Location Checklist

Operator / #	EXTRACTION OIL & GAS INC / 10459			
Location ID & Name	329855 KAMMERZELL-65N66W/29SWNW			
County	Weld, CO			
Well Information	Well Name:	KAMMERZELL #29-5		
	Well API #:	05-123-17939		
	Lat/Long as Drilled:	40.375910 / -104.811220		
	Plug Date & Form 6s Doc #:	10/18/2019 & 402225057		
Facility Entities	X	Tank Battery		Pits
	X	Wells	X	On-Location Flowlines (Form 42) Doc #: 402201086
		Domestic Taps	X	Off-Location Flowlines (Form 44) Doc #: 402539851
Equipment On-Site	X	None		Debris
		Pit mouse/rat holes, cellars backfilled		
Access Road	X	Regraded	X	Contoured
		Culverts removed	X	Gravel removed
		Pre-Existing (Must provide supporting documentation)		
Reclamation Status	X	Location and associated disturbances reclaimed		
		Subsidence		
Spills or Releases (Form 19)	X	No		Yes
Remediation (Form 27/27A)	X	No		Yes
On-Location Flowlines		No	X	Yes
Off-Location Flowlines		No	X	Yes
Inspection Corrective Actions		No	X	Yes – Resolved 2018
Sundry Notice	Form 4 Doc # & Date:	401149905 & 12/02/2016		
	Purpose:	Interim reclamation complete, site ready for inspection. Per Rule 1003.e(3) describe interim reclamation procedure in Comments below or provide as an attachment and attach required location photographs.		
	Attachments:	Location Photos Doc # 401149907		
Drone Information	Make & Model	DJI M300/DJI Mavic 3 Multispectral		
	Image Processing Software	Pix4dfields – RGB/Multispectral Imagery & Pix4dmatic – RGB Imagery		
	Pilot Name & FAA Certificate #	Sam Streeter, #4100157		
	Date of FAA Certificate Issuance	23 Dec 2023		

SITE-SPECIFIC QUALITY ASSURANCE & QUALITY CONTROL AUDIT

Final Reclamation Complete Notice – Cropland Drone Imagery

PERMIT CLOSURE REPORT – CROPLAND

Location ID 329855
Location Name KAMMERZELL-65N66W/29SWNW

Report Date

16 Aug 2024

Soil Sage has conducted a thorough data audit as part of our Quality Assurance and Quality Control (QA/QC) protocols. This report was developed in accordance with the ECMC Operator Guidance – Operator supplied cropland drone imagery and information for submitting a final reclamation complete notice.

Crop Year and Type

Crop 2023 – Alfalfa

Quality Assurance & Quality Control Audit

Auditor	Soil Sage
Audit Date	26 Jun 2024

Audit Methodology

The following source materials were consulted during the QA and QC audit process:

- ✓ Site Permit Closures provided by CIVITAS Resources
- ✓ Colorado Oil & Gas Information System – COGIS Database
- ✓ On-site Evaluation and Proprietary Soil Sage Drone Imagery data collection
- ✓ Review of legacy imagery for site location and facility parameters

All pertinent data, imagery, and materials are included at the end of this report.

Site Description

Name	KAMMERZELL-65N66W/29SWNW			
Location ID	329855			
Operator / #	EXTRACTION OIL & GAS INC / 10459			
Field	WATTENBERG / 90750			
County, State	Weld, CO			
Lat/Long	40.372264 / -104.810623			
	X	Planned Location		As Drilled
Facility Status	CL	**Location**		SWNW 29 5N66W
Facility Status Date	10/18/2019			
Facility Entities	X	Tank Battery (Off-Site)		Pits
	X	Wells	X	Off-Location Flowlines (**Form 44**)
		Domestic Taps	X	On-Location Flowlines (**Form 42**)
		Electric Utilities		
Equipment on Site	X	No		Yes
		If yes, list:		
		Pit mouse/rat holes, cellars backfilled		
Access Road	X	Regraded	X	Contoured
		Culverts Removed	X	Gravel Removed
		Pre-Existing: must provide supporting documentation		
Environment Incidents & Remediation	X	None		Spill or Release (**Form 19**)
		Remediation (**Form 27/27A**)		
Variance Requests	**No Variance Requests were detected during this QA & QC Audit.**			
Inspection Corrective Actions (CA)s	**Corrective Actions (CA)s were detected during the QA & QC Audit.** **CA Overall Status:** NO FOLLOW UP INSPECTION REQUIRED **CA-Approving Inspection Doc # & Date:** 691200037 & 04/02/2018 ○ **Inspector:** Bret Evins **Originating Field Inspection Report (FIR) Doc #:** 689300468 ○ **Corrective Action:** Install sign to comply with Rule 210.b. **Corrective Action Date:** 02/08/2018 ○ **Corrective Action:** Comply with Rule 603.f. For unused, unmarked flowline risers 24 hrs to lock out tag out, 30 days to remove riser. **Corrective Action Date:** 01/08/2018			

	Complete ECMC Inspection Search Results: Link
Sundry Notice (Form 4)	**Form 4s were detected during the QA & QC Audit.** See individual scout card data for details.
On Location Flowlines (Form 42)	**Form 42s were detected during the QA & QC Audit.** See individual scout card data for details.
Off-Location Flowlines (Form 44)	**Form 44 Doc # & Date:** 402539851 & 05/18/2021 ○ **Purpose:** Abandonment Verification ○ **Abandonment Date:** 01/21/2020 ○ **ECMC Approval Date & Signee:** 05/18/2021 by Julie Murphy ○ **Operator Comments:** This Form 44 is being submitted for two (2) Flowline Abandonments. Both flowlines have been removed in their entirety. 12317938FL - Previously serviced the Kammerzell 29-4H6 well (API #05-123-17938). - Recent PRESSURE TEST attached. - Updated GIS shapefile attached. 12317939FL - Previously serviced the Kammerzell 29-5 well (API #05-123-17939). - Recent PRESSURE TEST attached. - Updated GIS shapefile attached. ○ **Note:** This Form 44 includes data for two Off-Location Flowlines: 465382 and 465381. This Location is connected to 465381 below. **Flowline Facility Information** ○ **ECMC Flowline ID:** 465381 ○ **Operator Flowline ID:** 12317939FL ○ **Status & Date:** CL & 01/21/2020 ○ **Flowline Type:** Wellhead Line ○ **Type of Fluids Transported:** Multiphase ○ **Start Point Location ID:** 329855 ○ **Start Point Riser Lat/Long:** 40.372264/-104.810623 (KAMMERZELL #29-5 Well) ○ **Equipment at Start Point:** Well ○ **End Point Location ID:** 448598 ○ **End Point Riser Lat/Long:** 40.372491/ -104.812466 (Kammerzell 29 Location Production Facilities) ○ **Equipment at End Point Riser:** Separator
Field Inspection Form (Form INSP)	**Form INSP Doc # & Date:** 691200037 & 04/02/2018 ○ **Status Summary:** NO FOLLOW UP INSPECTION REQUIRED ○ **Inspected Facilities:** KAMMERZELL 29-5 (Well) ○ **Inspection Status:** SI

	○ **Inspection Date & Inspector:** 03/26/2018 by Bret Evins ○ **Comments:** Access road to Kammerzell 29-5 well is adequate. Already addressed in CA on inspection document #691200035. Iron panel fence around Kammerzell 29-5 wellhead. Commingles Kammerzell 29-4H6 & 29-5 wells. E. Gas Meter Run not in use. E. Gas Meter Run not in use. Berms capacity appears inadequate. Shares berms with 2 produced oil tanks. Oil tanks are connected near top with an equalizer line. Currently shut. Berms capacity appears inadequate. Shares berms with produced H2O vault. Unmarked header at separator inlet is closed. Valves at well are open for production. Please confirm production or SI status. Bradenhead appears to be plumbed to surface. ○ **Attachments:** Inspection Photos Doc # 691200038 **Form INSP Doc # & Date:** 689300468 & 12/15/2017 ○ **Status Summary:** FOLLOW UP INSPECTION REQUIRED ○ **Inspected Facilities:** KAMMERZELL 29-5 (Well) ○ **Inspection Status:** SI ○ **Inspection Date & Inspector:** 12/08/2017 & Shaun O'Donnell ○ **Comments:** Wellhead sign is reading incorrect well. Well is the Kammerzell 29-5, sign reading Kammerzell 29-4H6. 2" steel unused/unmarked riser north of separator. See attached photos. Shares berm with crude oil tanks. Bradenhead valve is exposed at surface. ○ **Attachments:** Inspection Photos Doc # 689300469
COGIS Tank Facilities Information (Scout Card)	**Tank Battery Name:** Kammerzell 29 Battery # **FACILITY ID:** 448599 ○ **Status & Date**: AC & 12/07/2016 ○ **Lat/Long**: 40.372481/ -104.812492 ○ **Note:** The Tank Battery is located at Location ID 448598 and is shared with API# 05-123-17938.
COGIS Well Information (Scout Card)	**Well Name**: KAMMERZELL #29-5 **API#**: 05-123-17939 **FACILITY ID**: 250136 ○ **Status & Date**: PA & 10/18/2019 ○ **Lat/Long as Drilled**: 40.375910 / -104.811220 ○ **Form 6 Doc # & Date:** 402225057 & 01/24/2020

	○ **Form 42 Doc # & Date:** 402211486 & 10/16/2019 **Purpose:** OFFSET MITIGATION COMPLETED This well was mitigated per the Horizontal Offset Policy. Permitted horizontal well requiring mitigation - API # 123-45545 Appropriate documentation for mitigation has been/will be submitted. ○ **Form 42 Doc # & Date:** 402201086 & 10/07/2019 **Purpose:** START OF PLUGGING OPERATIONS - 48-hour notice required. Date: 10/09/2019. ○ **Form 4 Doc # & Date:** 401149905 & 12/02/2016 **Purpose:** Interim reclamation complete, site ready for inspection. Per Rule 1003.e(3) describe interim reclamation procedure in Comments below or provide as an attachment and attach required location photographs. **Attachments:** Location Photos Doc # 401149907

ECMC Abbreviations: Location & Facility Status Codes, Inspection Types & Statuses and ECMC Help.

Audit Key Findings – Designation Land Use Observations

PREVIOUS LAND USE	CURRENT LAND USE
Reference Imagery for Infrastructure: DigitalGlobe 2016	**Remotely Sensed Imagery:** 28 Aug 2023; 2022
Designation: Oil & Gas Facility	**Designation:** Cropland

The following imagery sources were reviewed during this audit:

EarthExplorer, DRCOG 2002 - 2014, NAIP Imagery 2011, 2013, 2015, 2017, 2019, 2021, ESRI Maxar and Remotely Sensed Imagery Sep 2022

Site Observation Notes

No additional information.

In accordance with ECMC guidance, this cropland evaluation has demonstrated that this location has been returned to its original condition and crops are reflective of the cropland reference areas.

Closure Information

Location ID 329855 KAMMERZELL-65N66W/29SWNW is in Weld County, Colorado near the intersection of County Road 54 and 83rd Avenue. There is one plugged and abandoned well (Kammerzell #29-5 API # 05-123-17939). There is an Off-Location Flowline (Flowline ID 465381) between this well and the tank battery (Facility ID 448599) at Location ID 448598.

There were Corrective Actions at this location in December 2017 due to needing to install a sign to comply with Rule 210.b. and comply with Rule 603.f. for unused, unmarked flowline risers, 24 hours to lock out tag out, 30 days to remove riser. These were resolved in January and February 2018 and an ECMC inspection approved the Corrective Actions in April 2018.

Kammerzell #29-5 well (API # 05-123-17939) was plugged and abandoned on October 18th, 2019. The access road was reclaimed at this time. The related Tank Battery (Facility ID 448599) production facility, Location ID 448598, was closed and reclaimed at the same time.

Soil Sage drone imagery confirms that no equipment was left on site at this location after reclamation activities occurred.

Summary Acreage Table

Description	Acres
Historic Disturbance Extent	0.43
Access Road	0.30
Flowline	Not Included
Tank Battery	Off-Site (Loc ID 448598)
Well Pad	0.13

Drone Information

Make	DJI
Model	M300/Mavic 3 Multispectral
Image Processing Software	Pix4dfields – RGB/Multispectral Imagery & Pix4dmatic – RGB Imagery
Pilot Name	Sam Streeter
Pilot FAA Certificate Number	4100157
Date of FAA Certificate Issuance	23 Dec 2023

CIV - 329855- KAMMERZELL 29-5
Map Extent - Pre-Plugging Overview

Imagery: DigitalGlobe
Imagery Date: 12 Jul 2016
Map Date: 29 Jul 2024
Datum: WGS 1984 UTM Zone 13N
POC: Soil Sage

Wells
Flowline
Historic Disturbance Extent
Access Road
Ditch Road
TankBattery
Separator

0 40 80 160 Meters

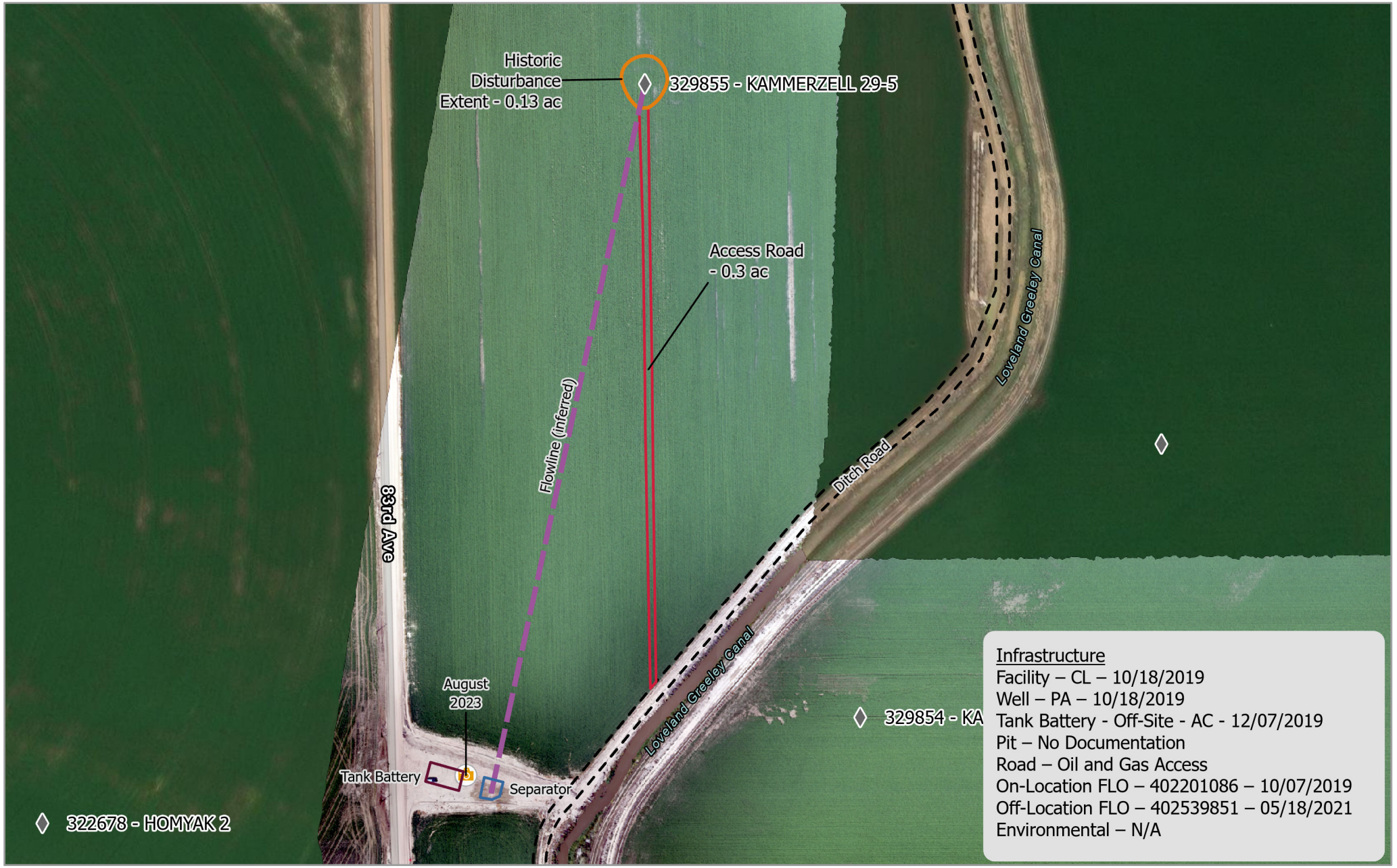
Total Disturbance
0.43 Acres

Scale: 1:2,800

Pad Location:
40.372264
-104.810623

N

Service Credits - esri_imagery, Esri Community Maps Contributors, City of Greeley, © OpenStreetMap, Microsoft, Esri, TomTom, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, US Census Bureau, USDA, USFWS, Maxar



CIV - 329855- KAMMERZELL 29-5
Map Extent - Post-Plugging Overview

Imagery: RS Orthomosaic
Imagery Date: 28 Aug 2023
Map Date: 29 Jul 2024
Datum: WGS 1984 UTM Zone 13N
POC: Soil Sage

Wells
Observation Points
Flowline
Historic Disturbance Extent
Access Road
Ditch Road
TankBattery
Separator

0 40 80 160 Meters

Total Disturbance
0.43 Acres

Scale: 1:2,800

Pad Location:
40.372264
-104.810623

N

Service Credits - Maxar, Microsoft, Esri Community Maps Contributors, City of Greeley, © OpenStreetMap, Microsoft, Esri, TomTom, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, US Census Bureau, USDA, USFWS

Cardinal Directional Drone Photos & Reference Area Photos

Site Investigation and Photos Date

28 Aug 2023

Drone Photo Height

80 feet

Cardinal directional photos of the site. Reference overview map.

In View – Well, Access Road, Flowlines **NORTH** – 40.375360/-104.811280

In View – Well, Access Road, Flowline **NORTH** – 40.372094/-104.810902

In View – Tank Battery (Location ID 448598) **NORTH** – 40.371417/-104.812191

In View – Well, Access Road, Flowlines **EAST** – 40.376352/-104.812192

In View – Tank Battery (Location ID 448598) **EAST –** 40.372449/-104.813546

In View – Well, Access Road, Flowlines **SOUTH –** 40.376856/-104.811205

In View – Well, Tank Battery, Access Road, Flowline **SOUTH –** 40.377098/-104.811095

In View – Tank Battery (Location ID 448598) **SOUTH –** 40.373320/-104.812388

In View – Well, Access Road, Flowlines **WEST –** 40.376311/-104.810628

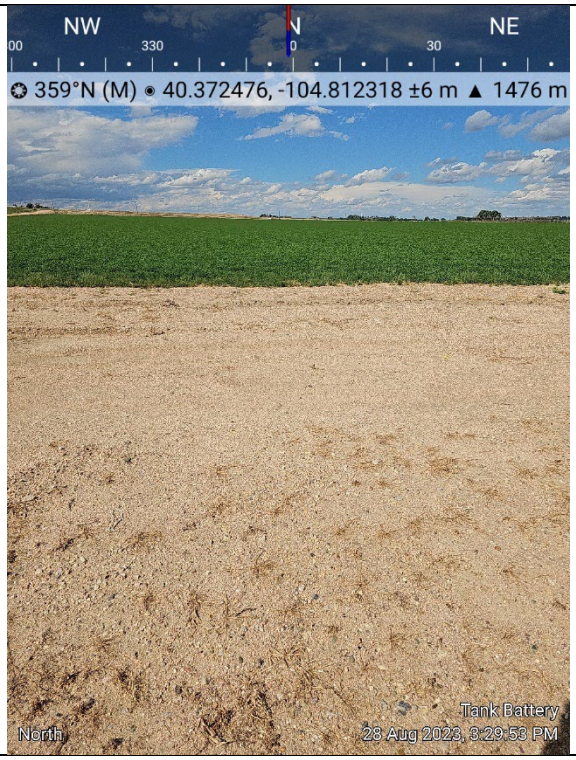
In View – Tank Battery (Location ID 448598) **WEST –** 40.372475/-104.810708

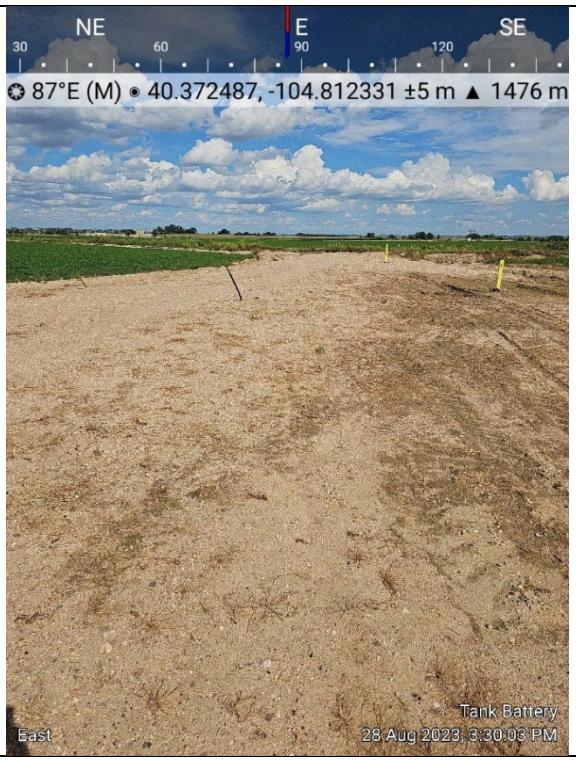
Off-Location Tank Battery Within Cropland – Handheld Photographic Evidence

Site Investigation and Photos Date

28 Aug 2023

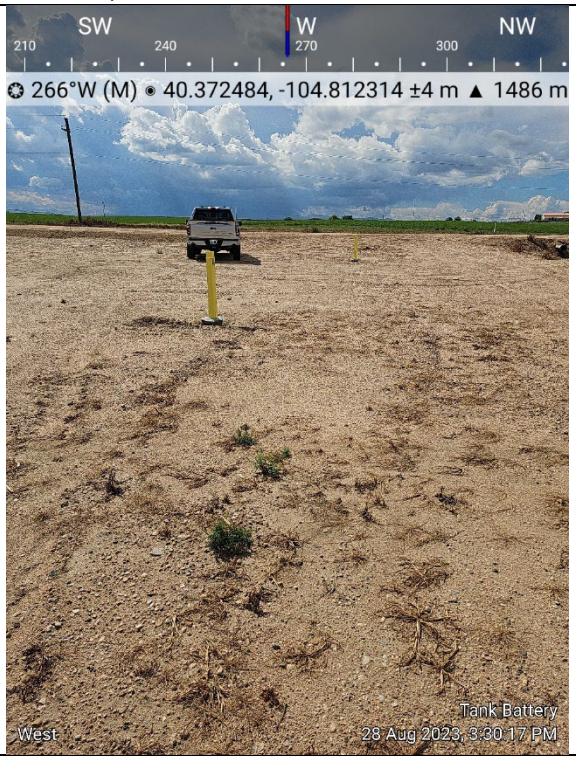
Handheld photos taken from the Production Facilities for the well, at Location ID 448598. No handheld photos taken from wellhead location due to crop height.

	
Overhead at tank battery location – 40.372415 / -104.812302	Looking North at tank battery location towards wellhead – 40.372476 / -104.812318

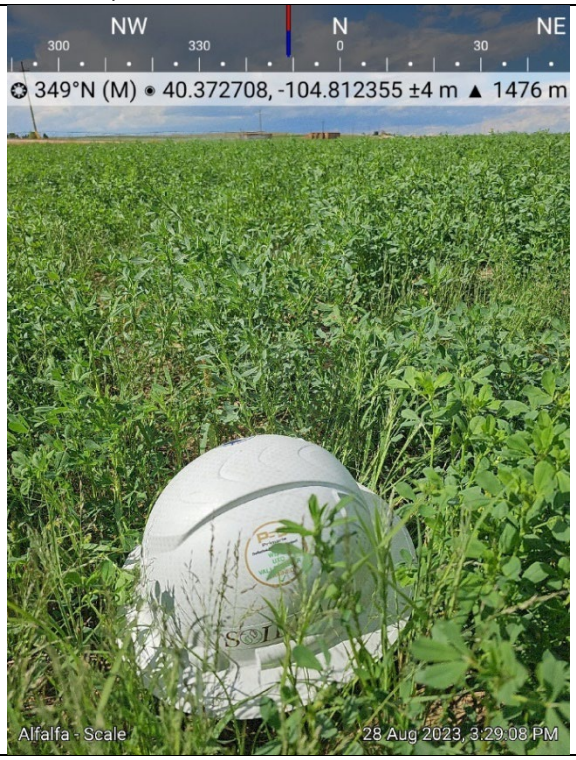


Looking East at tank battery and separator location – 40.372487 / -104.812331

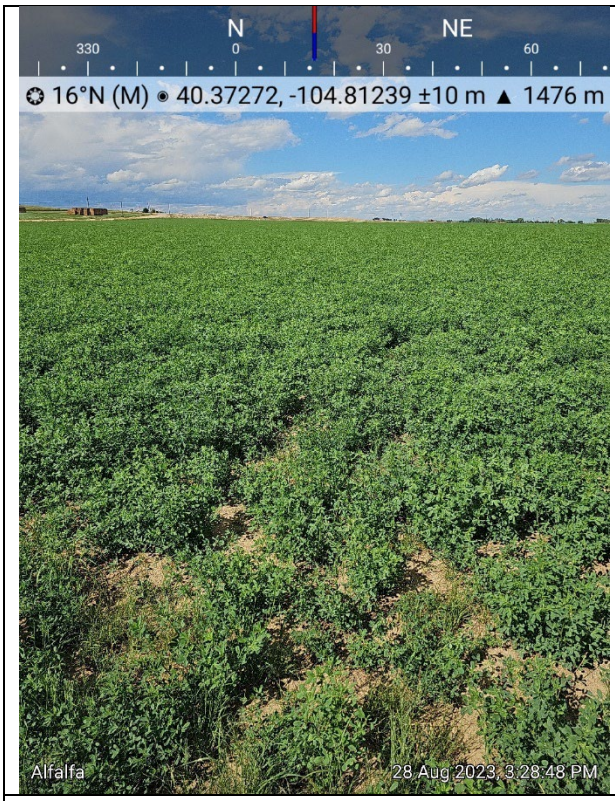
Looking South at tank battery and separator location – 40.372489 / -104.812319



Looking West at tank battery and separator location – 40.372484 / -104.812314



Alfalfa field – helmet for scale – 40.372708 / -104.812355

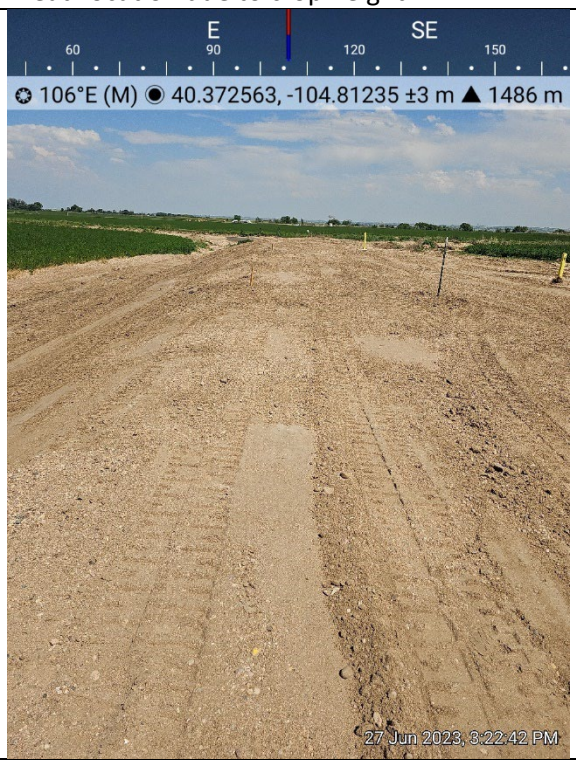
	
Looking North into alfalfa field towards wellhead – 40.372720 / -104.812390	

Off-Location Tank Battery Within Cropland – Handheld Photographic Evidence

Site Investigation and Photos Date

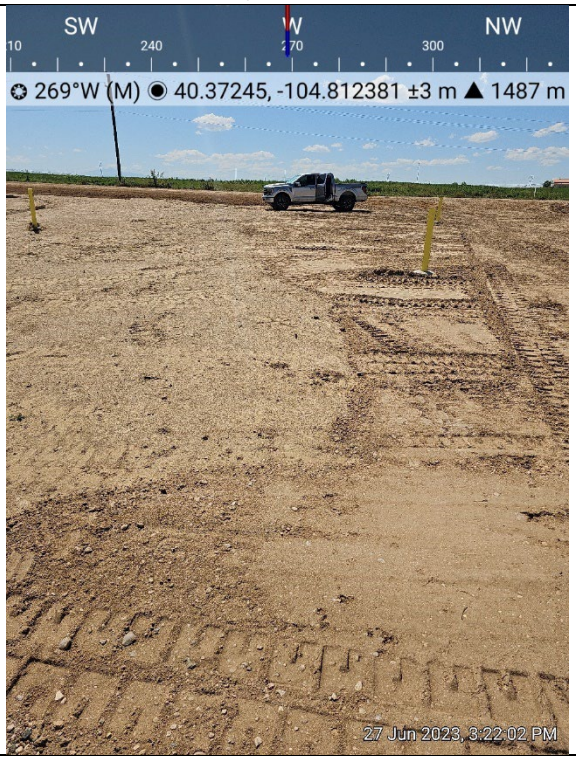
27 Jun 2023

Handheld photos taken from the Production Facilities for the well, at Location ID 448598, looking towards wellhead. No handheld photos taken from wellhead location due to crop height.

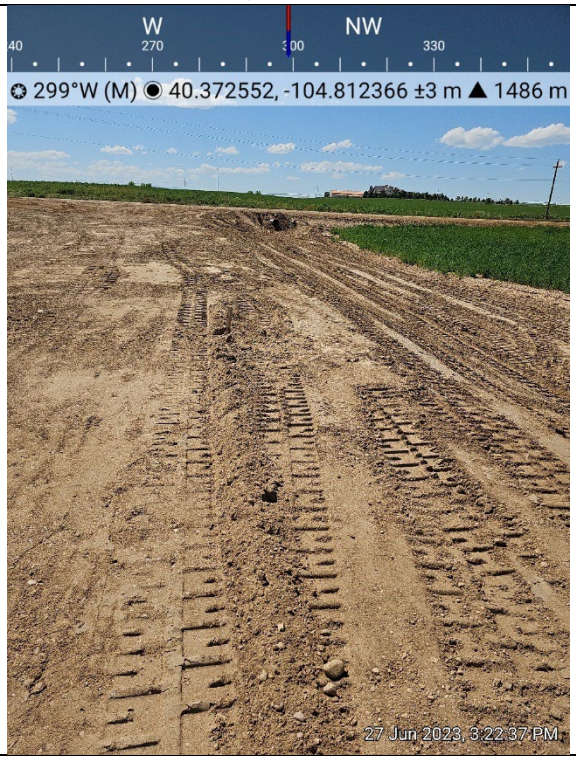
	
Looking North at tank battery and separator location towards wellhead – 40.372459 / -104.812371	Looking East at tank battery and separator location – 40.372563 / -104.812350

Looking East at tank battery and separator location – 40.372451 / -104.812369

Looking South at tank battery and separator location – 40.372449 / -104.812378



Looking West at tank battery and separator location – 40.372450 / -104.812381



Looking Northwest at tank battery and separator location – 40.372552 / -104.812366

Looking Southeast at tank battery and separator location – 40.372465 / -104.812351

Monitoring well at tank battery and separator location – 40.372527 / -104.812232

Monitoring well at tank battery and separator location – 40.372456 / -104.812369

Cardinal Directional Drone Photos Showing No Equipment Remaining

Site Investigation and Photos Date
20 Sep 2022

Drone Photo Height
215 feet

Cardinal directional photos of the site. Reference overview map.

In View – Well, Access Road, Flowline **NORTH** – 40.372180/-104.811254

In View – Well, Access Road, Flowline **EAST** – 40.375541/-104.814427

In View – Well, Access Road, Flowline, Tank Battery **SOUTH** – 40.378574/-104.811416

In View – Well, Access Road, Flowline **WEST** – 40.375453/-104.807256

ATTACHMENTS

Maps and Figures

Area Maps

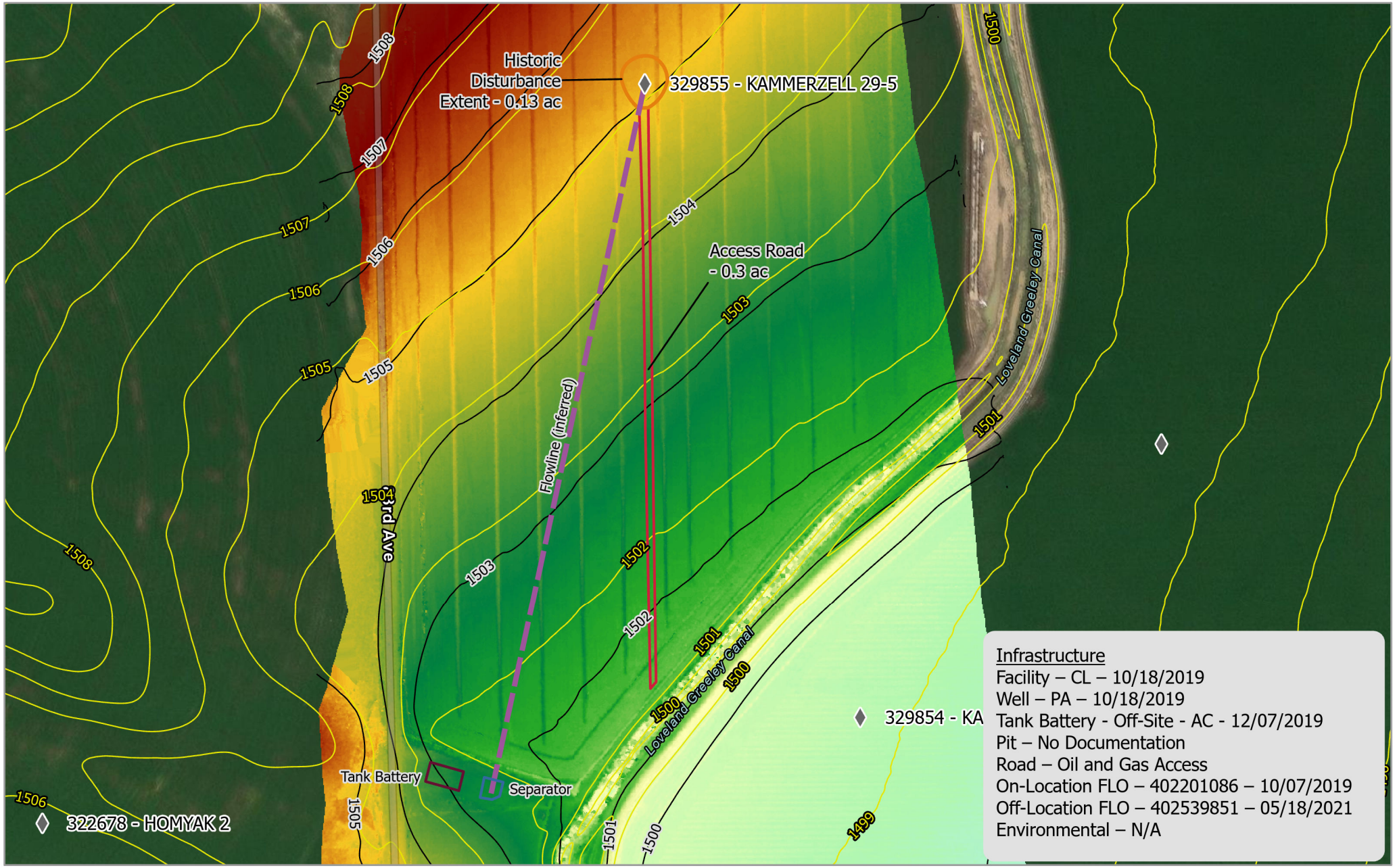
Elevation & Contours

Hydrology

Background Information

Natural Resources Conservation Service (NRCS) Map Unit Description

Reference Soil Document



CIV - 329855- KAMMERZELL 29-5
Map Extent - Elevation & Contours

Imagery: RS Orthomosaic, USGS
Imagery Date: 2022, 2014
Map Date: 29 Jul 2024
Datum: WGS 1984 UTM Zone 13N
POC: Soil Sage

Wells
Flowline
1 Meter Contours (2022)
1 Meter Contours (2014)
Historic Disturbance Extent
Access Road
TankBattery
Separator
Elevation
Meters
1522
1498

0 40 80 160 Meters

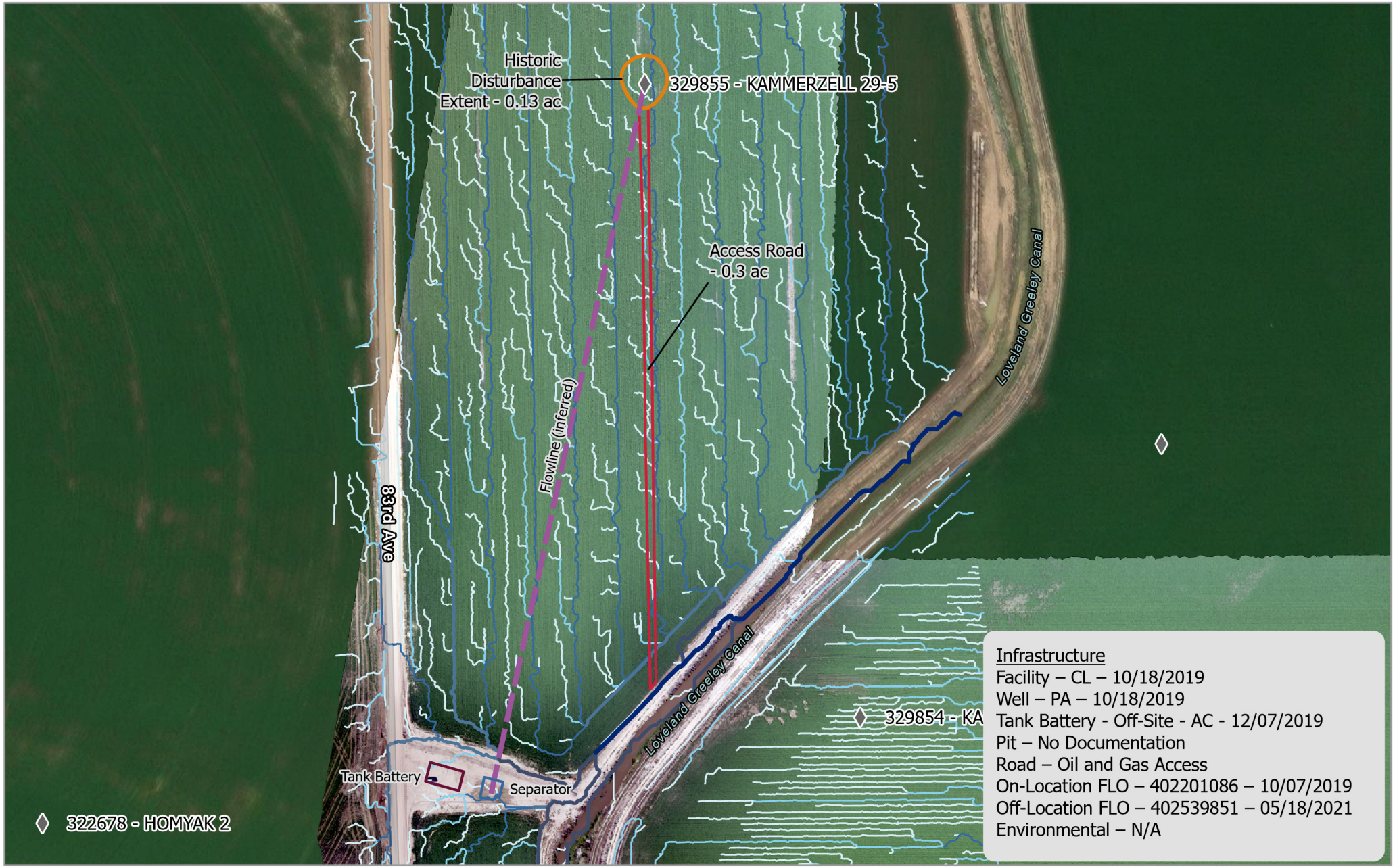
Total Disturbance
0.43 Acres

Scale: 1:2,800

Pad Location:
40.372264
-104.810623

N

Service Credits - Esri Community Maps Contributors, City of Greeley, © OpenStreetMap, Microsoft, Esri, TomTom, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, US Census Bureau, USDA, USFWS, Maxar



CIV - 329855- KAMMERZELL 29-5
Map Extent - Hydrology

Imagery: RS DSM, RS Orthomosaic
Imagery Date: 2022, 2023
Map Date: 29 Jul 2024
Datum: WGS 1984 UTM Zone 13N
POC: Soil Sage

Wells
Flowline
Historic Disturbance Extent
Access Road
TankBattery
Separator

Stream Order
1
2
3
4
5
6

0 40 80 160 Meters

Total Disturbance
0.43 Acres

Scale: 1:2,800

Pad Location:
40.372264
-104.810623

N

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Soil Properties

USDA Soil Description

Reference Soil Information

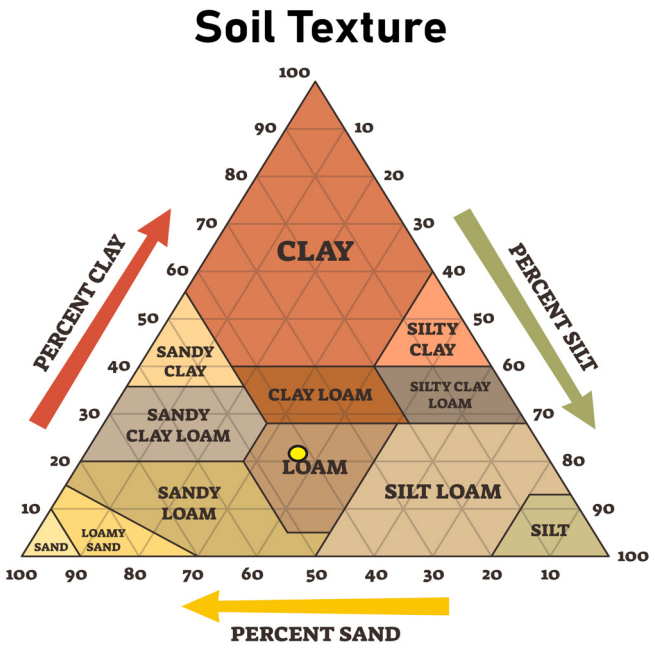
The location of the site is contained within three soil types, Kim loam, Olney Fine Sandy Loam, and Otero Sandy Loam.

Map Unit 32 Reference Soil information - Kim Loam

This soil is formed from mixed eolian deposits derived from sedimentary rock. Landform is plains, alluvial fans, with the Loamy Plains Ecological Site. Soils are well drained with a moderate water holding capacity, and slope 1 to 3 percent.

	Physical			Chemical			
Depth (in)	**Texture**	**Bulk Density**	**Particle Size Percent sand, silt, clay**	**pH**	**EC**	**SAR**	**OM%**
0-10	Loam	1.33	42-37-21	7.9	0.0	0.0	0.75
10-20	Loam	1.33	42-37-21	7.9	0.0	0.0	0.75
20-30	Loam	1.33	42-37-21	7.9	0.0	0.0	0.75
30-40	Loam	1.33	42-37-21	7.9	0.0	0.0	0.75
40-50	Fine Sandy Loam	1.43	65-20-15	7.9	0.0	0.0	0.25
50 +	Fine Sandy Loam	1.43	65-20-15	7.9	0.0	0.0	0.25

Soil Texture Triangle reflect the 0-10 in depth



Erosion Potential (10 inches)

- K Factor, Whole soil - .28. Values of K range from 0.02 to 0.69. Other factors being equal, the higher the value, the more susceptible the soil is to sheet and rill erosion by water.
- Wind Erodibility Group – 4L. The soils assigned to group 1 are the most susceptible to wind erosion, and those assigned to group 8 are the least susceptible.

Soil Properties

USDA Soil Description

Reference Soil Information

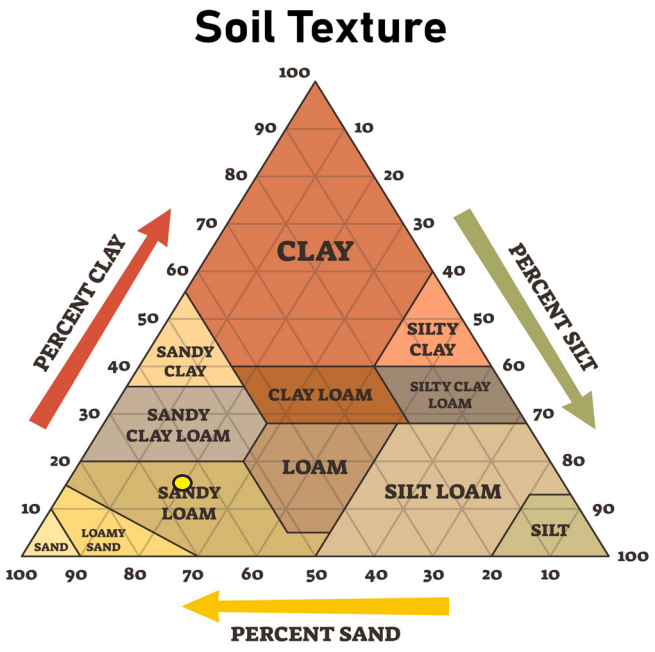
The location of the site is contained within three soil types, Kim loam, Olney Fine Sandy Loam, and Otero Sandy Loam.

Map Unit 47 Reference Soil information - Olney Fine Sandy Loam

This soil is formed from mixed deposit outwash. Landform is plains, with the Sandy Plains Ecological Site. Soils are well drained with a moderate water holding capacity, and slope 1 to 3 percent.

	Physical			Chemical			
Depth (in)	**Texture**	**Bulk Density**	**Particle Size Percent sand, silt, clay**	**pH**	**EC**	**SAR**	**OM%**
0-10	Fine Sandy Loam	1.43	65-20-15	7.2	0.0	0.0	0.75
10-20	Sandy Clay Loam	1.33	56-17-27	7.2	0.0	0.0	0.75
20-30	Sandy Clay Loam	1.41	62-22-16	8.3	1.0	0.0	0.25
30-40	Fine Sandy Loam	1.50	64-26-10	8.5	1.0	0.0	0.25
40-50	Fine Sandy Loam	1.50	64-26-10	8.5	1.0	0.0	0.25
50 +	Fine Sandy Loam	1.50	64-26-10	8.5	1.0	0.0	0.25

Soil Texture Triangle reflect the 0-10 in depth



Erosion Potential (10 inches)

- K Factor, Whole soil - .24. Values of K range from 0.02 to 0.69. Other factors being equal, the higher the value, the more susceptible the soil is to sheet and rill erosion by water.
- Wind Erodibility Group – 3. The soils assigned to group 1 are the most susceptible to wind erosion, and those assigned to group 8 are the least susceptible.

Soil Properties

USDA Soil Description

Reference Soil Information

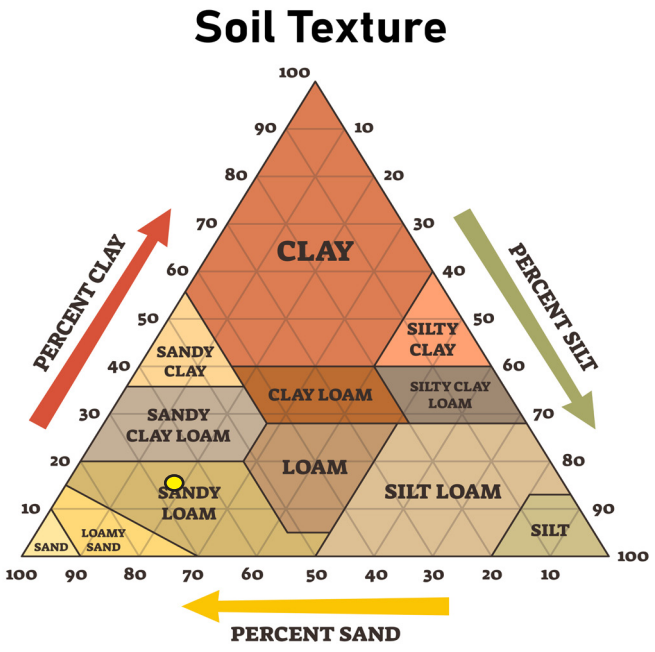
The location of the site is contained within three soil types, Kim loam, Olney Fine Sandy Loam, and Otero Sandy Loam.

Map Unit 53 Reference Soil information - Otero Sandy Loam

This soil is formed from eolian deposits and/or mixed outwash. Landform is plains, with the Sandy Plains Ecological Site. Soils are well drained with a moderate water holding capacity, and slope 5 to 9 percent.

	Physical			Chemical			
Depth (in)	**Texture**	**Bulk Density**	**Particle Size Percent sand, silt, clay**	**pH**	**EC**	**SAR**	**OM%**
0-10	Sandy Loam	1.43	66-19-15	7.9	1.0	0.0	0.25
10-20	Sandy Loam	1.43	66-19-15	7.9	1.8	0.0	0.44
20-30	Fine Sandy Loam	1.43	65-20-15	7.9	2.0	0.0	0.25
30-40	Fine Sandy Loam	1.43	65-20-15	7.9	2.0	0.0	0.25
40-50	Fine Sandy Loam	1.43	65-20-15	7.9	2.0	0.0	0.25
50 +	Fine Sandy Loam	1.43	65-20-15	7.9	2.0	0.0	0.25

Soil Texture Triangle reflect the 0-10 in depth



Erosion Potential (10 inches)

- K Factor, Whole soil - .15. Values of K range from 0.02 to 0.69. Other factors being equal, the higher the value, the more susceptible the soil is to sheet and rill erosion by water.
- Wind Erodibility Group – 3. The soils assigned to group 1 are the most susceptible to wind erosion, and those assigned to group 8 are the least susceptible.

Soil Reference Information

There is a general relationship of soil bulk density to root growth based on soil texture. Bulk densities ideal for root growth are less than 1.60 g/cc for sandy textures, less than 1.40 g/cc for loamy textures, and less than 1.10 g/cc for clayey textures. Bulk densities that restrict root growth are greater than 1.80 g/cc for sandy textures, 1.65 g/cc for loamy textures, and 1.47 g/cc for clayey textures.

Vegetation

Reference vegetation – Sandy Plains Ecology

Climate

Average Annual Precipitation 14 to 17 inches annually - average 15 inches

Average Annual Air Temperature ranges from 50 to 52 degrees F

Drought conditions in effect

Long-term effects of these latest drought events have yet to be determined. Growth of native cool-season plants begin about April 1 and continue to mid-June. Native warm-season plants begin growth about May 1 and continue to about August 15. Regrowth of cool-season plants occur in September in most years, depending on moisture.

Reference dynamics

The Reference State is characterized by 70-85% grasses and grass-like plants, 10-15% forbs, and 5-15% woody plants. The dominant tall warm season grasses are prairie sandreed, sand bluestem and switchgrass. Blue grama dominates the understory. Important cool season grasses and grass-likes are needle and thread and sun sedge. Key forbs and shrubs are American vetch, pacific peavine (manystem pea), purple prairie clover, and spreading buckwheat.

Drought has increased mortality of blue grama in some locations

Well suited for carbon sequestration

Reference Vegetation – Sandy Plains Ecology

At Risk Plant Community

Key species from the Reference Plant Community, sand bluestem, prairie sandreed, switchgrass, leadplant and western sandcherry have decreased in frequency and production. Blue grama has increased. Sand dropseed, Fendler threeawn, hairy goldaster, croton, slimflower scurfpea, western ragweed, stickleaf, heath aster, lupine, loco, milkvetch and plains pricklypear cactus have increased. Soils that have a sandy loam or coarser subsoil will show an increase in sand sagebrush.

The risk of losing key warm-season tallgrasses, important forbs and shrubs is a major concern. Blue grama is increasing at the expense of the tallgrasses and deep-rooted shrubs. Water cycle, nutrient cycle and energy flow may become impaired due to a shift in root structure and species composition. Less litter is being produced.

Vegetation

Sandy Plains Ecosystem Vegetative Community Composition

Common Name	Scientific Name
Blue Grama	*Bouteloua gracilis*
Prairie Sandreed	*Calamovilfa longifolia*
Sand Bluestem	*Andropogon hallii*
Switchgrass	*Panicum virgatum*
Needle and Thread	*Hesperostipa comata*
Western Wheatgrass	*Pascopyrum smithii*
Little Bluestem	*Schizachyrium scoparium*
Indiangrass	*Sorghastrum nutans*
Sideoats Grama	*Bouteloua curtipendula*
Sand Dropseed	*Sporobolus cryptandrus*
Indian Ricegrass	*Achnatherum hymenoides*
Buffalograss	*Bouteloua dactyloides*
Thin Paspalum	*Paspalum setaceum*
Purple Prairie Clover	*Dalea purpurea*
Upright Prairie Coneflower	*Ratibida columnifera*
Scarlet Globemallow	*Sphaeralcea coccinea*
American Vetch	*Vicia americana*
White Heath Aster	*Symphyotrichum ericoides*
Winged Buckwheat	*Eriogonum alatum*
White sagebrush	*Artemisia ludoviciana*

Vegetation

Reference vegetation – Loamy Plains Ecology

Climate

Average Annual Precipitation 14 to 17 inches annually

Average Annual Air Temperature 50 degrees F

Drought conditions in effect

Long-term effects of these latest drought events have yet to be determined. Growth of native cool-season plants begin about April 1 and continue to mid-June. Native warm-season plants begin growth about May 1 and continue to about August 15. Regrowth of cool-season plants occur in September in most years, depending on moisture.

Reference dynamics

The Reference State is characterized by co-dominant warm-season shortgrass (blue grama), and cool-season midgrass (western wheatgrass, green needlegrass). The Warm-Season Shortgrass State is characterized by a warm-season short bunchgrass (blue grama) and stoloniferous grass (buffalograss). The Increased Bare Ground State is characterized by early successional warm-season bunchgrass (Fendler threeawn), cool-season short bunchgrass (squirreltail), annual grasses, and annual forbs.

Drought has increased mortality of blue grama and buffalo grasses in some locations

The major grasses in the Reference Plant Community include western wheatgrass, green needlegrass, and blue grama. Western wheatgrass is a major cool-season grass in this plant community and is a valuable forage plant in late spring and/or early summer. Sub-dominant grasses include needle and thread, buffalograss, and sand dropseed. Major forbs include American vetch, upright prairie coneflower, scarlet globemallow, and dotted blazingstar (dotted gayfeather). A minor amount of shrubs such as fourwing saltbush and winterfat may also occur.

Well suited for carbon sequestration

Vegetation

Reference Vegetation – Loamy Plains Ecology

At Risk Plant Community

Key species from the Reference Plant Community, such as green needlegrass, western wheatgrass, American vetch, fourwing saltbush, and winterfat have been reduced in production. Blue grama and buffalograss have increased in abundance, are beginning to dominate the community, and will begin to exhibit a sod-bound appearance. Sand dropseed, red threeawn, sixweeks fescue, plains pricklypear, hairy false goldenaster, and bottlebrush squirreltail also have increased. This plant community is at risk of losing the cool-season grasses, key forbs such as American vetch and purple prairie clover, and key shrubs.

Total aboveground biomass has been reduced. Reduction of rhizomatous wheatgrass, nitrogen-fixing forbs, and the shrub component, and increased warm-season shortgrasses have begun to alter the biotic integrity of this community. Water and nutrient cycles may be impaired.

Loamy Plains Ecosystem Vegetative Community Composition

Common Name	Scientific Name
Western Wheatgrass	*Pascopyrum smithii*
Green Needlegrass	*Nassella viridula*
Indian Ricegrass	*Achnatherum hymenoides*
Needle and Thread	*Hesperostipa comata*
Blue Grama	*Bouteloua gracilis*
Buffalograss	*Bouteloua dactyloides*
Sand Dropseed	*Sporobolus cryptandrus*
Sideoats Grama	*Bouteloua curtipendula*
Little Bluestem	*Schizachyrium scoparium*
Little Barley	*Hordeum pusillum*
Sixweeks Fescue	*Vulpia octoflora*
American Vetch	*Vicia americana*
Purple Prairie Clover	*Dalea purpurea var. purpurea*
White Locoweed	*Oxytropis sericea*
Slimflower Scurfpea	*Psoralidium tenuiflorum*
Scarlet Globemallow	*Sphaeralcea coccinea*
Broadbeard Beardtongue	*Penstemon angustifolius*
Lacy Tansyaster	*Machaeranthera pinnatifida ssp. pinnatifida var. pinnatifida*
Dotted Blazing Star	*Liatris punctata*
Upright Prairie Coneflower	*Rativida columnifera*
Rush Skeletonplant	*Lygodesmia juncea*