1/22/2010	<2.0	0.51 J	<0.50	<1.0
MW-7	2/25/2011	<2.0	0.65	<0.50	<1.0
MW-7	7/28/2011	<2.0	0.60		
MW-7	1/27/2012	<2.0	0.60	<0.50	<2.0
MW-7	8/7/2012	<2.0 UJ	0.66 J		
MW-7	2/27/2013	<3.0	0.57	<0.50	<2.0
MW-7	7/24/2013	<3.0	0.52		
MW-7	1/17/2014	<3.0	0.59	<0.50	<2.0
MW-7	7/8/2014	<3.0	0.53 J		
MW-8	11/5/2004	<2		<5	
MW-8	12/9/2004	<2		<5	
MW-8	1/19/2005	<2		<5	<1
MW-8	4/27/2005	<2		<5	<1
MW-8	7/20/2005	<2		<5	<1

Table 5

Groundwater Analytical Summary

Former Universal Propulsion Company, Inc. Facility
Phoenix, Arizona

Sample ID	Date	Perchlorate (µg/L)		1,1-Dichloroethene (µg/L)	1,4-Dioxane (µg/L)
		USEPA 314.0	USEPA 332.0		
Remedial Goal (µg/L)		**14.0**		**7.0**	**3.5**
MW-8	10/26/2005	<2		<2	<1
MW-8	3/22/2006	<2		<2	<1
MW-8	8/30/2006	<2.0		<2.0	<1.0
MW-8	11/15/2006		0.99		
MW-8	2/15/2007	<2.0	1.0	<2.0	<1.0
MW-8	8/2/2007	<2	1.4	<2.0	<1.0
MW-8	1/18/2008	<2.0	0.92	<2.0	<2.0
MW-8	7/31/2008	<2.0	0.88		
MW-8	1/14/2009	<2.0	1.1	<0.50	<2.0
MW-8	8/18/2009	<2.0	1.0 J		
MW-8	1/20/2010	<2.0	0.93 J	<0.50	<1.0
MW-8	3/1/2011	<2.0	1.1	<0.50	<1.0
MW-8	7/28/2011	<2.0	1.0		
MW-8	1/31/2012	<2.0	0.93	<0.50	<2.0
MW-8	8/8/2012	<2.0 UJ	1.2 J		
MW-8	2/27/2013	<3.0	0.89	<0.50	<2.0
MW-8	7/17/2013	3.0	0.89		
MW-8	1/15/2014	<3.0	0.92	<0.50	<2.0
MW-8	7/10/2014	<3.0	0.98		
MW-9	2/10/2005	<2		<5	<1
MW-9	4/25/2005	<2		<5	<1
MW-9	7/20/2005	<2		<5	<1
MW-9	10/26/2005	<2		<2	<1
MW-9	3/23/2006	<2		<2	<1
MW-9	8/31/2006	<2.0		<2.0	<1.0
MW-9	11/15/2006		0.77		
MW-9	2/14/2007	<2.0	0.81	<2.0	<1.0
MW-9	8/1/2007	<2	0.80 J	<2.0	<1.0
MW-9	1/18/2008	<2.0	0.68	<2.0	<2.0
MW-9	8/1/2008	<2.0	0.86		
MW-9	1/14/2009	<2.0	0.84	<0.50	<2.0
MW-9	8/18/2009	<2.0	0.78 J		
MW-9	1/20/2010	<2.0	0.64 J	<0.50	<1.0
MW-9	3/1/2011	<2.0	0.75	<0.50	<1.0
MW-9	7/27/2011	<2.0 UJ	2.7		
MW-9	1/27/2012	<2.0	0.71	<0.50	<2.0
MW-9	8/9/2012	2.1 J			
MW-9	3/4/2013	<3.0	0.59	<0.50	<2.0
MW-9	7/17/2013	<3.0	0.58		
MW-9	1/17/2014	<3.0	0.78	<0.50	<2.0
MW-9	7/8/2014	<3.0	0.73 J		
MW-10	2/10/2005	<2		<5	<1
MW-10	4/27/2005	<2		<5	<1
MW-10	7/20/2005	<2		<5	<1

Table 5

Groundwater Analytical Summary

Former Universal Propulsion Company, Inc. Facility
Phoenix, Arizona

Sample ID	Date	Perchlorate (µg/L)		1,1-Dichloroethene (µg/L)	1,4-Dioxane (µg/L)
		USEPA 314.0	USEPA 332.0		
Remedial Goal (µg/L)		**14.0**		**7.0**	**3.5**
MW-10	10/26/2005	<2		<2	<1
MW-10	3/23/2006	<2		<2	<1
MW-10	8/30/2006	<2.0		<2.0	<1.0
MW-10	11/15/2006		0.78		
MW-10	2/15/2007	<2.0	0.81	<2.0	<1.0
MW-10	8/2/2007	<2	1.3	<2.0	<1.0
MW-10	1/18/2008	<2.0	0.75	<2.0	<2.0
MW-10	7/31/2008	<2.0	0.87		
MW-10	1/14/2009	<2.0	0.96	<0.50	<2.0
MW-10	8/18/2009	<2.0	0.93 J		
MW-10	1/20/2010	<2.0	1.2 J	<0.50	<1.0
MW-10	2/25/2011	<2.0	1.0	<0.50	<1.0
MW-10	7/28/2011	<2.0	0.92		
MW-10	1/31/2012	<2.0	0.80	<0.50	<2.0
MW-10	8/8/2012	2.5 J			
MW-10	3/5/2013	<3.0	0.91	<0.50	<2.0
MW-10	7/17/2013	<3.0	0.90		
MW-10	1/21/2014	<3.0	1.1	<0.50	<2.0
MW-10	7/9/2014	<3.0	0.93 J		
MW-11	3/21/2006	<2		<2	<1
MW-11	5/22/2006	2.1			
MW-11	8/29/2006	2.0		<2.0	<1.0
MW-11	11/14/2006	<2.0	2.2		
MW-11	2/13/2007	<2.0	2.2	<2.0	<1.0
MW-11	4/10/2007	<2.0	2.1		
MW-11	7/31/2007	2.3	1.9 J	<2.0	<1.0
MW-11	10/17/2007	2.4			
MW-11	1/16/2008	<2.0	2.6	<2.0	<1.0
MW-11	8/1/2008	2.6	2.2		
MW-11	1/15/2009	2.0	2.0	<0.50	<2.0
MW-11	8/18/2009	2.3	2.1 J		
MW-11	1/21/2010	2.0	2.1 J	<0.50	<1.0
MW-11	2/28/2011	<2.0	2.2	<0.50	<1.0
MW-11	7/29/2011	2.0	2.0		
MW-11	1/30/2012	2.6	2.0	<0.50	<2.0 UJ
MW-11	8/13/2012	2.2	2.2		
MW-11	3/4/2013	<3.0	2.2	<0.50	<2.0
MW-11	7/16/2013	<3.0	2.3		
MW-11	1/20/2014	<3.0	2.7	<0.50	<2.0
MW-11	7/11/2014	<3.0	2.5 J		
MW-12	3/21/2006	<2		<2	<1
MW-12	5/22/2006	<2			
MW-12	8/28/2006	<2.0		<2.0	<1.0
MW-12	11/13/2006	<2.0	0.76		

Table 5

Groundwater Analytical Summary

Former Universal Propulsion Company, Inc. Facility
Phoenix, Arizona

Sample ID	Date	Perchlorate (µg/L)		1,1-Dichloroethene (µg/L)	1,4-Dioxane (µg/L)
		USEPA 314.0	USEPA 332.0		
Remedial Goal (µg/L)		**14.0**		**7.0**	**3.5**
MW-12	2/13/2007	<2.0	0.68	<2.0	<1.0
MW-12	7/31/2007	<2	1.0 J	<2.0	<1.0
MW-12	1/15/2008	<2.0	0.66	<2.0	<1.0
MW-12	7/31/2008	<2.0	1.2		
MW-12	1/23/2009	<2.0	1.2	<0.50	<2.0
MW-12	8/14/2009	<2.0	0.78 J		
MW-12	1/21/2010	<2.0	1.1 J	<0.50	<1.0
MW-12	3/1/2011	<2.0	0.79	<0.50	<1.0
MW-12	7/29/2011	<2.0	0.71		
MW-12	2/3/2012	<2.0	0.67 J	<0.50	<2.0
MW-12	8/13/2012	<2.0	0.74		
MW-12	2/28/2013	<3.0		<0.50	<2.0 UJ
MW-12	7/16/2013	<3.0	0.84		
MW-12	1/21/2014	<3.0	0.72	<0.50	<2.0
MW-12	7/10/2014	<3.0	0.62		
MW-13	8/8/2008	**330**	**250**	<0.50	<1.0
MW-13	10/17/2008	**220**	**210**		
MW-13	1/16/2009	**190**		<0.50	<2.0
MW-13	4/16/2009	**81**			
MW-13	8/13/2009	**40**			
MW-13	10/29/2009	**30**			
MW-13	1/22/2010	**22**		<0.50	<1.0
MW-13	6/15/2010	12			
MW-13	3/2/2011	6.4		<0.50	<1.0
MW-13	4/27/2011	7.0			
MW-13	8/2/2011	7.4			
MW-13	10/26/2011	8.7			
MW-13	1/24/2012	11		<0.50	<2.0
MW-13	5/10/2012	12			
MW-13	8/16/2012	**16**			
MW-13	3/6/2013	**20.8**		<0.50	<2.0
MW-13	5/1/2013	**22.1**			
MW-13	7/18/2013	**25.6**			
MW-13	10/9/2013	**30.3**			
MW-13	1/22/2014	**35.9**		<0.50	<2.0
MW-13	4/2/2014	**39.5**			
MW-13	7/15/2014	**54.7**			
MW-13	10/13/2014	**68.5**			
MW-14	8/19/2008	2.5	2.6	<2.0	1.3
MW-14	10/17/2008	<2.0	1.1		
MW-14	1/16/2009	<2.0	1.1	<0.50	<2.0
MW-14	8/13/2009	<2.0	1.1 J		
MW-14	1/20/2010	<2.0	0.98 J	<0.50	<1.0
MW-14	3/1/2011	<2.0	0.90	<0.50	<1.0

Table 5

Groundwater Analytical Summary

Former Universal Propulsion Company, Inc. Facility
Phoenix, Arizona

Sample ID	Date	Perchlorate (µg/L)		1,1-Dichloroethene (µg/L)	1,4-Dioxane (µg/L)
		USEPA 314.0	USEPA 332.0		
Remedial Goal (µg/L)		14.0		7.0	3.5
MW-14	8/2/2011	<2.0			
MW-14	2/1/2012	<2.0	0.94	<0.50	<2.0
MW-14	8/10/2012	2.4 J			
MW-14	3/5/2013	<3.0	0.98	<0.50	<2.0
MW-14	7/17/2013	<3.0	1.1		
MW-14	1/21/2014	<3.0	1.1	<0.50	<2.0
MW-14	7/9/2014	<3.0	0.97		
MW-15	8/8/2008	<2.0	0.88	<0.50	2.7
MW-15	10/16/2008	<2.0	0.82		
MW-15	1/15/2009	<2.0	0.82	<0.50	<2.0
MW-15	8/13/2009	<2.0	0.83 J		
MW-15	1/22/2010	<2.0	0.86 J	<0.50	<1.0
MW-15	3/1/2011	<2.0	0.79	<0.50	<1.0
MW-15	7/29/2011	<2.0	0.77		
MW-15	2/1/2012	<2.0	0.67	<0.50	<2.0
MW-15	8/9/2012	<2.0 UJ	0.80		
MW-15	3/1/2013	<3.0		<0.50	<2.0
MW-15	7/16/2013	<3.0	0.70		
MW-15	1/20/2014	<3.0	0.77	<0.50	<2.0
MW-15	7/8/2014	<3.0	0.65 J		
MW-16	4/28/2011	<2.0	0.65	<0.50	<2.0
MW-16	8/2/2011	<2.0			
MW-16	2/1/2012	<2.0	0.42	<0.50	<2.0
MW-16	8/10/2012	<2.0 UJ	0.82		
MW-16	3/1/2013	<3.0		<0.50	<2.0
MW-16	7/17/2013	<3.0	0.53		
MW-16	1/21/2014	<3.0	0.62	<0.50	<2.0
MW-16	7/9/2014	<3.0	0.52 J		
MW-17	4/28/2011	<2.0	0.73	<0.50	<2.0
MW-17	1/31/2012	<2.0	0.31	<0.50	<2.0
MW-17	8/10/2012	<2.0 UJ	0.37		
MW-17	2/28/2013	<3.0		<0.50	<2.0 UJ
MW-17	7/17/2013	<3.0	0.28		
MW-17	1/17/2014	<3.0	0.39	<0.50	<2.0
MW-17	7/10/2014	<3.0	0.34		
MW-18	10/30/2009	<2.0	1.5	<0.50	<1.0
MW-18	1/27/2010	<2.0	<2.0 UJ	<0.50	<1.0
MW-18	3/30/2011	<2.0	<0.50 UJ	<0.50	<2.0
MW-18	8/2/2011	<2.0			
MW-18	1/31/2012	<2.0	<0.10	<0.50	<2.0
MW-18	8/8/2012	<2.0 UJ	<0.10		
MW-18	2/27/2013	<3.0	<0.10	<0.50	<2.0
MW-18	7/17/2013	<3.0	0.12		
MW-18	1/15/2014	<3.0	0.47	<0.50	<2.0

Table 5

Groundwater Analytical Summary

Former Universal Propulsion Company, Inc. Facility
Phoenix, Arizona

Sample ID	Date	Perchlorate (µg/L)		1,1-Dichloroethene (µg/L)	1,4-Dioxane (µg/L)
		USEPA 314.0	USEPA 332.0		
Remedial Goal (µg/L)		**14.0**		**7.0**	**3.5**
MW-18	7/10/2014	<3.0	0.72		
MW-19	4/28/2011	**55000**		<0.50	<2.0
MW-19	8/3/2011	**48000**			
MW-19	10/27/2011	**45000**			
MW-19	1/26/2012	**35000**		<0.50	<2.0
MW-19	5/11/2012	**36000**			
MW-19	8/19/2012	**33000**			
MW-19	3/7/2013	**32500**		<0.50	**3.8**
MW-19	5/3/2013	**29200**			
MW-19	7/19/2013	**31200**			
MW-19	10/9/2013	**29400**			
MW-19	1/23/2014	**27300**		<0.50	<2.0
MW-19	4/4/2014	**24900**			
MW-19	7/17/2014	**21700**			
MW-19	10/14/2014	**21000**			
MW-20	2/6/2012	**430**			**14**
MW-20	5/11/2012	**410**		0.60	**14**
MW-20	8/19/2012	**400**			
MW-20	3/7/2013	**447**		<0.50	**14.2 J**
MW-20	5/2/2013	**417**		0.50	**12.2**
MW-20	7/19/2013	**442**		<0.50	**12.6**
MW-20	10/9/2013	**419**			
MW-20	1/23/2014	**382**		0.62	**12.3**
MW-20	4/4/2014	**367**		0.69	**13.1**
MW-20	7/16/2014	**319**		0.60	**16.7**
MW-20	10/14/2014	**324**			
MW-21	2/9/2012	6.2		<0.50	<2.0
MW-21	5/10/2012	5.5			
MW-21	8/16/2012	5.5			
MW-21	3/7/2013	6.1		<0.50	2.1 J
MW-21	5/1/2013	5.6			
MW-21	7/18/2013	5.1			
MW-21	10/8/2013	5.4			
MW-21	1/22/2014	4.9		<0.50	<2.0
MW-21	4/1/2014	4.0			
MW-21	7/11/2014	4.5			
MW-21	10/10/2014	4.5			
MW-22	4/7/2014	<3.0		<0.50	<2.0
MW-22	7/15/2014	<3.0	0.72	<0.50	<2.0
MW-22	10/9/2014		0.66		
PW-1	4/16/2004	1.4		7	
PW-1	11/4/2004	<2		5	
PW-1	12/9/2004	<2		5.1	
PW-1	1/17/2005	<2		5.7	2.6

Table 5

Groundwater Analytical Summary

Former Universal Propulsion Company, Inc. Facility
Phoenix, Arizona

Sample ID	Date	Perchlorate (µg/L)		1,1-Dichloroethene (µg/L)	1,4-Dioxane (µg/L)
		USEPA 314.0	USEPA 332.0		
Remedial Goal (µg/L)		**14.0**		**7.0**	**3.5**
PW-1	4/25/2005	2.1		<5	2
PW-1	7/18/2005	<2		<5	2.3
PW-1	10/25/2005	<2		2.3	2
PW-1	3/23/2006	<2		2	1.4
PW-1	5/23/2006	2.3		3.5	2
PW-1	8/31/2006	<2.0		3.5	2.8
PW-1	11/16/2006	<2.0	1.8	3.6	2.5
PW-1	2/15/2007	2.0		<2.0 UJ	1.2 J
PW-1	4/10/2007	<2.0		3.0	1.7 J
PW-1	8/1/2007	2.3		<2.0 UJ	2.7
PW-1	10/17/2007	<2.0		<2.0	2.2
PW-1	1/18/2008	<2.0		4.3	2.2
PW-1	4/2/2008	<2.0		3.5	3.0
PW-1	8/1/2008	2.1		<0.50 UJ	1.8
PW-1	10/20/2008	2.2		<0.50	1.8
PW-1	1/12/2009	4.8		<0.50	<2.0
PW-1	4/15/2009	2.6		3.6	2.5
PW-1	7/6/2009	2.4		<0.50	2.9
PW-1	10/30/2009	<2.0		<0.50 UJ	2.4 J
PW-1	3/30/2011	3.8		5.0	2.9
PW-1	9/6/2011	4.1		6.2	3.0
PW-1	10/25/2011	4.4			
PW-1	2/1/2012	3.7	3.3	5.5	3.2
PW-1	5/9/2012	4.4			
PW-1	8/16/2012	5.9		5.0	3.1
PW-1	3/5/2013	4.3		4.2	<2.0
PW-1	5/2/2013	4.1			
PW-1	7/18/2013	3.8		4.9	2.7
PW-1	10/8/2013	3.0			
PW-1	1/18/2014	3.2		**7.1**	3.0
PW-1	4/1/2014	3.0			
PW-1	7/14/2014	3.4		5.2	**3.6**
PW-1	10/15/2014	4.2			
RW-1	8/21/2014	<3.0			
RW-1	10/15/2014		3.5		
RW-2	8/26/2014	<3.0			
RW-2	10/15/2014		0.24		

Notes:

Bold results indicate concentration above Remedial Goal

< = Analyte was not detected above the listed reporting limit

J = Estimated value

UJ = The reporting limit is considered an estimated value

Table 6

SVW-1 Analytical Summary

Former Universal Propulsion Company, Inc. Facility
Phoenix, Arizona

Sample Interval (ft bgs)	Sample Date	Constituent (ppbv)		
		1,1-Dichloroethene	2-Butanone (Methyl Ethyl Ketone)	Acetone
	Remedial Goals	**26,900**	**194,200**	**65,440**
30-40	11/13/2008	800	<20	870
	1/19/2009	1600	<20	<99
	4/14/2009	2200	<100	1100
	8/19/2009	1900	76	610 J
	10/27/2009	3200	<50	650 J
	6/16/2010	650	66 J	740 J
	2/24/2011	460	27	76 J
	4/25/2011	2300	160	1500 J
	7/26/2011	2600	21	<97
	10/25/2011	1900	64 J	220 J
	5/30/2012	430	170 J	500 J
	5/7/2013	170	30 J	68 J
	1/29/2014	1,900	<28	<69
90-100	11/13/2008	11000	<20	1200
	1/19/2009	450	<20	<99
	4/14/2009	22000	<500	<2500
	8/19/2009	23000	35 J	240 J
	10/27/2009	23000	<200	<1000
	6/16/2010	11000	37 J	280 J
	2/24/2011	5300	10	25 J
	4/25/2011	6700	260	2500 J
	7/26/2011	6900	48 J	110 J
	10/25/2011	540	40	100 J
	5/30/2012	420 J	120 J	360 J
	5/7/2013	4.6	78	140
	1/29/2014	4,400	<66	<160
140-150	11/13/2008	3100	29	1300
	1/19/2009	3000	<20	180
	4/14/2009	3500	<200	1300
	8/19/2009	240	29 J	390 J
	10/27/2009	910	<20	570 J
	6/16/2010	620	73 J	710 J
	2/24/2011	47	9.6 J	46 J
	4/25/2011	280	100	1200 J
	7/26/2011	850	56 J	120 J
	10/25/2011	30	45	110 J
	5/30/2012	6.0	370	1300 J
	5/7/2013	<1.2	15 J	42 J
	1/29/2014	11	<4.8	<12
190-200	11/13/2008	180	<20	530
	1/19/2009	210	<20	210
	4/14/2009	360	<100	3500
	8/19/2009	260	490	970
	10/27/2009	320	<19	150 J
	6/16/2010	330	40 J	380 J
	2/24/2011	36	11	45 J
	4/25/2011	210	84 J	450
	7/26/2011	660	67 J	140 J
	10/25/2011	530	33 J	120 J
	5/30/2012	600	900	4300 J
	5/7/2013	580	8.7 J	28 J
	1/29/2014	6.8	<4.6	<11

Notes:
Bold results indicate analyte was detected above the Remedial Goal.
< = Analyte was not detected above the listed laboratory reporting limit.
ft bgs = feet below ground surface
J = Analyte was positively identified; however, the result should be considered an estimated value.
ppbv = parts per billion by volume

Table 7

Potential Chemical-Specific Standards

Former Universal Propulsion Company, Inc. Facility
Phoenix, Arizona

Media	Authority	Requirement	Status	Requirement Synopsis
Soil	Federal Criteria, Advisories, and Guidance	USEPA RSLs for Chemical Constituents of Concern at Superfund Sites	To be considered	Provides screening levels for constituents in soil based on risk or potential migration to groundwater used as a drinking water source. Arsenic protection of groundwater risk-based SSL = 1.3 µg/kg. Lead protection of groundwater MCL-based SSL = 14,000 µg/kg. Perchlorate = Not established.
	State Regulatory Requirements	AAC Title 18, Chapter 7, Article 2 - Arizona SRLs	Relevant and appropriate	Provides cleanup levels for constituents in soil based on direct contact risk (dermal contact, ingestion, inhalation). Arsenic residential SRL (10^{-6} risk) = 10,000 µg/kg. Lead residential SRL (non-carcinogen risk) = 400,000 µg/kg. Perchlorate residential SRL (non-carcinogen risk) = 55,000 µg/kg.
	State Criteria, Advisories, and Guidance	ADEQ Guidance - Arizona GPLs	Relevant and appropriate	Provides cleanup levels for constituents in soil based on potential migration to groundwater used as a drinking water source. Arsenic minimum GPL = 290,000 µg/kg. Lead minimum GPL = 290,000 µg/kg. Perchlorate = Not established by ADEQ, guidance given for site-specific GPL calculations. Site-specific perchlorate GPL = 16,000 µg/kg.

Table 7

Potential Chemical-Specific Standards

Former Universal Propulsion Company, Inc. Facility
Phoenix, Arizona

Media	Authority	Requirement	Status	Requirement Synopsis
Groundwater	Federal Regulatory Requirement	SDWA (42 USC 300 et seq.) – National Primary Drinking Water Regulations and Implementation (40 CFR 141 and 142)	Relevant and appropriate	Establishes MCLs, for public water systems. Relevant or appropriate for groundwater remediation at sites where potential drinking water sources (aquifers) are impacted. Perchlorate MCL = not established.
	Federal Criteria, Advisories, and Guidance	SDWA (42 USC 300 *et seq.*) – National Secondary Drinking Water Standards (40 CFR 143)	To be considered	Establishes standards to protect aesthetic quality of public water systems (Secondary MCLs).
	State Regulatory Requirement	AAC Title 18, Chapter 11, Article 4 – AWQS	Relevant and appropriate	Establishes standards to protect aquifers designated as drinking water sources. Perchlorate = not established.
	State Criteria, Advisories, and Guidance	ADHS – HBGLs	Relevant and Appropriate	Establishes guidance levels for constituents in water (cleanup standard for perchlorate) based on ingestion risk. Perchlorate HBGL= 14 µg/L.

Notes:

AAC = Arizona Administrative Code
ADEQ = Arizona Department of Environmental Quality
ADHS = Arizona Department of Health Services
AWQS = Aquifer Water Quality Standards
CFR = Code of Federal Regulations
GPLs = groundwater protection levels
HBGLs = health-based guidance levels
MCLs = maximum contaminant levels
RSL = regional screening levels
SDWA = Safe Drinking Water Act
SRLs = soil remediation levels
SSL = soil screening levels
µg/kg = micrograms per kilogram
µg/L = micrograms per liter
USC = United States Code
USEPA = U.S. Environmental Protection Agency

Table 8

Potential Location-Specific Standards

Former Universal Propulsion Company, Inc. Facility
Phoenix, Arizona

Site Feature	Authority	Requirement	Status	Requirement Synopsis
Endangered Species	Federal Regulatory Requirement	Endangered Species Act (7 USC 136, 16 USC 460 et seq.)	Relevant and appropriate	Provides a program for conservation of threatened and endangered plants and animals and the habitats in which they are found. Requires that action be taken to conserve endangered or threatened species. In addition, actions must not destroy or adversely modify critical habitat. No endangered species have been identified at the site. However, prior to on-site habitat disturbance, consultation with federal agencies is recommended to verify that remedial actions do not jeopardize the continued existence of any endangered or threatened species, or adversely modify or destroy critical habitat.
		Migratory Bird Treaty Act (16 USC 703 et seq.)	Relevant and appropriate	Actions taken or funded that result in the killing, hunting, taking, or capturing any migratory birds, part, nest, or egg are unlawful. Impact on migratory birds will be incorporated into the planning and decision-making about remedial alternatives.
	State Regulatory Requirement	AGFD	Relevant and appropriate	Implements the Endangered Species Act within Arizona under a Memorandum of Understanding with the U.S. Department of the Interior, Fish and Wildlife Service, Region 2. AGFD maintains a list of Special Status Species. No endangered species have been identified at the site. However, prior to on-site habitat disturbance, consultation with state agencies is recommended to verify that remedial actions do not jeopardize the continued existence of any endangered or threatened species, or adversely modify or destroy critical habitat.
		Arizona Native Plant Law (ARS 3-901 et seq.)	Relevant and appropriate	Protects certain native plants and encourages, but does not mandate, habitat protection. Violators are subject to fines of no more than $5,000 and a misdemeanor or felony citation. Impact on habitat will be incorporated into the planning and decision-making about remedial alternatives.
Buildings and Historic Features	Federal Regulatory Requirement	Archaeological and Historic Preservation Act (16 USC 469 et seq.)	To be considered	Provides for the preservation of historical or archaeological data that might be destroyed or lost as a result of alteration of terrain caused by federal construction projects or activities. No historical artifacts have been identified at the site.
	State Regulatory Requirement	Arizona SHPO (Arizona State Historic Preservation Act; ARS §41-861 et seq.)	To be considered	Provides for the protection of archaeological sites, historic buildings and structures, traditional cultural places, and other places or objects that are important to the state's history from the activities of state agencies. No historical artifacts have been identified at the site.

Notes:
AGFD = Arizona Game and Fish Department
ARS = Arizona Reporting Standards
SHPO = State Historic Preservation Office
USC = United States Code

Table 9

Potential Action-Specific Standards

Former Universal Propulsion Company, Inc. Facility
Phoenix, Arizona

Media	Authority	Requirement	Status	Requirement Synopsis
Air	Federal Criteria, Advisories, and Guidance	National Emissions Standards for Hazardous Air Pollutants (40 CFR Parts 50 and 61)	To be considered	Establishes air emissions limits for hazardous air pollutants. Air emissions from remedial actions will meet the regulatory limits.
	State Criteria, Advisories, and	ADHS Arizona Health-Based Guidance Levels	To be considered	HBGLs for HAPs may be used as generic risk-based screening/initial remediation levels for HAPs in ambient air.
	County Regulatory Requirements	Maricopa County Rule 310 - Fugitive Dust from Dust-Generating Operations	Applicable	Establishes limits for the emissions of particulate matter into the ambient air from any property, operations, or activity that may serve as a fugitive dust source.
	County Regulatory Requirements	Maricopa County Rule 372 - Maricopa County HAPs Program	Applicable	Describes Maricopa County's program for the regulation of HAPs.
Groundwater	Federal Regulatory Requirement	RCRA Groundwater Protection (40 CFR 264)	Applicable	Regulations include groundwater protection standard requirements for groundwater monitoring, detection monitoring, and compliance monitoring and the corrective action program. All alternatives will comply with the portions of the regulations that apply to installing groundwater monitoring wells and compliance monitoring.
		USEPA – SDWA	Relevant and appropriate	Safe drinking water standards include the national primary (MCLs and MCLGs) and the secondary drinking water standards. MCLs enforceable drinking water regulations that are protective of public health to the extent feasible in public water supplies. MCLGs are non-enforceable health goals. Applicable to sites with possibly COCs in groundwater.
	Federal Criteria, Advisories, and Guidance	USEPA RSLs	To be considered	Established risk-based screening levels used by Regions 3 and 9 for soil to groundwater and tap water.
		USEPA – MCL Goals	To be considered	Non-enforceable health goals, based solely on possible health risks and exposure over a lifetime with an adequate margin of safety, are called MCLGs. COCs are any physical, chemical, biological, or radiological substances or matter in water. Required per the SDWA.
	State Regulatory Requirement	ADEQ – AWQS (AAC R18-11-400; ARS § 49-223)	Applicable	Establishes maximum COC levels in groundwater. Groundwater standards in Arizona are the Safe Drinking Water standards established for public water systems and surface water standards for the Domestic Water Source designated use.
		ADEQ – Aquifer Protection Permits (AAC R18-9-101 through R18-9-403; ARS §§ 49-241 through 49-252)	To be considered	Establishes broad authorities for managing and protecting groundwater quality and remediating point and non-point sources of pollution. Establishes limits (AWQS) for the levels of pollutants that are allowed to be discharged from an applicable point of compliance. Facilities that may produce discharges to groundwater require an APP.
	State Criteria, Advisories, and	ADEQ – GPLs	Applicable	The ADEQ minimum GPLs are protective of soil COCs leaching to groundwater, based on achieving the drinking water standards in groundwater.

Table 9

Potential Action-Specific Standards

Former Universal Propulsion Company, Inc. Facility
Phoenix, Arizona

Media	Authority	Requirement	Status	Requirement Synopsis
Surface Water	Federal Regulatory Requirement	Federal NPDES Regulations (40 CFR Part 122)	Applicable	Established federal water quality standards and pollutant effluent discharge standards. Treated water discharged to surface water during remedial activities will meet the substantive requirements of these regulations.
		CWA Ambient Water Quality Criteria, 40 CFR Part 122, 125, 129, 133, and 136	Relevant and appropriate	Non-enforceable guidance used by states in conjunction with a designated use for a stream effluent to establish water quality standards. WQC levels for protection of human health from consuming fish and aquatic organisms have been developed for several COCs. The standards are relevant and appropriate if state standards are no more stringent. Applicable to any point-source discharges of wastewaters to waters of the United States. At this site, it is applicable to the discharge of treated waters from the groundwater treatment system to any surface water body.
	Federal Criteria, Advisories, and Guidance	USEPA National Recommended WQC (2006)	To be considered	USEPA-recommended standards for water used for human consumption or exposed to aquatic organisms. These criteria may be considered to the extent that groundwater discharging to surface water may affect surface water quality.
	State Regulatory Requirement	ADEQ – APDES (18 AAC 9, Art 9; ARS §§ 49-255 through 49-255.03)	To be considered	Delegates permit authority for the NPDES permit program, including stormwater permits for all areas, except Indian lands. The state does not authorize issuance of Section 404 permits.
		ADEQ – Surface Water Quality Standards (AAC R18-11-108, Appendix A; ARS § 49-222)	To be considered	Established surface water quality standards for surface waters that are more stringent than the CWA. Includes a designated use or uses to be made of the water and criteria necessary to protect those uses. Narrative standards should be used when a numeric standard is not available. Complies with Section 303 (33 USC 1313) of the CWA, where states are required to develop water quality standards for waters of the United States within the state. Surface water quality standards do not apply to groundwater.

Table 9

Potential Action-Specific Standards

Former Universal Propulsion Company, Inc. Facility
Phoenix, Arizona

Media	Authority	Requirement	Status	Requirement Synopsis
Waste	Federal Regulatory Requirement	RCRA-Hazardous Waste Identification (40 CFR, Part 261), Standards Applicable to Generators of Hazardous Waste (40 CFR Part 262), Standards Applicable to Transporters of Hazardous Waste (40 CFR Part 263)	Applicable	Defines waste that is subject to regulation as hazardous waste under 40 CFR Parts 262-264. Defines regulations applicable to generators and transporters of hazardous waste. If remedial alternatives require excavation of waste, management approaches for listed and characteristic waste, if encountered, will be met. If hazardous waste will be generated and stored on site, these standards will apply.
	Federal Criteria, Advisories, and Guidance	USEPA National Recommended WQC (2006)	To be considered	USEPA-recommended standards for water used for human consumption or exposed to aquatic organisms. These criteria may be considered to the extent that groundwater discharging to surface water may affect surface water quality.
	State Regulatory Requirement	ADEQ – RCRA	Applicable	Authorizes the ADEQ to enforce hazardous waste management rules and regulations in Arizona. If a site has been extensively contaminated by hazardous waste, the provisions of CERCLA (Superfund), the state WQARF program, and the Arizona Remediation Standards apply to cleanup efforts.
		ADEQ – Arizona Hazardous Waste Management Act (AAC Title 18, Chap. 8, Art.2; ARS § 49-921 *et seq* .)	Applicable	Requires a permit for hazardous waste generators; transporters; and treatment, storage, and disposal facilities as authorized under RCRA. RCRA regulations are incorporated by reference and supplemented by Arizona requirements. In Arizona, generators obtain permits, pay fees, submit reports, and are subject to inspection and enforcement authority from ADEQ instead of the USEPA.
		ADEQ – Solid Waste Management (ARS § 49-701 *et seq* . (Supp. 1999))	Applicable	Arizona's solid waste management laws impose requirements on solid wastes that do not otherwise qualify as hazardous waste (e.g., tires, used oil, agricultural landfills, lead acid batteries).
General	Federal Regulatory Requirement	Federal Underground Injection Control Regulations (40 CFR Parts 144 -148)	Applicable	Establishes federal requirements for controlling underground injections. All underground injections will comply with the regulations.
	Federal Criteria, Advisories, and Guidance	Draft Interim Final OSWER Monitored Natural Attenuation Policy (OSWER Dir.9200.4-17) (12/1/97)	To be considered	Provides guidance on how the USEPA will implement national policy on the use of monitored natural attenuation. Decisions on use and efficacy of monitored natural attenuation will be consistent with guidance.
	State Regulatory Requirement	ADEQ – Remedial Action (AAC Title 18, Ch.7)	Applicable	Establishes soil remediation standards in Arizona.
		ADEQ – Remedial Action Criteria (ARS §§ 49-281 through 49-298)	Applicable	Provides for the control, management, or cleanup of the hazardous substances to allow the maximum beneficial use of the waters of the state. Specifies that remedial actions will be reasonable, necessary, cost-effective, and technically feasible; and requires the establishment of the level and extent of cleanup at a site or a portion of a site.

Notes:

AAC = Arizona Administrative Code
ADEQ = Arizona Department of Environmental Quality
ADHS = Arizona Department of Health Services
APDES = Arizona Pollutant Discharge Elimination System
ARS = Arizona Reporting Standards
AWQS = Aquifer Water Quality Standards
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
CFR = Code of Federal Regulations
COC = constituent of concern
CWA = Clean Water Act
GPLs = groundwater protection levels
HAPs = hazardous air pollutants
HBGLs = Health-Based Guidance Levels
MCLs = maximum contaminant levels
MCLGs = maximum contaminant level goals
NPDES = National Pollutant Discharge Elimination System
OSWER = Office of Solid Waste and Emergency Response
RCRA = Resource Conservation and Recovery Act
RSL = Regional Screening Levels
SDWA = Safe Drinking Water Act
USEPA = U.S. Environmental Protection Agency
WQARF = Water Quality Assurance Revolving Fund
WQC = water quality criteria

Table 10

Soil and Groundwater Cleanup Levels

Former Universal Propulsion Company, Inc. Facility
Phoenix, Arizona

Media	COC	Cleanup Level	Basis
Soil	Perchlorate	16 mg/kg	Site-specific GPL for soil AZ HWMA Permit, Part IV, Conditions B.5 and C.10
	Lead	400 mg/kg	Arizona Residential SRL AAC Title 18, Chapter 7, Article 2 AZ HWMA Permit, Part IV, Condition C.10 AZ HWMA Permit, Part II, Condition I.1(b)(i)(b)
	Arsenic	10 mg/kg	Arizona Residential SRL AAC Title 18, Chapter 7, Article 2 AZ HWMA Permit, Part IV, Condition C.10 AZ HWMA Permit, Part II, Condition I.1(b)(i)(b)
Groundwater	Perchlorate	14 µg/L	AZ HBGL AZ HWMA Permit, Part IV, Condition C.9 AZ HWMA Permit, Part II, Condition I.1(b)(i)(a)
	1,1-Dichloroethene	7.0 µg/L	Arizona AWQS
	1,4-Dioxane	3.5 µg/L	ADEQ-Established Site-Specific Remediation Level

Notes:
AAC = Arizona Administrative Code
ADEQ = Arizona Department of Environmental Quality
AWQS = Aquifer Water Quality Standard
AZ HBGL = Arizona health-based guidance level
AZ HWMA = Arizona Hazardous Waste Management Act
COC = constituent of concern
GPL = groundwater protection level
mg/kg = milligrams per kilogram
SRL = soil remediation level
µg/L = micrograms per liter

Table 11

Corrective Action Objectives

Former Universal Propulsion Company, Inc. Facility
Phoenix, Arizona

Media	CAO	Description	Basis
Soil	1-S	Reduce or eliminate direct contact by a potential receptor (including ingestion, inhalation, or dermal absorption), or threat of direct contact, with COCs in surface or subsurface soils.	AZ HWMA Permit, Part IV, Condition J.1
	2-S	Reduce or eliminate the potential for COCs in surface or subsurface soils to migrate to groundwater.	AZ HWMA Permit, Part IV, Condition J.1
	3-S	To the maximum extent practical, reduce or eliminate further releases that might pose a threat to human health and the environment.	AZ HWMA Permit, Part IV, Condition J.1
	4-S	In accordance with Part IV, Condition C.10 of the Permit, achieve a cleanup level for soils that is in accordance with the Arizona Soil Remediation Standards rule (AAC Title 18, Chapter 7, Article 2). A site-specific GPL for perchlorate of 16 mg/kg has been established.	AZ HWMA Permit, Part IV, Conditions B.5, C.10, and J.1 AZ HWMA Permit, Part II, Condition I.1(b)(i)(b) AAC. Title 18, Chapter 7, Article 2
	5-S	Meet applicable waste management requirements.	AZ HWMA Permit, Part IV, Condition J.1
Groundwater	1-GW	Minimize, stabilize, or eliminate further migration of the dissolved COC plume.	AZ HWMA Permit, Part IV, Condition J.1
	2-GW	Prevent migration of perchlorate in groundwater to any active private domestic well in the area bounded by Central Avenue, 7th Street, Yearling Road, and Jomax Road at concentrations above 14 µg/L.	AZ HWMA Permit, Part IV, Condition C.11
	3-GW	Control the source(s) or release(s) so as to reduce or eliminate, to the maximum extent practicable, further releases that might pose a threat to human health and the environment.	AZ HWMA Permit, Part IV, Condition J.1
	4-GW	In accordance with Part IV, Condition C.9 of the Permit, achieve a site-wide groundwater cleanup goal or remedial action objective for perchlorate of 14 µg/L.	AZ HWMA Permit, Part IV, Condition C.9
	5-GW	Meet applicable waste management requirements.	AZ HWMA Permit, Part IV, Condition J.1
	6-GW	Corrective measures will achieve the site-wide groundwater cleanup goal within 30 years.	AZ HWMA Permit, Part IV, Condition J.1 AZ HWMA Permit, Part II, Condition I.1(b)(i)(a)

Notes:
AAC = Arizona Administrative Code
AZ HWMA = Arizona Hazardous Waste Management Act
CAO = corrective action objective
COC = constituent of concern
GPL = groundwater protection level
mg/kg = milligrams per kilogram
µg/L = micrograms per liter

Table 12

Identification and Screening of Soil Remediation Technologies

Former Universal Propulsion Company, Inc. Facility
Phoenix, Arizona

General Response Action	Corrective Action Technology and Process Option	CMS Objectives Addressed [1]	Effectiveness	Implementability	Past Performance	Relative Cost [2]	Action
No Action	**No Action**	5-S	Relies on natural attenuation processes. Not effective for COPCs given site conditions.	Readily implementable. No additional work required.	NA	No costs associated with this technology	**Retained:** Per RCRA guidance, retained for baseline comparison.
Institutional Controls	**Access Restrictions by Deed Restrictions**	1-S, 3-S	Limits access and future uses to reduce potential exposures. Effective at limiting potential receptors from coming into contact with COPCs.	Readily implementable assuming stakeholder acceptance.	Commonly used to reduce exposure risk.	Low capital cost and low O&M cost	**Retained.** Requires combination with other technologies.
	Access Restrictions by Fencing	1-S	Limits access to reduce potential exposures. Effective at limiting potential receptors from coming into contact with COPCs.	Fencing is already in place around the site perimeter.	Commonly used to reduce exposure risk.	No capital cost and low O&M cost	**Retained.** Requires combination with other technologies.
Containment	**Soil Capping with an Engineered Cap Cover**	1-S, 3-S, 5-S	Relies on engineered soil caps to limit infiltration and COPC migration to groundwater. Applicable to all COPCs.	Easily implemented, will require maintenance to maintain long-term integrity.	Soil caps have been widely used to prevent exposure.	Low capital cost, moderate O&M cost due to length of monitoring	**Retained.**
Removal	**Soil Excavation with Off-Site Landfill Disposal**	1-S, 2-S, 3-S, 4-S, 5-S	Soil achieves CMS objectives by direct COPC removal. Applicable to all COPCs.	Easily implemented given the current site use and accessibility. May not be practical for concentrations detected greater than 20 feet below grade surface.	Common technology.	Moderate to high capital cost, low O&M cost	**Retained.**
Ex Situ Treatment	**Physical Treatment with Stabilization**	1-S, 2-S, 3-S, 4-S	Additives are mixed with soil (ex situ) to encapsulate and reduce the leachability of COCs, thereby reducing overall mobility. Applicable to lead and arsenic at the site.	May not be practical for concentrations detected greater than 20 feet below grade surface due to difficulty to excavate soil at those depths.	Common technology for lead and arsenic.	High capital cost, low O&M cost	**Eliminated.** Likely difficult to implement and other technologies more cost effective given lead and arsenic impacts are shallow.
In Situ Treatment	**Physical Treatment with Solidification**	1-S, 2-S, 3-S, 4-S	Additives are mixed with soil (in situ) to encapsulate and reduce the leachability of COCs, thereby reducing overall mobility. Applicable to lead and arsenic at the site.	May be difficult to implement at some locations due to the highly cemented alluvium and fractured bedrock at the site.	Common technology for lead and arsenic.	High capital cost, low O&M cost	**Eliminated.** Likely difficult to implement and other technologies more cost effective given lead and arsenic impacts are shallow.
	Physical Treatment with Soil Flushing	1-S, 2-S, 4-S	Water is infiltrated into the ground surface using ponds of similar structures to mobilize perchlorate in the vadose zone for recovery/treatment by groundwater technologies. Multiple pore flushes are often required to achieve CMS objectives. Requires field pilot testing to assess effectiveness in the highly cemented alluvium and fractured bedrock at the site.	May be difficult to implement at the site due to subsurface conditions. Requires a field pilot test to evaluate ability to reach and address impacts throughout vadose zone. Existing data suggest low probability of success, although may be more implementable in some zones than others. Results in additional COC mass migrating to groundwater. Could result in larger, more costly, and longer groundwater treatment remedy.	Has been used for perchlorate at other sites.	Moderate capital cost	**Eliminated**. Likely difficult to implement.
	Biological Treatment with Anaerobic Reduction	1-S, 2-S, 3-S, 4-S, 5-S	Carbon substrates are injected into the vadose zone via wells to generate a biological reduction zone (developed from facultative naturally occurring perchlorate/nitrate reducing bacteria) that anaerobically degrades perchlorate to carbon dioxide, water, and chloride. Technology effective for perchlorate, but distribution of injected substrate cannot be achieved at the site based on the pre-design testing.	Implementability depends on local site conditions, but assumes introduction of carbon substrate can follow similar pathway as COCs have followed through the vadose zone. Injection pressure, location, and point spacing require care in design and injection test would be required for final design.	Has been successful for perchlorate at sites under a range of subsurface conditions.	High capital cost, moderate O&M cost	**Eliminated.** Cannot effectively inject substrate and distribution of the carbon substrate is very poor for a 5-foot ROI. Perchlorate. Not cost effective and not reliable.

Footnotes:

[1] CMS Objectives:

1-S = Reduce or eliminate direct contact by a potential receptor (including ingestion, inhalation, or dermal absorption), or threat of direct contact, with COCs in surface or subsurface soils.
2-S = Reduce or eliminate the potential for COCs in surface or subsurface soils to migrate to groundwater.
3-S = To the maximum extent practical, reduce or eliminate further releases that might pose a threat to human health and the environment.
4-S = In accordance with Part IV, Condition C.10 of the Permit, achieve a cleanup level for soils that is in accordance with the Arizona Soil Remediation Standards rule (AAC Title 18, Chapter 7, Article 2). A site-specific GPL for perchlorate of 16 mg/kg has been established.
5-S = Meet applicable waste management requirements.

[2] Costs were considered based on engineering judgment, and each remedial technology was relative to the other identified technologies. Relative costs were then assigned as either high, moderate, or low.

Notes:

Shading indicates that the technology was eliminated
AAC = Arizona Administrative Code
CMS = Corrective Measures Study
COC = constituent of concern
COPC = constituent of potential concern
GPL = groundwater protection level
mg/kg = milligrams per kilogram
NA = not applicable
O&M = operation and maintenance
RCRA = Resource Conservation and Recovery Act
ROI = radius of influence

Table 13

Identification and Screening of Groundwater Remediation Technologies

Former Universal Propulsion Company, Inc. Facility
Phoenix, Arizona

General Response Action	Corrective Action Technology and Process Option	CMS Objectives Addressed [1]	Effectiveness	Implementability	Past Performance	Relative Cost [2]	Action
No Action	**No Action**	5-GW	This technology will not achieve any of the CMS Objectives (except applicable waste management). Relies on-natural processes to achieve CMS objectives. Site data show that residential groundwater pumping wells effect groundwater gradients, and perchlorate may reach residential pumping wells under a no action alternative.	Technically implementable. Administratively unimplementable as technology does not achieve CAOs.	NA	No costs associated with this technology	**Retained:** Per RCRA guidance, retained for baseline comparison.
Institutional Controls	**Access Restrictions by Deed Restrictions**	5-GW	Uses legal actions to prevent groundwater use, control land use, and prohibit potable use of groundwater. Effective at limiting exposure.	Implementable on site assuming stakeholder acceptance, but not for the upgradient residential supply wells.	Commonly used to reduce exposure risk.	Low capital cost, low O&M cost	**Eliminated.** Would not be implementable for off-site residential supply wells.
	Access Restrictions by Fencing	3-GW	Limits access to reduce potential use of groundwater. Effective at limiting potential receptors from coming into contact with COPCs.	Fencing is already in place around the site perimeter.	Commonly used to reduce exposure risk.	No capital cost and low O&M cost	**Retained.** Requires combination with other technologies.
Containment	**Hydraulic Control through Groundwater Extraction**	1-GW, 2-GW, 3-GW, 4-GW, 6-GW	Planned pumping test will further assess effectiveness, but effectiveness is assumed based on available subsurface hydrogeologic data. Low hydraulic conductivity and plume age may constrain effectiveness either locally or site-wide and technology dependent on source removal/control. Effectiveness may be dependent on implementation with other technologies that enhance mass removal (e.g. in situ biological reduction, aquifer flushing).	Readily implementable.	Common technology. Degree of success highly dependent on subsurface hydrogeology, plume age, and details of application.	Moderate to high capital and O&M costs	**Retained.** Must be combined with other technologies.
	Hydraulic Control with In Situ Barrier	1-GW, 2-GW, 5-GW	Installation of an impermeable physical barrier to control groundwater flow. Typically includes sheet pile or soil bentonite walls. Effectiveness dependent on subsurface conditions.	Likely not technically implementable due to depth of contamination and shallow depth of bedrock.	Has been implemented at many sites, but requires proper in situ conditions for success.	High capital costs	**Eliminated.** Low probability of successful implementation.
Ex Situ Treatment	**Physical Treatment with Reverse Osmosis**	3-GW, 4-GW	Application of high pressure to force water through a semi-permeable membrane to remove cations and anions. Produces high TDS rejectate requiring disposal. Effective for oxyanions such as perchlorate.	Implementable, but requires combination with an extraction and disposal technology (for treated water and rejectate). Results in highly concentrated waste stream with volume as a high as 20% of extracted water volume. Waste would be difficult to manage due to high concentration of COCs in waste, limiting local disposal options. Volume of waste disposal would add significantly to costs.	Proven technology.	Moderate capital cost, high O&M cost	**Eliminated.** Difficult to implement. More effective ex situ treatment technologies (for cost and waste management) will be retained.
	Chemical Treatment with Ion Exchange	3-GW, 4-GW	Relies on anionic COCs in groundwater being effectively removed by anion exchange and replacement with a highly exchangeable anion, such as chloride. Effective at removing site perchlorate from extracted groundwater.	Readily implementable, although large quantities of ion exchange resin will likely be required based on perchlorate concentrations. Requires combination with an extraction and disposal technology (for treated water and spent resin).	Widely implemented technology, but utilization rates and cost vary based on perchlorate loading and groundwater geochemistry. Based on perchlorate concentrations, this technology will not be cost effective.	Moderate capital cost, high O&M cost	**Eliminated.** Perchlorate concentrations will require large quantities of ion exchange resin for treatment, so this technology will not be feasible based on costs.
	Biological Treatment with Anaerobic Bioreactor	3-GW, 4-GW	Bioreactor is created that anaerobically degrades perchlorate to carbon dioxide, water, and chloride using a combined electron donor and carbon source and select nutrients. Technology is very effective for perchlorate and similar anions.	Implementable. Requires combination with an extraction and disposal technology. More reliant on on-site labor for operations and maintenance than other technologies.	Proven technology. Typically, more cost-effective than other technologies as mass loading increases.	Moderate to high capital cost, moderate O&M cost	**Retained.** Requires combination with extraction and disposal technologies.
In Situ Treatment	**Biological Treatment with Anaerobic Reduction**	1-GW, 2-GW, 3-GW, 4-GW, 5-GW, 6-GW	Carbon substrates are injected into wells for distribution into the aquifer to generate a biological reduction zone (developed from facultative naturally occurring perchlorate/nitrate reducing bacteria) that anaerobically degrades perchlorate to carbon dioxide, water, and chloride. Technology highly effective for perchlorate.	Readily implementable, once injection hydraulics and required substrate concentrations and injection volumes are evaluated. UIC permit required.	Widely implemented technology. Eliminates need for aboveground treatment and disposal.	Moderate capital and O&M costs	**Retained.** May require combination with an extraction technology to achieve CAOs.
	MNA	5-GW	MNA relies on a combination of biological degradation, adsorption, and dilution to attenuate groundwater impacts and achieve CAOs. Available data do not indicate natural attenuation is occurring other than dilution.	Technically implementable but wholly reliant on dilution. Administratively implementability dependent on combination with other technologies.	Has been combined with other technologies at other sites to create successful corrective action alternatives.	Low capital cost, low O&M cost	**Eliminated.** Available data does not indicate significant natural attenuation is occurring, likely not administratively feasible.
Waste Management Technologies	**Reinjection**	1-GW, 2-GW, 3-GW, 5-GW	Mass removal is accelerated by injecting clean water to enhance mass flux towards extraction wells. Also, technology can be used to control groundwater flow patterns and support a barrier application. Degree of effectiveness dependent on subsurface hydrogeology and details of application.	Implementability dependent on results of injection testing.	Proven technology but highly dependent on details of application. Reinjection is well known to enhance mass removal when coupled with extraction, particularly for constituents with low Koc values.	Moderate capital cost, low O&M cost	**Retained.** Reinjection may be important to enhance mass removal given site subsurface conditions. Would be combined with extraction and treatment technologies.
	Discharge to POTW	5-GW	Treated groundwater is discharged to a POTW.	Not readily implementable, no POTW in the immediate vicinity of the site.	Common technology.	Moderate capital and O&M costs	**Eliminated.** Difficult to implement.
	Discharge to Land Surface	5-GW	Treated groundwater is discharged to land surface.	Technically implementable, but may affect large surface area due to volume of wastewater that may be generated. Administratively, permitting may be difficult and care would be taken not to create habitat requiring monitoring.	Common technology.	Low capital and O&M costs	**Eliminated.** Difficult to implement with volume of water that may be generated.
	Off-Site Disposal	5-GW	Waste generated by ex situ treatment technologies is stored on site and transported off site for disposal. Groundwater is stored on site and transported off site for disposal.	Implementable. Logistically, highly impractical for wastewater management due to volume of wastewater most likely to be generated. Would result in constant, daily, flow of waste management vehicles (i.e., water trucks) on site for the duration of the remedy. Will significantly add to remedy costs.	Common technology for treatment-related wastes. Typically not implemented for long-term management of treated wastewater.	Low capital cost, very high O&M cost	**Eliminated.** Not practical for wastewater management. Retained for treatment-generated wastes (e.g., spent resin).
	Discharge to Surface Water	5-GW	Treated groundwater is discharged to a surface water body.	Technically implementable, assuming on-site washes qualify as surface waters under APDES. Administratively, permitting may be difficult and care would be taken not to create habitat requiring monitoring.	Common technology.	Moderate capital and O&M costs	**Eliminated.** Difficult to implement given site features and volume of water that may be generated.

Footnotes:

[1] CMS Objectives:
1-GW = Minimize, stabilize, or eliminate further migration of the dissolved COC plume.
2-GW = Prevent migration of perchlorate in groundwater to any active private domestic well in the area bounded by Central Avenue, 7th Street, Yearling Road, and Jomax Road at concentrations above 14 µg/L.
3-GW = Control the source(s) or release(s) so as to reduce or eliminate, to the maximum extent practicable, further releases that might pose a threat to human health and the environment.
4-GW - In accordance with Part IV, Condition C.9 of the Permit, achieve a site-wide groundwater cleanup goal or remedial action objective for perchlorate of 14 µg/L.
5-GW = Meet applicable waste management requirements.
6-GW = Corrective measures will achieve the site-wide groundwater cleanup goal within 30 years.

[2] Costs were considered based on engineering judgment, and each remedial technology was relative to the other identified technologies. Relative costs were then assigned as either high, moderate, or low.

Notes:

Shading indicates that the technology was eliminated.
APDES = Arizona Pollutant Discharge Elimination System
CAO = Corrective Action Objective
CMS = Corrective Measures Study
COC = constituent of concern
COPC = constituent of potential concern
Koc = soil organic carbon-water partitioning coefficient
MNA = monitored natural attenuation
NA = not applicable
O&M = operation and maintenance
POTW = publicly owned treatment works
RCRA = Resource Conservation and Recovery Act
TDS = total dissolved solid
UIC = Underground Injection Control
µg/L = micrograms per liter

Table 14

Summary of Assembled Alternatives

Former Universal Propulsion Company, Inc. Facility
Phoenix, Arizona

	Soil Alternatives				Groundwater Alternatives			
	SA-1	**SA-2**	**SA-3**	**SA-4**	**GW-1**	**GW-2**	**GW-3**	**GW-4**
No Action	●				●			
Access Restrictions								
➢ Deed Restrictions		●						
➢ Fencing		●	●	●		●	●	●
Soil								
➢ Soil Excavation and Off-Site Disposal		●	●	●				
➢ Soil Capping		●		●				
➢ In Situ Biological Reduction			●					
Groundwater								
➢ Source Area Groundwater Extraction						●	●	●
➢ Ex Situ Treatment with Anaerobic Bioreactor						●		●
➢ Source Area In Situ Biological Reduction							●	
➢ Source Area Groundwater Reinjection						●	●	
➢ Property Boundary Groundwater Reinjection								●
➢ Alluvium In Situ Biological Reduction						●	●	

Table 15

Detailed Evaluation of Soil Remedial Alternative SA-1: No Action

Former Universal Propulsion Company, Inc. Facility
Phoenix, Arizona

Objective	Evaluation
Overall Protection of Human Health and the Environment	Does not further minimize, reduce, or control COCs in soils or provide measures to control potential leaching. Concentrations of perchlorate in soils may be reduced by natural processes, but specific monitoring would not be performed.
Attainment of Media Cleanup Objectives	This alternative will not attain media cleanup standards, because no remediation would take place.
Control Sources of Releases	The constituent sources are from historic operations. Ongoing sources are not present. The lead and arsenic present in site soils are not likely mobile, although potential migration of perchlorate in soil to groundwater will not be controlled.
Compliance with Standards for Management of Wastes	Will not comply with chemical-specific standards, as no action will be taken to control potential exposure pathways or reduce COC concentrations. No action- or location-specific standards.
Long-Term Reliability and Effectiveness	This alternative is not reliable or effective in meeting the CAOs or protecting human health and the environment in the long term.
Reduction in Toxicity, Mobility, or Volume	Does not reduce the toxicity, mobility, or volume through treatment, except that which will occur through natural attenuation.
Short-Term Effectiveness	No activities will be implemented that will present potential short-term exposure risks to human health or the environment.
Implementability	Technically feasible because no technical components are necessary. However, likely not administratively feasible, as there will be no controls on the potential exposure pathways or the potential leaching of COCs in soil to groundwater.
Cost	Capital Costs: $0 Total O&M Costs: $0 Total Present Value Cost: $0

Notes:
CAO = corrective action objective
COC = constituent of concern
O&M = operation and maintenance

Table 16

Detailed Evaluation of Soil Remedial Alternative SA-2:
Soil Excavation and Off-Site Disposal, Soil Capping, and Deed Restrictions

Former Universal Propulsion Company, Inc. Facility
Phoenix, Arizona

Objective	Evaluation
Overall Protection of Human Health and the Environment	Protective of human health and the environment by removing COC mass through excavation and off-site disposal and limiting the potential for leaching of COCs from soil to groundwater by constructing a soil cap. Deed restrictions will restrict access and enforce the retention and maintenance of the soil cap.
Attainment of Media Cleanup Objectives	This alternative will attain media cleanup standards. The potential for direct contact by a receptor with COCs in soil is reduced or eliminated by excavation, capping, and deed restrictions. The potential for COCs in soil to migrate to groundwater is controlled by excavation, capping, and deed restrictions.
Control the Sources of Releases	The constituent sources are from historic operations. Ongoing sources are not present. Lead and arsenic in soils are not likely to be mobile and will be removed from the site through excavation. Potential migration of perchlorate in soils to groundwater will be controlled by excavation and capping.
Compliance with Standards for the Management of Wastes	This alternative would comply with chemical-, location-, and action-specific standards.
Long-Term Reliability and Effectiveness	Effective and permanent reduction of COC mass in soil through excavation will eliminate potential exposure pathways in excavation areas. The engineered cap creates a physical barrier to reduce potential exposure pathways in capping areas. The potential for COCs in soil to leach to groundwater will be effectively controlled while the soil cap is in place.
Reduction in Toxicity, Mobility, or Volume	Permanently reduces volume of COCs in soil by excavation. COC mobility will be reduced and controlled by installing the engineered cap. Perchlorate toxicity and volume may be reduced by natural attenuation mechanisms, although monitoring would not be performed.
Short-Term Effectiveness	The short duration of construction activities from excavation and capping will result in limited short-term exposure risks to the community, workers, or the environment that will be managed through engineering controls and worker training. Implementation of this alternative can be completed in 1 year, making it effective in the short term.
Implementability	This alternative is technically feasible with readily available equipment and subcontractors. This alternative is also administratively feasible and proven for the COCs.
Cost	Capital Costs: $2,026,950 Total O&M Costs: $459,000 Total Periodic Cost: $35,000 Total Present Value Cost: $2,089,000

Notes:
COC = constituent of concern
O&M = operation and maintenance

Table 17

Detailed Evaluation of Soil Remedial Alternative SA-3:
Soil Excavation and Off-Site Disposal, In Situ Biological Reduction

Former Universal Propulsion Company, Inc. Facility
Phoenix, Arizona

Objective	Evaluation
Overall Protection of Human Health and the Environment	Excavation and off-site disposal is protective of human health and the environment. However, in situ biological reduction is not likely to reduce perchlorate concentrations in soils at the Waterbore Area and New Burn Area to levels protective of groundwater because substrate injection is not feasible due to low geologic permeability and low injection capacity as demonstrated during 2014 supplementary study.
Attainment of Media Cleanup Objectives	Excavation and off-site disposal will attain cleanup objectives for portions of the Site. Implementing an in situ biological reduction system in the Waterbore Area and New Burn Area, however, is not likely to reduce the mass of COCs in soil because substrate injection is not feasible due to low geologic permeability and low injection capacity. Therefore, this corrective measure is not likely to eliminate the potential for perchlorate in soils to migrate to groundwater, and is not likely to achieve the established perchlorate cleanup level.
Control Source of Releases	The constituent sources are from historic operations. Ongoing sources are not present. Lead and arsenic in soils are not likely to be mobile and will be removed from the site through excavation. However, in situ biological reduction of perchlorate is not likely to eliminate the potential for COCs in soils to migrate to groundwater because substrate injection is not feasible.
Compliance with Standards for Management of Wastes	Alternative SA-3 is not likely to comply with chemical-specific standards for COCs in soil because substrate injection is not feasible; thus, COCs present in soils at concentrations higher than the standard would likely remain in place at the C-Complex, New Burn Area, and Waterbore Area. Alternative SA-3 is not likely to comply with location- and action-specific standards for the same reason.
Long-Term Reliability and Effectiveness	Alternative SA-3 will not be effective and reliable in the long term. Permanent reduction of COC concentrations in soil will be achieved through excavation, but not by in situ biological reduction. Soil excavation will eliminate the potential for direct contact with COCs in soil by a receptor and for COCs in soil to leach to groundwater. However, the vadose zone does not support adequate injection rates or reagent distribution to provide a long-term reliability and effectiveness of in situ biological reduction.
Reduction in Toxicity, Mobility, or Volume	Permanently reduces the toxicity, mobility, or volume of COCs in soil through excavation or in situ biological reduction. However, because of the ineffectiveness of in situ biological reduction, some COC mass is likely to remain in place without the implementation of additional actions.
Short-Term Effectiveness	The short duration of construction activities from excavation and installation of the in situ biological reduction system will result in limited short-term exposure risks to the community, workers, or the environment that will be managed through engineering controls and worker training. Implementation of this alternative can be completed in 1 year. In situ biological reduction will only be effective if a 5-foot ROI reagent distribution and full injection volume of the reagent during each event is attained in the short-term.
Implementability	Implementation of this alternative is administratively feasible but not technically feasible. Equipment, services, methods, and materials necessary for implementation are readily available. Excavation is a conventional remediation technology and is proven for these COCs. Biological reduction of perchlorate and in situ biological reduction of constituents located within the vadose zone are proven technologies. Effectiveness depends upon the ability to deliver sufficient carbon substrate to the vadose-zone soils to establish and maintain the anaerobic conditions that will degrade perchlorate. Because carbon substrate cannot be effectively delivered to the vadose zone, additional capital and O&M expenditures will likely be required for future remediation.
Cost	Capital Costs: $2,602,386 Total O&M Costs: $1,063,300 Periodic Costs: $198,750 Total Present Value Cost: $3,010,000

Notes:
CAO = corrective action objective
COC = constituent of concern
O&M = operation and maintenance
ROI = radius of influence

Table 18

Detailed Evaluation of Soil Remedial Alternative SA-4:
ADEQ Soil Treatment Scenario: Waterbore Area Excavation and Off-Site Disposal and Soil Capping

Former Universal Propulsion Company, Inc. Facility
Phoenix, Arizona

Objective	Evaluation
Overall Protection of Human Health and the Environment	Protective of human health and the environment in the Waterbore, C-Complex, and New Burn areas by removing COC mass through excavation and off-site disposal and limiting the potential for leaching of COCs from soil to groundwater by constructing an engineered cap. Outside of these areas, does not further minimize, reduce, or control COCs in soils or provide measures to control potential leaching. Concentrations of perchlorate in soils may be reduced by natural processes, but specific monitoring will not be performed.
Attainment of Media Cleanup Objectives	This alternative will not attain media cleanup standards because no remediation will take place in the SMA or Old Burn areas, and soil greater than 5 feet deep in the New Burn Area will not be removed. Media cleanup standards will be achieved within the Waterbore Area, and shallow soils within the C-Complex and New Burn areas.
Control Source of Releases	The constituent sources are from historic operations. Ongoing sources are not present. The lead and arsenic present in site soils are not likely to be mobile, although potential migration of perchlorate in soil to groundwater will not be controlled in areas outside of the Waterbore Area.
Compliance with Standards for Management of Wastes	Will not comply with chemical-specific standards, as no action will be taken to control potential exposure pathways or reduce COC concentrations in soils outside of the Waterbore Area. For remedial actions implemented, this alternative will comply with location- and action-specific standards.
Long-Term Reliability and Effectiveness	This alternative is not reliable or effective in meeting the CAOs or protecting human health and the environment in the long-term, as remedial actions or controls will not be implemented in all applicable areas of the site.
Reduction in Toxicity, Mobility, or Volume	Within the Waterbore, C-Complex, and New Burn areas, the volume of COCs in soil is permanently reduced by excavation. COC mobility is reduced in the Waterbore Area by installing an engineered cap. Does not reduce the toxicity, mobility, or volume of COCs in soils deeper than 5 feet in the C-Complex and New Burn areas or at other areas of the site through treatment, except that which will occur through natural attenuation.
Short-Term Effectiveness	The short duration of construction activities from excavation and capping will result in limited short-term exposure risks to the community, workers, or the environment that will be managed through engineering controls and worker training. Implementation of this alternative can be completed in 1 year, making it effective in the short-term for the Waterbore, C-Complex, and New Burn areas.
Implementability	This alternative is technically feasible with readily available equipment and subcontractors and a proven technology for the COCs. However, likely not administratively feasible as there will be no controls on the potential exposure pathways or the potential leaching of COCs in soil to groundwater in the SMA or Old Burn areas or deeper soils in the C-Complex and New Burn areas.
Cost	Capital Costs: $4,484,250 Total O&M Costs: $270,000 Total Present Value Cost: $4,303,000

Notes:
CAO = corrective action objective
COC = constituent of concern
O&M = operation and maintenance
SMA = Storage Magazine Area

Table 19

Detailed Evaluation of Groundwater Remedial Alternative GW-1: No Action

Former Universal Propulsion Company, Inc. Facility
Phoenix, Arizona

Objective	Evaluation
Overall Protection of Human Health and the Environment	Does not further minimize, reduce, or control COCs in groundwater or provide measures to eliminate or control potential migration of the contaminant plume. Concentrations of perchlorate in groundwater may be reduced by natural processes, but specific monitoring will not be performed.
Attainment of Media Cleanup Objectives	This alternative will not attain media cleanup standards because no remediation will take place.
Control Sources of Releases	The constituent sources are from historic operations. Ongoing sources are not present. Potential migration of groundwater containing perchlorate will not be controlled.
Compliance with Standards for Management of Wastes	Will not comply with chemical-specific standards as no action will be taken to control potential exposure pathways or reduce COC concentrations. No action- or location-specific standards.
Long-Term Reliability and Effectiveness	This alternative is not reliable or effective in meeting the CAOs or protecting human health and the environment in the long-term.
Reduction in Toxicity, Mobility, or Volume	Does not reduce the toxicity, mobility, or volume of COCs through treatment, except that which will occur through natural attenuation.
Short-Term Effectiveness	No activities will be implemented that will present potential short-term exposure risks to human health or the environment.
Implementability	Technically feasible because no technical components are necessary. However, likely not administratively feasible, as there will be no controls on the potential exposure pathways or the potential migration of COCs in groundwater.
Cost	Capital Costs: $0 Total O&M Costs: $0 Total Present Value Cost: $0

Notes:
CAO = corrective action objectives
COC = constituent of concern
O&M = operation and maintenance

Table 20

Detailed Evaluation of Groundwater Remedial Alternative GW-2:
Bedrock Source Area Groundwater Extraction, Ex Situ Treatment with Anaerobic Bioreactor, Reinjection, and Alluvium In Situ Biological Reduction

Former Universal Propulsion Company, Inc. Facility
Phoenix, Arizona

Objective	Evaluation
Overall Protection of Human Health and the Environment	Protective of human health and the environment by hydraulically controlling bedrock source area groundwater and removing COC mass through groundwater extraction and ex situ treatment. Downgradient alluvial in situ biological reduction will permanently reduce COC mass.
Attainment of Media Cleanup Objectives	This alternative will attain media cleanup standards. The potential for migration of the contaminant plume is controlled by groundwater extraction and in situ biological reduction. The groundwater cleanup goals will be met by ex situ groundwater treatment and in situ biological reduction. Achieving the cleanup goals within 10 years will be accomplished by the recirculation cell established by the extraction and injection well network within the bedrock source area and the alluvial in situ biological reduction.
Control Sources of Releases	The constituent sources are from historic operations. Ongoing sources are not present. Potential migration of perchlorate in groundwater will be controlled by groundwater extraction and ex situ biological reduction.
Compliance with Standards for Management of Wastes	This alternative will comply with chemical-, location-, and action-specific standards.
Long-Term Reliability and Effectiveness	Effective and permanent reduction of COC mass in groundwater through extraction and ex situ treatment or in situ biological reduction that will eliminate potential migration of the contaminant plume. Reinjection of treated groundwater in the bedrock source area will decrease the timeframe required to achieve CAOs.
Reduction in Toxicity, Mobility, or Volume	Permanently reduces volume of COCs in groundwater by extraction and ex situ treatment. COC mobility will be reduced and controlled by the groundwater extraction and injection wells. Perchlorate toxicity and volume will also be reduced through the alluvium in situ biological reduction system.
Short-Term Effectiveness	The short duration of construction activities from installation of extraction and injection wells will result in limited short-term exposure risks to the community, workers, or the environment that will be managed through engineering controls and worker training. O&M will be performed by trained personnel. Implementation of this alternative can be completed in 2 years, making it effective in the short-term.
Implementability	This alternative is technically feasible with readily available equipment and subcontractors. This alternative is also administratively feasible and proven for the COCs.
Cost	Capital Costs: $3,221,900 Total O&M Costs: $6,697,500 Total Periodic Cost: $313,200 Total Present Value Cost: $6,669,000

Notes:
CAO = corrective action objective
COC = constituent of concern
O&M = operation and maintenance

Table 21

Detailed Evaluation of Groundwater Remedial Alternative GW-3:
Bedrock Source Area Hydraulic Control and In Situ Biological Reduction and Alluvium In Situ Biological Reduction

Former Universal Propulsion Company, Inc. Facility
Phoenix, Arizona

Objective	Evaluation
Overall Protection of Human Health and the Environment	Groundwater extraction in the bedrock source area will provide hydraulic control of plume and in situ biological reduction in bedrock groundwater will destroy perchlorate. However, potential to cause further migration of the constituent plume outside of the bedrock areas under hydraulic control by injecting untreated groundwater. Therefore, Alternative GW-3 is not likely to be protective of human health and the environment.
Attainment of Media Cleanup Objectives	This alternative may not attain media cleanup objectives. Reinjection of untreated groundwater into the bedrock groundwater has the potential to spread COC mass outside the areas under hydraulic contol. Achieving the cleanup goals have been met in the alluvium near MW-6, and implementation of groundwater monitoring will confirm COA have been attained in alluvium groundwater within the 30-year requirement.
Control Sources of Releases	Alternative GW-3 has the potential to redistribute groundwater containing COCs at concentrations higher than cleanup levels by injecting untreated groundwater outside areas under hydraulic control. There is also uncertainty regarding the flowpath of reagent reinjection and undemonstrated treatment effectiveness for in situ biological reduction within the bedrock aquifer at the Site, which may jeopardize source control.
Compliance with Standards for Management of Wastes	This alternative is not likely to comply with chemical-, location-, and action-specific standards because of the potential to reinject perchlorate above cleanup goal. Additionally, there is a potential to extract total organic carbon and redistribute it outside of the source area in bedrock groundwater.
Long-Term Reliability and Effectiveness	Long-term effectiveness and permanence is not likely to be achieved. Permanent reduction of COC concentrations in groundwater will be achieved through in situ biological reduction in both the bedrock source are and alluvium, which will permanently minimize or eliminate portions of the constituent plume. However, it is uncertain whether the treatment period is shorter and if lifecycle costs are less than Groundwater Alternative GW-2. This alternative poses a higher risk of injection well fouling and increased maintenance and costs such as well rehab and well replacement. Reagent injection effectiveness would be reduced due to the well fouling. The reinjection of untreated groundwater from the bedrock extraction wells directly into the proposed injection wells has the potential to cause further migration of the constituent plume outside the areas under hydraulic control. Reinjection of the untreated groundwater will result in residual risks of COC migration remaining at the Site after implementing this alternative. It is assumed that, after 10 years of operating the bedrock source remedial system, the perchlorate groundwater cleanup goals will have been met within the bedrock source area, but additional action will likely be required to manage redistributed COC mass. This will result in extending the remediation timeframe.
Reduction in Toxicity, Mobility, or Volume	Permanently reduces toxicity and volume of COCs in groundwater by in situ biological reduction. COC mobility will be reduced and controlled by the groundwater extraction and injection wells. The injection of untreated groundwater from the bedrock extraction wells directly into the proposed injection wells has the potential to cause further migration of the constituent plume outside of the areas of hydraulic control.
Short-Term Effectiveness	The short duration of construction activities from installation of extraction and injection wells will result in limited short-term exposure risks to the community, workers, or the environment that will be managed through engineering controls and worker training. O&M will be performed by trained personnel. Implementation of this alternative can be completed in 2 years, making it effective in the short term.
Implementability	This alternative is technically feasible with readily available equipment and subcontractors. While biological reduction of perchlorate in groundwater is a proven technology, injection of untreated groundwater is likely to meet with high resistance from regulatory agencies; thus, this alternative is not administratively feasible.
Cost	Capital Costs: $1,584,300 Total O&M Costs: $5,856,800 Total Periodic Cost: $313,200 Total Present Value Cost: $4,750,000

Notes:
CAO = corrective action objective
COC = constituent of concern
O&M = operation and maintenance

Table 22

Detailed Evaluation of Groundwater Remedial Alternative GW-4:
ADEQ Groundwater Treatment Scenario

Former Universal Propulsion Company, Inc. Facility
Phoenix, Arizona

Objective	Evaluation
Overall Protection of Human Health and the Environment	Protective of human health and the environment by creating hydraulic control over the contaminant plume and removing COC mass through groundwater extraction and ex situ treatment, limiting the potential for COCs in groundwater to migrate.
Attainment of Media Cleanup Objectives	This alternative may achieve all media cleanup standards. The potential for migration of the contaminant plume is controlled by groundwater extraction and reinjection at the property boundary. The groundwater cleanup goals will be met by ex situ groundwater treatment.
Control Source of Releases	The constituent sources are from historical operations. Ongoing sources are not present. Potential migration of perchlorate in groundwater will be controlled by groundwater extraction and reinjection.
Compliance with Standards for Management of Wastes	This alternative will comply with chemical-, location-, and action-specific standards.
Long-Term Reliability and Effectiveness	Permanent reduction of COC mass in groundwater through extraction and ex situ treatment that will eliminate potential migration of the contaminant plume.
Reduction in Toxicity, Mobility, or Volume	Permanently reduces volume of COCs in groundwater by extraction and ex situ treatment. COC mobility will be reduced and controlled by the groundwater extraction and reinjection wells.
Short-Term Effectiveness	The short duration of construction activities from installation of extraction and injection wells will result in limited short-term exposure risks to the community, workers, or the environment that will be managed through engineering controls and worker training. O&M will be performed by trained personnel. Implementation of this alternative can be completed in 2 years, making it effective in the short-term.
Implementability	This alternative is technically feasible with readily available equipment and subcontractors. This alternative is also administratively feasible and proven for the COCs.
Cost	Capital Costs: $5,261,400 Total O&M Costs: $10,006,900 Total Present Value Cost: $8,770,000

Notes:
COC = constituent of concern
O&M = operation and maintenance

Table 23

Comparative Analysis and Ranking of Soil Remedial Alternatives

Former Universal Propulsion Company, Inc. Facility
Phoenix, Arizona

Alternative	Overall Protection of Human Heath and the Environment	Attainment of Media Cleanup Objectives	Control the Source of Releases	Compliance with Standards for Management of Waste	Long-Term Reliability and Effectiveness	Reduction of Toxicity, Mobility, and Volume of Wastes	Short-Term Effectiveness	Implementability	Cost	Overall Score
SA-1: No Action	0	0	0	0	0	0	5	2	5	12
SA-2: Soil Excavation and Off-Site Disposal, Soil Capping, and Deed Restrictions	5	4	5	5	4	4	3	5	3	38
SA-3: Soil Excavation and Off-Site Disposal, In Situ Biological Reduction	2	1	1	2	1	2	3	3	3	18
SA-4: ADEQ Soil Treatment Scenario: Soil Excavation and Off-Site Disposal, Soil Capping	2	1	2	3	2	2	4	3	1	20

Notes:
ADEQ = Arizona Department of Environmental Quality
Ratings categories for criteria (excluding cost):

- **(0)** None
- **(1)** Low
- **(2)** Low to moderate
- **(3)** Moderate
- **(4)** Moderate to high
- **(5)** High

Table 24

Comparative Analysis and Ranking of Groundwater Remedial Alternatives

Former Universal Propulsion Company, Inc. Facility
Phoenix, Arizona

Alternative	Overall Protection of Human Heath and the Environment	Attainment of Media Cleanup Objectives	Control the Source of Releases	Compliance with Standards for Management of Waste	Long-Term Reliability and Effectiveness	Reduction of Toxicity, Mobility, and Volume of Wastes	Short-Term Effectiveness	Implementability	Cost	Overall Score
GW-1: No Action	0	0	0	0	0	0	5	2	5	12
GW-2: Source Area Groundwater Extraction, Ex Situ Treatment with Anaerobic Bioreactor, Reinjection, and Alluvium In Situ Biological Reduction	4	5	5	5	5	5	3	4	3	39
GW-3: Source Area Hydraulic Control and In Situ Biological Reduction and Alluvium In Situ Biological Reduction	2	2	2	2	2	3	3	2	4	22
GW 4: ADEQ Groundwater Treatment Scenario	4	4	5	5	4	4	2	3	2	33

Notes:
ADEQ = Arizona Department of Environmental Quality
Ratings categories for criteria (excluding cost):

- **(0)** None
- **(1)** Low
- **(2)** Low to moderate
- **(3)** Moderate
- **(4)** Moderate to high
- **(5)** High