

**FINAL**  
**Vegetation Monitoring Plan**  
**Arches Anomaly Repair**

**March 2010**



**Prepared for:**  
**Williams Gas Pipelines**

**Prepared by:**



14 Inverness Drive East, A-100, Englewood, CO 80112  
303-770-9788 office@habitatmanagementinc.com

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## Introduction

This plan details monitoring methods to track the effectiveness of mitigation work related to the repair of two anomaly sites along the Northwest Pipeline within Arches National Park, sites 22250 and 26520. In order to access and repair the anomalies, it was necessary to move heavy equipment and support vehicles across the landscape on or near the pipeline corridor. As a result, repair activities involved the disturbance of established vegetation and soils along the access routes. Additionally, the anomaly sites were excavated in order to conduct pipeline repairs. To mitigate these impacts, native shrubs (mainly blackbrush, *Coleogyne ramosissima*) and some grasses, forbs, and soil crusts were salvaged and replanted at the anomaly sites and along access routes. Priority was placed on salvaging blackbrush shrubs, and grasses and forbs in specified areas, based on agreements between Williams and the National Park Service. Further details regarding mitigation efforts can be found in the report “Vegetation Mitigation Report- Arches Anomaly Repair,” dated March 23, 2009 (Habitat Management, Inc.).

## Monitoring Plan

Monitoring should be conducted annually, during late spring or early summer at the height of the growing season. Monitoring activities will include making general visual observations, taking photographs at specified locations, and collecting quantitative data in various areas. The access routes for both anomaly sites have been broken into sections for monitoring purposes. These sections are generally arbitrary and were determined for convenience. They are described below, shown on the attached maps, and GPS data is available that shows the location of each section and photo monitoring points.

For each anomaly site and access route section, the following general information will be collected:

- General observations about site condition.
- General observations of visual impact- evidence of equipment tracks or soils disturbance as compared to the surrounding landscape.
- General observations about the evidence of wind or water erosion, including notes about any exposed sections of pipe found.
- General observations about the presence or development of cryptobiotic soil crusts.
- General observations regarding any plant regeneration and new seedlings.
- Photographs taken from specified photo monitoring points established in 2009. Some photographs from 2009 contain flags marking transplanted and tracked individuals. If possible, these areas should be re-flagged for photographs in subsequent years.
- Additional photographs of interesting or pertinent items.
- NPS staff and volunteers watered the salvaged plants at both anomaly sites and the access to site 26520 a few times during the spring and summer of 2009. Watering information will be collected from NPS staff and added to the monitoring data. If discernable, impacts of these few waterings during the first hot season after disturbance will be evaluated.
- Weather and precipitation patterns during the monitoring year will be included in the report. There are weather stations at Devil’s Garden campground and the Arches Visitor Center, and the information can be obtained from the NPS.

Additionally, the following data will be collected at both anomaly sites, in Sections 1-8 of the access route to 22250, and Sections A & B of the access route to 26520. This data should be collected annually beginning in 2010.

- Counts of blackbrush shrubs in each relevant section. Transplants and tracked individuals should be counted separately *if* it is possible to determine which group individual plants belong to. (Transplants were trimmed back before replanting, which will aid in visually determining group affiliation for some time.)
- If possible, GPS points of individual shrubs should be compared to shrubs on the ground- it will be necessary to determine when returning to the sites in 2010 if the GPS data is accurate enough for this data to be useful.

In sections 8-10 and 12-13, the following data will be collected.

- The second growing season after seeding, a native plant stocking rate should be measured in each section, using 2m by 5m rectangular plots. This data should be compared to data collected adjacent to the section, on the portion of the pipeline corridor that was not disturbed during the anomaly repair process. A minimum of five and a maximum of 20 plots should be measured on and adjacent to each section, to obtain a statistically adequate sample at an 80% confidence level. The plant stocking density of each recently disturbed section will be compared to the adjacent portion of the pipeline corridor that was not affected by recent anomaly repair activities. Equation 1 details the calculation for sample adequacy.
- Areas where jute matting was installed should be examined to determine if the matting is effectively stabilizing soil and trapping sediment. This will be documented with visual observations and photographs. Observations will also be made to determine whether the matting is presenting an unacceptable visual impact to the site. Observations and photographs will be used to make a recommendation whether the matting should remain in place or be removed from the site. When making this recommendation, the potential disturbance caused by removal of the jute should also be considered. If the results are questionable, consultation will occur with NPS staff.

GPS data is available that documents the centerline of each access route, the outline of the anomaly sites, photo monitoring points, breaks between sections, and some specific shrub locations. Success standards for revegetation of areas disturbed by anomaly repair activities are provided in Table 1 and GPS locations and compass bearings for each photo point are provided in Table 2.

When additional mitigation work is implemented at the site, the monitoring plan should be revised to measure the effectiveness of this mitigation work i.e., monitoring the survival of nursery stock transplants, etc.

## Success Standards

Monitoring will continue until the data shows that success standards have been met. If these standards are not met within two years, additional mitigation measures may be required such as re-seeding, transplanting nursery stock, or additional erosion control work. Success standards for each section are detailed below.

**Anomaly Site 22250:** 80% survival of transplanted blackbrush shrubs as determined by a basic count in the transplant area. Additionally, there should be no evidence of excessive erosion in the area related to anomaly repair activities.

**Access Route Sections 1-8:** 80% survival of transplanted and tracked blackbrush shrubs. If transplanted and tracked shrubs cannot be accurately identified, all shrubs will be counted and the total number compared to the total number of avoided shrubs plus half of the impacted (transplanted and tracked) shrubs for that section (See example below).

### Example:

In section 1, 68 blackbrush were avoided, 32 were transplanted, and 58 were tracked, for a total of 158 shrubs.

Combining the transplanted and tracked shrubs,  $32 + 58 = 90$ .

80% survival of these shrubs would be 72.

Add this to the number of avoided shrubs,  $72 + 68 = 140$ .

Therefore, a minimum of 140 shrubs should be present in the section. This assumes 100% survival of avoided species and 80% survival of impacted species. 100% survival of avoided plants will be assumed, barring any unforeseen circumstances such as wildfire or other incident that would affect the blackbrush population in the area.

Success standards for blackbrush counts using this method are summarized for each monitoring section in Table 1. Additionally, there should be no evidence of excessive erosion in the area related to anomaly repair activities and the slope breaker in Section 2 should be structurally sound and working properly.

**Access Route Section 8-10, 12-13:** Native plant stocking density should be a minimum of 95% of the density of an adjacent sample within three years after the area was seeded. There should be no evidence of excessive erosion in the area related to anomaly repair activities.

**Access Route Section 11:** The soil chemistry in this area is highly alkaline and salty (pH = 9.8, EC = 17.4 mmhos/cm and SAR= 190). These conditions will preclude the growth of plant life (pH > 9.0 and SAR values greater than 20 prevent plant growth). Therefore, the success standard for this area is no evidence of excessive erosion in the area related to anomaly repair activities.

**Anomaly Site 26520:** 80% survival of transplanted blackbrush shrubs and two junipers that were transplanted in this area as determined by a basic count in the transplant area. There should be no evidence of excessive erosion in the area related to anomaly repair activities after two years.

**Access Route Sections A & B:** 80% survival of transplanted and/or tracked blackbrush shrubs and four junipers that were transplanted along section A. There should be no evidence of excessive erosion in the area related to anomaly repair activities.

**Table 1. Success Standards**

Site	Area	COLRAM Shrub Count (including avoided shrubs)	Native Plant Stocking Rate	Erosion
22250	Anomaly Site	121		No evidence of excessive erosion in the area related to anomaly repair activities.
	Section 1	140		
	Section 2	94		
	Section 3	0		
	Section 4	14		
	Section 5	26		
	Section 6	44		
	Section 7	4		
	Section 8	6	At least 95% <sup>1</sup> of density of adjacent samples.	
	Section 9			
	Section 10			
	Section 11			
	Section 12			
Section 13		At least 95% of density of adjacent samples.		
26520	Anomaly Site	22		No evidence of excessive erosion in the area related to anomaly repair activities.
	Section A	7		
	Section B	59		

<sup>1</sup> This success rate will be subject to review with NPS technical professionals if lower success rate achieves visual acceptability and minimizes future disturbance associated with achieving a 95% rate.

## Sample Population Statistical Adequacy

Sample adequacy statistics (Equation 1) will be calculated to demonstrate that a statistically adequate sample size has been obtained for each quantitative vegetation parameter measured.

Equation 1:

$$N_{\min} = \frac{(S * T_{(0.1, n-1)})^2}{(d * \bar{X})^2} \quad \text{Where:}$$

$N_{\min}$  = the minimum number of samples needed in a given sample set

$S$  = sample standard deviation

$d$  = Precision (value is 0.2 for 80% confidence interval)

$\bar{X}$  = sample mean for the given vegetation parameter

$T$  = critical value for t-statistic distribution at 80 % confidence interval for the number of samples collected

## Section Descriptions

**Anomaly Site 22250** - The planting area encompasses approximately 0.17 acres.

**Access Route to Site 22250** – The access route to Site 22250 is approximately two miles long and extends from the park boundary near a thermo-electric generator station on Yellow Cat Flat, through Salt Wash, and across the upper reach of Clover Canyon. Southwest of Salt Wash, the access route deviates from the pipeline right-of-way and follows a previously disturbed track, mainly across slick rock, for about ½ mile before re-joining the pipeline right-of-way. The access route monitoring sections begin nearest the anomaly site and work back toward the generator station at Yellowcat Flats.

**Section 1-** Section 1 of the access route is approximately 800 feet long and 12 feet wide. It runs from the anomaly site to the crest of the hill just past the two large junipers.

**Section 2-** Section 2 is approximately 946 feet by 15 feet, and runs from the crest of the hill just past the two large junipers to the rock barrier at where the access route crosses the pipeline. A portion of the shrubs in section two were mapped with a GPS unit.

**Section 3-** Section 3 is approximately 374 feet by 12 feet, and runs from the west side of the pipeline crossing to the end of the slick rock before the upper reaches of Clover canyon wash.

**Section 4-** Section 4 is approximately 888 feet by 15 feet, and runs from the end of the slick rock, south west of the wash, to the beginning of the red slick rock and soil. The blackbrush shrubs in this section were mapped with a GPS and that data is available.

**Section 5-** Section 5 is approximately 1246 feet by 12 feet, and runs from the beginning of the red slick rock and soil to a bend in the old road.

**Section 6-** Section 6 is approximately 437 feet by 15 feet, and runs from the bend in the old road to a large juniper tree adjacent to the road.

**Section 7-** Section 7 is approximately 1711 feet by 12 feet, and runs from the large juniper tree adjacent to the road to the top of the hill on the south west side of Salt Wash. One GPS point shows the location of the few blackbrush in this section.

**Section 8-** Section 8 is the south west slope of salt wash, and is approximately 1102 feet by 15 feet, ending at the toe of the steepest part of the slope.

**Section 9-** Section 9 encompasses the lower Salt Wash area, beginning at the toe of the steep slope on the south west side of the wash and ending at the start of the flats to the north east side of the creek. It is approximately 245 feet by 12 feet.

**Section 10-** Section 10 is approximately 381 feet by 12 feet, and encompasses the southwestern portion of the flats just north east of the creek crossing area.

**Section 11-** Section 11 is a hardpan area in the flats, covered in jute matting. It is approximately 571 feet by 15 feet.

**Section 12-** Section 12 is approximately 1088 feet by 12 feet, and runs from end of the hard pan/jute mat area to the toe of the slope on north east side of salt wash.

**Section 13-** Section 13 is the north east slope of Salt Wash, and is approximately 490 feet by 15 feet.

**Anomaly Site 26520** - The planting area encompasses approximately 0.15 acres.

**Access Route to Site 26520** – The access route to this site is approximately 0.15 miles long and extends from the Salt Valley gravel road southwest to the anomaly site, generally following the pipeline right-of-way. The access route sections begin nearest the anomaly site and work back toward the gravel road.

**Section A-** Section A of the access route begins at the anomaly site and includes about ½ the length of the access route. It is approximately 412 feet long by 12 feet wide.

**Section B-** Section B is approximately 383 feet by 12 feet and runs from about the center of the access route to the gravel road.

**Table 2. Photo Monitoring Points, GPS Locations.**

<b>Area</b>	<b>Comment</b>	<b>X</b>	<b>Y</b>	<b>Bearing</b>
22250	Anomaly photo 1	625130.586504	4293300.827190	30
22250	Anomaly photo 2	625175.659665	4293365.475230	200
22250	Section 1 begin	625174.183890	4293365.002140	40
22250	Section 1-2	625325.703976	4293529.253430	180 & 340
22250	Section 2 midway photo a	625348.208759	4293592.070020	40
22250	Section 2 midway photo b	625416.841672	4293666.856710	30
22250	Section 2 end	625481.175837	4293737.588870	220
22250	Section 3 begin	625469.239416	4293750.471210	360
22250	Section 3-4	625547.633848	4293829.881400	220 & 40
22250	Crust Transplant area	625590.113766	4293865.935280	n/a
22250	Section 4-5	625764.786293	4293974.176820	250 & 50
22250	Section 5 midway photo	625926.950730	4294004.423100	50
22250	Section 5-6	626100.410654	4293984.779530	50 & 110
22250	Section 6 midway photo	626148.684910	4293949.747280	110
22250	Section 6-7	626212.574694	4293927.600030	270 & 90
22250	Section 7 midway photo	626342.354874	4293957.893360	320
22250	COLRAM- 3 avoid, 1 crush	626324.909950	429005.530510	n/a
22250	Section 7-8	626353.197702	4294256.139350	210 & 60
22250	Section 8 midway photo	626406.892085	4294296.255810	200 & 450
22250	Section 8-9	626617.213187	4294455.325080	210 & 30
22250	Section 9-10	626670.985361	4294505.896260	220 & 30
22250	Section 10-11	626760.074353	4294578.562580	220 & 40
22250	photo side area looking west	626813.315097	4294623.003600	270
22250	Section 11-12	626902.351477	4294684.544810	220 & 40
22250	Section 12-13	627169.523542	4294867.106820	220 & 40
22250	Section 13 midway photo	not available (from slope breaker)		220 & 40
22250	Section 13 end	627283.078845	4294963.649420	220
26520	Photo 1	621379.598381	621379.598381	20
26520	Photo 2	621412.274927	621412.274927	200
26520	Photo 3 Begin Section A	621407.552691	621407.552691	10
26520	Photo 4-5	621434.991768	621434.991768	220 & 20
26520	photo 6-7	621472.415030	621472.415030	220 & 20
26520	Photo 8 Begin section B	621493.082986	621493.082986	20
26520	Photo 9	621521.041516	621521.041516	30
26520	Photo 10-11	621553.234924	621553.234924	220 & 50
26520	Photo 12	621588.574738	621588.574738	260

Coordinate system is UTM NAD83 Zone 12N

## **Appendix 1. Maps**

**Site 22250**



Anomaly photo 1- taken from next to rock on trail toward sand dune arch, from southwest of anomaly site, looking northeast (30°). Green flags indicate perimeter of planting area. Photo taken 2-27-09.



Anomaly photo 2- taken from access route looking south (200°). Green flags indicate perimeter of planting area. Photo taken 2-27-09.



Beginning of section 1- looking northeast (40°). Pink flags mark blackbrush transplants, green flags mark tracked blackbrush individuals. Avoided blackbrush individuals are not flagged. Photo taken 2-27-09.



End of section 1- looking south (180°). This and all subsequent photos were taken on March 2<sup>nd</sup>, 2009 unless otherwise indicated.



Beginning of section 2- looking north (340°). Pink flags mark blackbrush transplants, green flags mark tracked blackbrush individuals. Avoided blackbrush individuals are not flagged.



Section 2 midway photo a- looking northeast (40°). Pink flags mark blackbrush transplants, green flags mark tracked blackbrush individuals. Avoided blackbrush individuals are not flagged.



Section 2 midway photo b- looking northeast (30°). Pink flags mark blackbrush transplants, green flags mark tracked blackbrush individuals. Avoided blackbrush individuals are not flagged.



End of section 2- looking southwest (220°) from near pipe crossing. Pink flags mark blackbrush transplants, green flags mark tracked blackbrush individuals. Avoided blackbrush individuals are not flagged.



Beginning of section 3- taken from next to pipeline crossing, looking north (360°).



End of section 3- taken next to large rock where slick rock turns to sand, looking southwest (220°).



Beginning of section 4- taken next to large rock where slick rock turns to sand. Looking across small wash to the northeast (40°).



End of section 4- taken southwest of small wash where slick rock and soil turns red, looking southwest (240°).



Beginning section 5- taken southwest of small wash where slick rock and soil turns red, looking northeast (50°).



Section 5 midway photo- looking northeast (50°). Pink flags mark blackbrush transplants, green flags mark tracked blackbrush individuals. Avoided blackbrush individuals are not flagged.



End of section 5- taken from bend in road, looking northeast (50°).



Beginning of section 6- Taken from bend in road, looking southeast (110°). Pink flags mark blackbrush transplants, green flags mark tracked blackbrush individuals. Avoided blackbrush individuals are not flagged.



Section 6 midway photo- looking east (110°). Pink flags mark blackbrush transplants, green flags mark tracked blackbrush individuals. Avoided blackbrush individuals are not flagged.



End of section 6- Taken from next to large juniper tree adjacent to road, looking west (270°). Pink flags mark blackbrush transplants, green flags mark tracked blackbrush individuals. Avoided blackbrush individuals are not flagged.



Beginning of section 7- Taken from next to large juniper tree adjacent to road, looking east (90°).



Section 7 midway photo- Looking northwest (320°)



End of section 7- Taken from top of salt wash, looking southwest (210°)



Beginning section 8- looking northeast (60°)



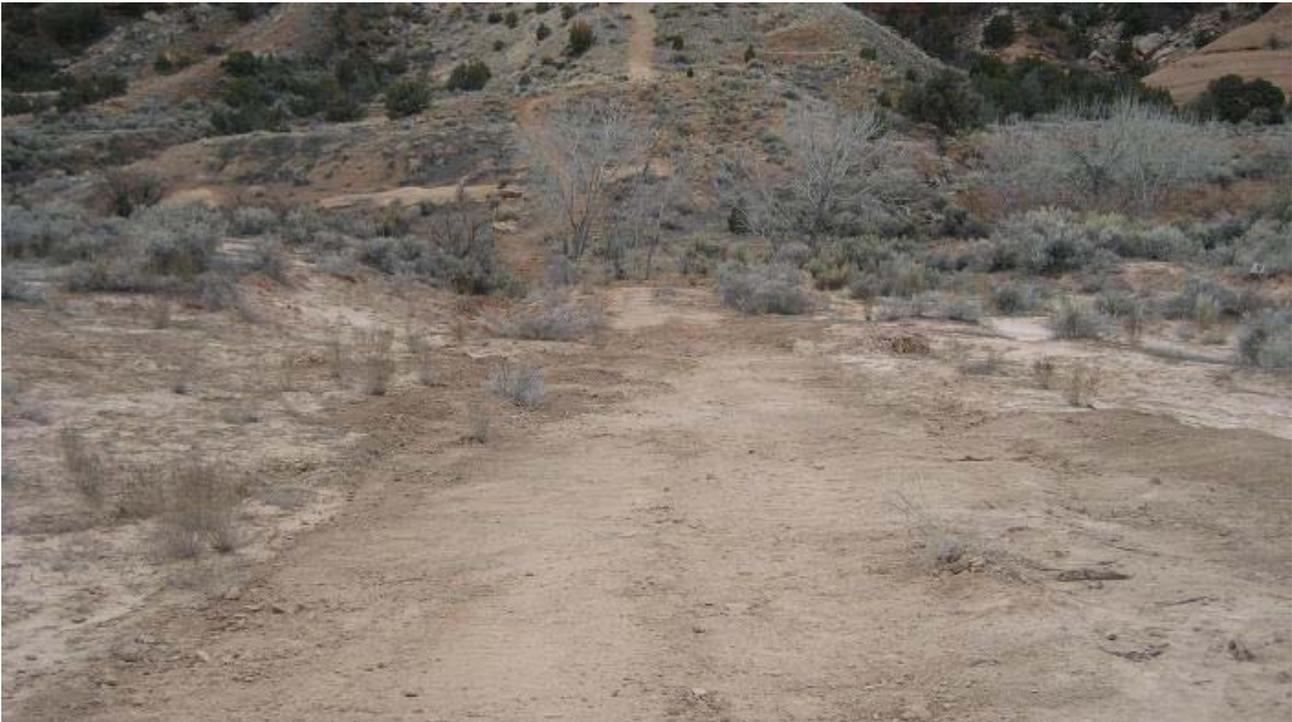
Section 8 midway photo taken from top of middle water bar, looking uphill, south (200°).



Section 8 midway photo taken from top of middle water bar, looking downhill, northeast (45°).



End of section 8, looking uphill, south (210°).



Beginning of Section 9 looking northeast (30°).



Section 9- Photo of rock check dam structure in salt wash.



Section 9- Photo of sagebrush transplants just north of salt creek. Pink flags show locations of transplants.



End of section 9, looking southwest (220°).



Beginning of section 10 looking northeast (30°).



End of section 10 looking southwest (220°).



Beginning of section 11, looking northeast (40°).



“Deep well” area, taken next to “170” sign, looking west (270°).



End of section 11, looking southwest (220°).



Beginning of section 12 looking northeast (40°).



End of section 12 looking southwest (220°).



Photo of grass transplants at end of section 12, from same location as above.



Beginning of section 13 looking uphill, northeast (40°).



Section 13- Photos taken from atop water bar looking downhill, southwest (220°).



Section 13- Photos taken from atop water bar looking uphill, northeast (40°).



End of section 13 looking downhill, southwest (220°).

Site 26520



Photo 1- Anomaly site from atop pipeline mound, looking north (20°).



Photo 2- Anomaly site from atop pipeline mound, looking south (200°).



Photo 3- Beginning of access route section A, looking north (10°).



Photo 4- Access route section A, taken from atop water bar looking southwest (220°).



Photo 5- Access route section A, taken from atop water bar looking north (20°)



Photo 6- Access route section A, taken from atop water bar looking southwest (220°).



Photo 7- Access route section A, taken from atop water bar looking north (20°).



Photo 8- Beginning of access route section B, looking north (20°) Transplants are flagged, colors are meaningless.



Photo 9- Access route section B, looking northeast (30°). Transplants are flagged, colors are meaningless.



Photo 10- Access route section B, looking southwest (220°).



Photo 11- Access route section B, looking northeast (50°). Transplants are flagged, colors are meaningless.



Photo 12- End of access route section B, from across road, looking west (260°).

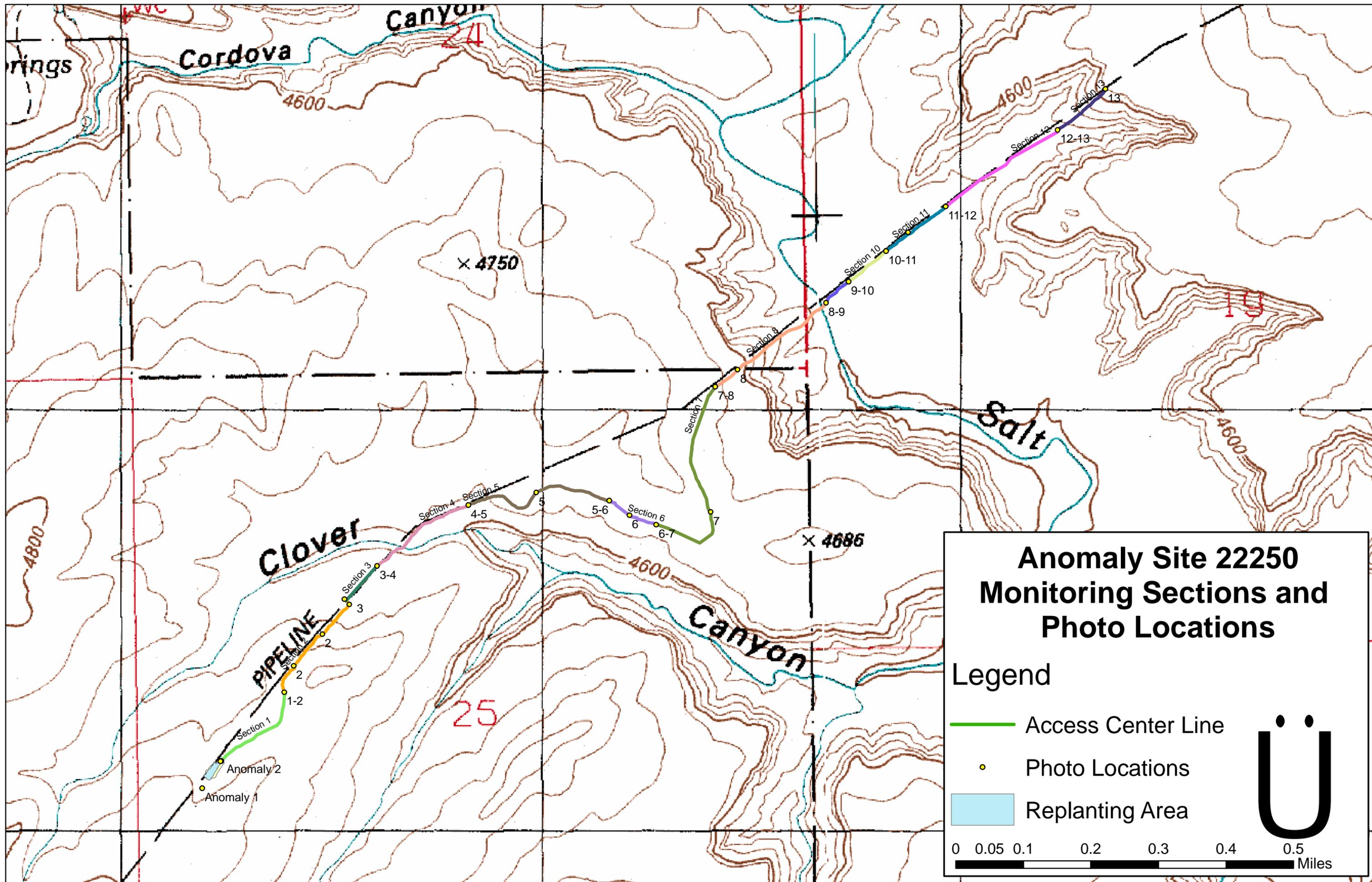
## **Appendix 2. GPS Coordinates**

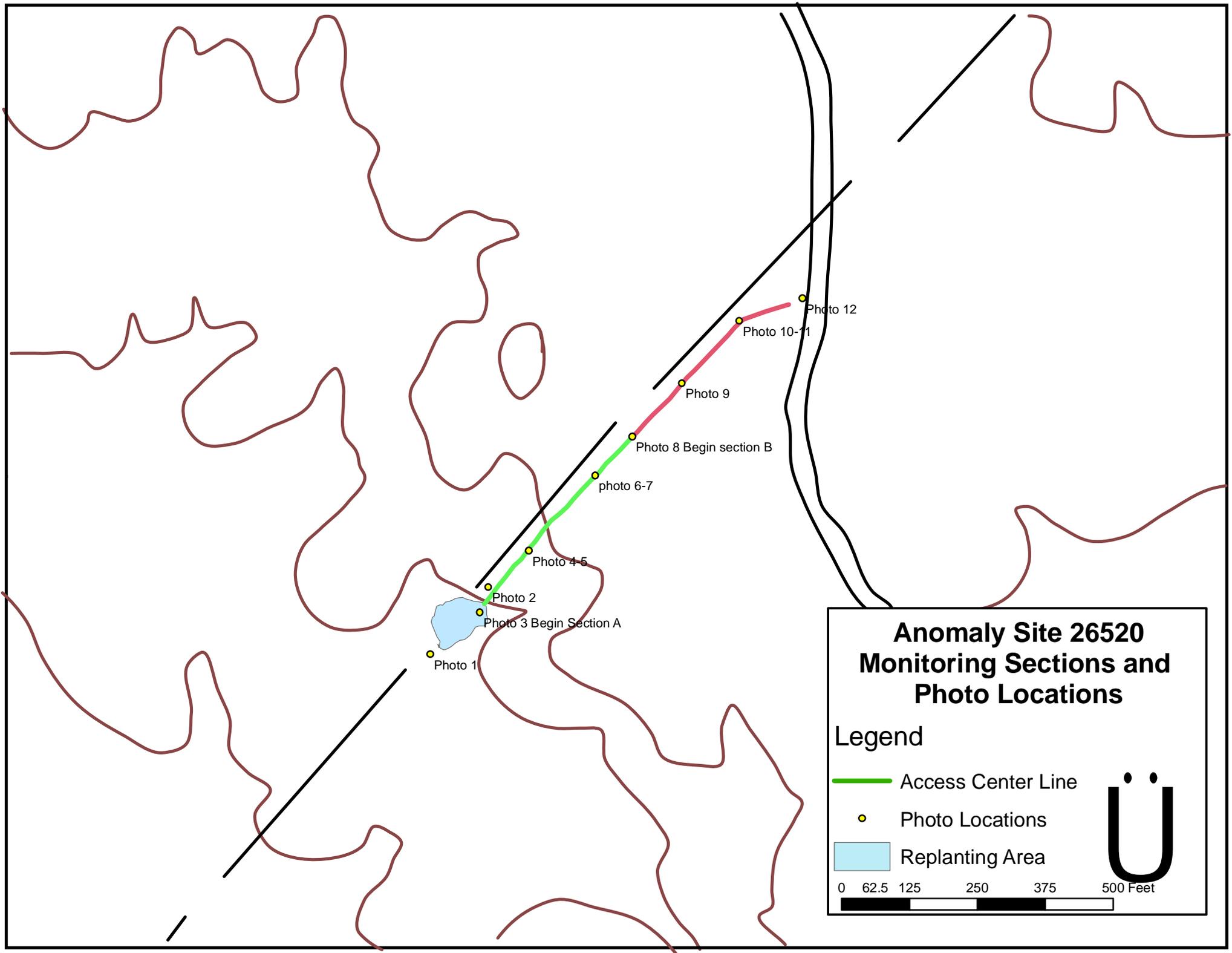
**Appendix 2. GPS locations for photo points, etc.**

<b>Area</b>	<b>Comment</b>	<b>X</b>	<b>Y</b>	<b>Bearing</b>
22250	Anomaly photo 1	625130.586504	4293300.827190	30
22250	Anomaly photo 2	625175.659665	4293365.475230	200
22250	Section 1 begin	625174.183890	4293365.002140	40
22250	Section 1-2	625325.703976	4293529.253430	180 & 340
22250	Section 2 midway photo a	625348.208759	4293592.070020	40
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22250	Section 5-6	626100.410654	4293984.779530	50 & 110
22250	Section 6 midway photo	626148.684910	4293949.747280	110
22250	Section 6-7	626212.574694	4293927.600030	270 & 90
22250	Section 7 midway photo	626342.354874	4293957.893360	320
22250	COLRAM- 3 avoid, 1 crush	626324.909950	429005.530510	n/a
22250	Section 7-8	626353.197702	4294256.139350	210 & 60
22250	Section 8 midway photo	626406.892085	4294296.255810	200 & 450
22250	Section 8-9	626617.213187	4294455.325080	210 & 30
22250	Section 9-10	626670.985361	4294505.896260	220 & 30
22250	Section 10-11	626760.074353	4294578.562580	220 & 40
22250	photo side area looking w	626813.315097	4294623.003600	270
22250	Section 11-12	626902.351477	4294684.544810	220 & 40
22250	Section 12-13	627169.523542	4294867.106820	220 & 40
22250	Section 13 midway photo	not available (from water bar)		220 & 40
22250	Section 13 end	627283.078845	4294963.649420	220
26520	Photo 1	621379.598381	621379.598381	20
26520	Photo 2	621412.274927	621412.274927	200
26520	Photo 3 Begin Section A	621407.552691	621407.552691	10
26520	Photo 4-5	621434.991768	621434.991768	220 & 20
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26520	Photo 9	621521.041516	621521.041516	30
26520	Photo 10-11	621553.234924	621553.234924	220 & 50
26520	Photo 12	621588.574738	621588.574738	260

Coordinate system is UTM NAD83 Zone 12N

## **Appendix 3. Maps**





# Anomaly Site 26520 Monitoring Sections and Photo Locations

## Legend

-  Access Center Line
-  Photo Locations
-  Replanting Area

