ORIGINAL

State of Oklahoma
Department of Mines
2915 N. Classen Blvd., Ste. 213
Oklahoma City, OK 73106

APPLICATION FOR PERMIT TO ENGAGE IN NON-COAL MINING

The Mining Lands Reclamation Act, O.S., 2016 721-728

Section 1

ODM Permit Number 2841
(Office Use Only)

Date JANUARY 18, 2024

Number of years for which Permit plan is requested: LIFE EXPECTANCY OF MINE

UNISANDS, LLC — (314) 808-4006
Name of Company, Corporation, Partnership, Individual — Telephone Number

404 WARRIOR ROAD — MCLOUD — OK — 74851
Mailing Address — City — State — Zip Code

HUCKIE.DEEJAY@GMAIL.COM
Email Address

hereby make application for a permit to mine (type of material) SHALE, LIMESTONE, SANDSTONE, SAND, GRAVEL & CLAY by the following method:
Type of Mineral(s)

by the following method: SURFACE X UNDERGROUND ____

Specify Method: Quarrying ☒ Stripping ☒ Dredging ☒ Pumping ☒ Auger Mining ☐ Hydraulic Mining ☒ Other ____

Mine Name or Number OTEKA QUARRY Nearest Town MARSHALL

Section 15 Township 5S Range 4E County MARSHALL

Section 16 Township 5S Range 4E County MARSHALL

Section 22 Township 5S Range 4E County MARSHALL

Section ____ Township ____ Range ____ County ____

Type of perimeter markers to be used: STEEL TEE POSTS WITH PLASTIC SLEEVES

Operational Section
General Characteristics of the Mine

NOTE: All of the following questions must be thoroughly answered regarding your mining operation for the intended life of the mine.

1. Answer **all** of the following that apply:

1a. If this is an application for a **NEW** permit, indicate the total acreage at the site to be covered by the permit: ~582

Will this application replace a limited use permit? Yes ☐ No ☒
Limited Use Permit No.: N/A

1b. If this application is for RENEWAL of a mining permit, indicate the mining permit number and the total (overall) acreage covered by the existing permit:
Mining Permit No.: N/A Total permitted acreage: N/A

1c. If this application is for the **REVISION** of a mining permit, indicate the mining permit number and the total (overall) acreage covered by the existing permit.
Mining Permit No.: N/A Total permitted acreage: N/A

Does the request involve acreage **within** the previously approved permitted boundary?
Yes ☐ No ☒.
If yes, indicate the acreage to be covered by this revision: N/A

Does the request involve acreage to be added to the previously approved permitted boundary?
Yes ☐ No ☒.
If yes, indicate the acreage to be added by this request: N/A
If no was indicated, please explain the revision request: N/A

This request will be considered an amendment to the permit (Title 45 § 724 J.).
The application must be submitted as required by and in accordance with OAC:10-19-4.(d).

1d. If this is an application for the **TRANSFER** of a mining permit, indicate the mining permit number and the total (overall) acreage covered by the existing permit.
Mining Permit No.: N/A Total permitted acreage: N/A
Name of Company: N/A

1e. If this is an application for **PURCHASE** of a mining permit, indicate the mining permit number and the total (overall) acreage covered by the existing permit.

Mining Permit No.: N/A Total permitted acreage: N/A
Name of Company: N/A
Will additional acreage be affected? Yes ☐ No ☒
If yes, indicate how much additional acreage will be added: N/A

All the acreage within the "Operational Section" must include the proposed mine excavation(s), processing plants, haul roads, stockpiles, and any refuse/waste areas or tailing ponds."

TOTAL PERMITTED AND BONDED ACRES AND MAPPING REQUIREMENTS

2. Will you file a bond covering all your mining acreage under your plan or will you file for an incremental mining plan?

Total Permit Acres: _____ Incremental Bonding Yes ☒ No ☐

Please show your acreage below. If you have indicated incremental mining plan, then your acreage will be progressive to each incremental area. Prior to the issuance of this permit, a bonding map must be included detailing the sequence proposed for incremental bonding.

460:10-9-6. Mine maps should be accurate drawings, aerial photographs, or enlarged topographic maps of the entire mine area and of a scale sufficient to clearly illustrate the following:

(1) Outline of the area to be permitted detailing the affected areas, incremental mining areas, planned future reserves if requested by the applicant, buffer zones, easements, and rights-of-ways, for the number of years the permit is requested.

460:10-21-4. (b) An operator shall not disturb surface acreage or extend any underground shafts, tunnels, or operations prior to receipt of approval from the Department of a performance bond covering the surface acreage to be affected.

(1) Liability on the performance bond shall cover all non-coal surface mining and reclamation operations to be conducted within the permit area. Except for limited use permits, after the amount of the bond has been determined for the permit area in accordance with Subchapter 23 of this Chapter, the permittee or applicant may either file:

- ***(A) The entire performance bond required during the term of the permit;***
- ***(B) A cumulative bond schedule and the sequence of release of acreage as it progresses through varying reclamation phases and for the addition of acreage as it is affected. The amount of bond required to obtain a permit shall include the full reclamation cost of the initial area being affected; or***
- ***(C) An incremental bond schedule and the new performance bond required for the first increment in the schedule.***

(2) When the operator elects to "increment" the amount of the performance bond during the term of the permit, he shall identify the initial and successive incremental areas for bonding on the permit application map submitted for approval as provided in Subchapter 17 of this Chapter and shall specify the proportion of the total bond amount required for the term of the permit which will be filed prior to commencing operations on each incremental area. The schedule amount of each performance bond increment shall be filed with the Department at least 45 days prior to the commencement of non-coal surface mining and reclamation operations in the next incremental area.

A separate schedule detailing each increment must be attached to the application. An Incremental bonding map must be submitted if the total permitted acreage is not covered by bond.

Total Acreage to be covered by the permit: ~582

REQUIRED Bond Coverage: Minimum bond shall be $2,000.00.

Type: Surety ☐ Cash ☐ Check ☐ Certificate of Deposit ☐

Letter of Credit ☐ Other _____

Bond Number Identification: TBA Amount of Bond Coverage ~180 ac x $1,500= $270,000 (Phase 1)

Bond coverage submitted must be a total of the first increment or the entire permitted acreage requested.

INCREMENTAL BONDING SCHEDULE

	ACREAGE		PERMIT PERIOD					BOND
	Increment	Cumulative		Start		End		
Phase 1	~180	~180	from	2024	to	Life of Mine	$	180 ac x $1,500 = $ 270.000
Phase 2	~402	~582	from	>2024	to	Life of Mine	$	180 ac x $1,500 = $ 270,000 402 ac x $1,500 = $ 603,000 582 ac x $1,500 = $ 873,000
Phase 3			from		to		$	
Phase 4			from		to		$	
Phase 5			from		to		$	

(Note: This schedule represents the best prediction of the proposed mining increments at the time the application was prepared. The actual phases and the timing of phases most likely will vary. Unisands, LLC reserves the right to make temporal and spatial changes with regard to the incremental mining schedule. However, Unisands, LLC will provide the ODM with an updated schedule and/or associated maps as required.)

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State of Oklahoma
Department of Mines
2915 N. Classen Blvd., Ste. 213
Oklahoma City, OK 73106

LEGAL ESTATE

Name of Legal Estate Owner: Dan V. Little, individually (owner of 40% interest)

Mailing Address: P.O. Box 618, 202 West Lillie Blvd., Madill, OK 73446

Telephone Number: 580-795-3397 Office, 580-564-5083 Cell

Section(s)	Township	Range	County
15, 16 & 22	5S	4E	Marshall

Is the permit application area owned or leased? Owned ☑ Leased ☐

I, Dan V. Little, individually (Legal Estate Owner) certify that I am the owner of the Legal estate of the property being represented in this Application for a Non-Coal Mining Permit, and that the (Company, Corporation, Individual(s)) UNISANDS, LLC have the right to mine this property.

Signature of Legal Estate Owner: Dan V. Little

Subscribed and sworn to before me this 11 day of December 20 23

My Commission expires 11/21/2027 Notary Public Katie Harp

KATIE HARP NOTARY PUBLIC #23015317 EXP. 11/21/27 STATE OF OKLAHOMA

IF THE OWNER OF THE LEGAL ESTATE OF THE PROPERTY CHANGES, A NEW LEGAL ESTATE FORM MUST BE SIGNED BY THE NEW OWNER OF THE LEGAL ESTATE. IF THERE ARE MULTIPLE OWNERS OF THE PROPERTY ON THIS APPLICATION, A SEPARATE LEGAL ESTATE FORM MUST BE EXECUTED FOR EACH OWNER.

NOTE: The Department of Mines does not have authority to adjudicate property title disputes.

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Oklahoma City, OK 73106

LEGAL ESTATE

Name of Legal Estate Owner: Prudence Little Living Trust, Dated 12/27/2005, Amended and Restated on 6/17/2009(owner of 60% interest)

Mailing Address: P.O. Box 618, 202 West Lillie Blvd., Madill, OK 73446

Telephone Number: 580-795-3397 Office, 580-564-5083 Cell

Section(s)	Township	Range	County
15, 16 & 22	5S	4E	Marshall

Is the permit application area owned or leased? Owned ☑ Leased ☐

I, Dan V. Little, Trustee of the Prudence Little Living Trust (Legal Estate Owner) certify that I am the owner of the Legal estate of the property being represented in this Application for a Non-Coal Mining Permit, and that the (Company, Corporation, Individual(s)) UNISANDS, LLC have the right to mine this property.

Signature of Legal Estate Owner: Dan V. Little

Subscribed and sworn to before me this 11 day of December 20 23

My Commission expires 11/21/2027 Notary Public Katie Harp

KATIE HARP NOTARY PUBLIC #23015317 EXP. 11/21/27 STATE OF OKLAHOMA

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COMPLIANCE AND RELATED INFORMATION

Section 2

ODM Permit Number 2841
(Office Use Only)

Date JANUARY 5, 2025

UNISANDS, LLC			(314) 808-4006
Name of Company, Corporation, Partnership, Individual			Telephone Number
404 WARRIOR ROAD	MCLOUD	OK	74851
Mailing Address	City	State	Zip Code

NOTE: Answer all questions on this form. (If no answer, write "none".) Properly identify and secure any attached exhibits, if used. Please refer to the specific item number of this form.

Identification of Interests - In compliance with Section 460:10-11-5 of the Rules and Regulations for Non-Coal Surface Mining and Reclamation, the APPLICANT is required to furnish the following:

460:10-11-5(b)

1a. Applicant is an Individual or Single Proprietorship If yes, provide Social Security # _____

1b. Applicant is a: Joint Venture ☐ Partnership ☐ Other LLC

2a. Please provide the names of every officer, partner, director, or other person performing similar to director of the applicant.

Name	Address	City	State	Zip	Position
DEE JAY HUCKIE	404 WARRIOR ROAD	MCLOUD	OK	74851	PRESIDENT
AGOSTINHO CALCADA	404 WARRIOR ROAD	MCLOUD	OK	74851	VICE-PRESIDENT
JEFFERSON ROCHE	404 WARRIOR ROAD	MCLOUD	OK	74851	SECRETARY
WILLIAM SHEPHARD	404 WARRIOR ROAD	MCLOUD	OK	74851	TREASURER

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460:10-11-5(c)

Did the applicant, partner, or corporation or subsidiary of, operate a non-coal surface mining operation in the State of Oklahoma within the five (5) years preceding the date of the application? Yes ☒ No ☐

If yes, answer the following:

PONTOTOC SANDS PS1	**N/A**	**PONTOTOC**	**Parts of: 25-1N6E 7 30 1n7E**	**1995**
Name of Mine	City	County	Legal Location of Mine	Permit #
Name of Mine	City	County	Legal Location of Mine	Permit #
Name of Mine	City	County	Legal Location of Mine	Permit #
Name of Mine	City	County	Legal Location of Mine	Permit #
Name of Mine	City	County	Legal Location of Mine	Permit #

Please include any additional mining operations on a separate sheet.

Compliance Information

460:10-11-6(1)

1. Has the applicant for the permit, or any subsidiary, affiliate or by or under common control with the applicant:

460:10-11-6(1)(A)

1a. Had a federal or state mining permit suspended or revoked in the last five (5) years? ☐ Yes ☒ No

460:10-11-6(1)(B)

1b. Forfeited a mining bond or similar security deposited in lieu of bond? ☐ Yes ☒ No

460:10-11-6(2)

2. If the answer to either 1a or 1b above was yes, applicant should provide the following information:

460:10-11-6(2)(A)

2a. Permit Identification # N/A , or Amount of bond $ _____

2b. Provide the name of the authority that suspended or revoked a permit or forfeited a bond:
N/A

Provide the reason for such action:
N/A

460:10-11-6(2)(B)

2c. What is the current status of the permit, bond or similar security involved?

N/A

460:10-11-6(2)(C)

2d. Provide the date, location and type of any administrative or judicial proceedings initiated concerning the suspension, revocation or forfeiture:

N/A

Date Location Type

460:10-11-6(2)(D)

2e. What is the current status of these proceedings? N/A

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APPLICATION FOR PERMIT TO ENGAGE IN NON-COAL MINING

The Mining Lands Reclamation Act, O.S., 2016 721-728

Section 3

ODM Permit Number 2841
(Office Use Only)

Date JANUARY 18, 2024

UNISANDS, LLC	(314) 808-4006
Name of Company, Corporation, Partnership, Individual	Telephone Number

404 WARRIOR ROAD	MCLOUD	OK	74851
Mailing Address	City	State	Zip Code

☒ Yes ☐ No 1. Will the operation involve crushing or any other air contaminant emissions?

If you indicated yes, please be advised that a permit may be required from the Air Quality Division of the Oklahoma Department of Environmental Quality. Please contact the agency for their respective requirements.

☒ Yes ☐ No 2. Will explosives be used?

If you indicated yes, review the enclosed Blasting Regulations and complete the enclosed Blasting Plan. Said plan should accompany the application upon submission. If a Blasting Plan does not accompany the application and explosives will be used, then a permit will not be issued until a plan is secured.

☒ Yes ☐ No 3a. Will the operation involve washing the material mined, recycling processed water or other water handling?

☒ Yes ☐ No 3b. Will the operation involve dewatering the mine or discharging fresh or wastewater from the mine or plant?

☒ Yes ☐ No 3c. Does the operation fall within the jurisdictional requirements of the stormwater regulations of the Oklahoma Department of Environmental Quality?

If you indicated yes to either 3a, 3b, or 3c, please be advised that a permit may be required from either the Department of Environmental Quality, Oklahoma Water Resources Board, or the Army Corps of Engineers. Please contact each agency for its respective requirements.

☐ Yes ☒ No 4. Will this operation involve removing minerals from within any boundaries of a river or streambed?

If you indicated yes, please complete the following questions regarding the type of stream and its name and location. If you indicated no, please proceed to Section 4.

5a. What is the name of the stream or river? **N/A**

5b. Which of the following classifies this stream or river? Please refer to OAC 460:10-13-2 for descriptions of each.

b.

☐ High Quality Water (HQW)

☐ Outstanding Resources Waters (ORW)

☐ Scenic River Area

☒ None of the above

Please note: Certain permitting and operating procedures are required for mining permits in these environmental areas. Please refer to 460:10-13-3 for the requirements.

☐ Yes ☒ No 6. Does your operation overlie a sensitive sole source groundwater basin or subbasin?

Effective August 1, 2011, if you indicated yes, this operation falls within the permitting guidelines established by SB 597. You must contact the Oklahoma Water Resources Board to comply with additional permitting requirements.

7. How wide a buffer will be maintained between any mining activity and any mining permit boundary or right-of-way at this site? Show all buffer locations and widths on the mine map(s). All buffers must be located with the permit boundaries.

BUFFER WILL MEET LATERAL SUPPORT REQUIREMENTS SPELLED OUT IN OS TITLE 45, CHAPTER 8, SECTION 730.

O.S. Title 45, Chapter 8, Section 730 "In the case of strip mining operations which remove and do not replace lateral support, unless pursuant to written agreement between the operator and the adjacent property owner, the top of the consolidated material of the open cut adjacent to the property line of other property not owned or leased by the operator shall, at the time mining is completed, not be closer to such other property line than a distance of twenty-five (25) feet plus one and one-half (1 1/2) times the depth of such cut as measured from original ground surface to the top of consolidated material."

OTHER LICENSES AND PERMITS

☒ Yes ☐ No

8. Has any other agency, local, county, state, or federal, been contacted to ascertain the need for other licenses and permits with respect to this operation?

If you indicated no other agencies have been contacted, please be advised failure to obtain all the permits necessary for a mining operation may result in issuance of a permit violation or an interruption in mining activity until the required permits are secured.

Please refer to the *Non-Coal Permitting Guidelines and Summary* and the Notice below regarding other possible governing entities that may need to be contacted. Provide a list of all other licenses and permits needed for this mining operation. If a license or permit has been issued, please provide the Permit Identification Number and date of Approval or a copy of said permit or license. (Title 45 § 724 I.) If a permit or license is pending, please provide copies of your applications or Notices of Intent (N.O.I.) that have been submitted to other agencies.

If this application is for a revision to an existing permit, copies of all issued permits must be included.

AGENCY	IDENTIFICATION NUMBER	DATE OF APPROVAL
Department of Environmental Quality	OKR05 Storm Water Discharges Associated with Industrial Activity General OKR054285	ISSUED Submitted 1/10/2024
Oklahoma Water Resources Board	ASA Pit Water Determination Letter Request	Pending Submitted 12/21/2023

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Please Note: A special permit to operate within certain municipalities or counties may be required. It is the responsibility of each applicant to contact the appropriate city or county officials to determine if the mining operation falls within their respective jurisdiction.

SPECIALIZED PROCESSING OR MANUFACTURING

☐ Yes ☒ No

9. Will specialized processing or manufacturing be conducted on site with the material mined that is not directly associated to mining? This includes specialized processing of the material ***after*** mining and processed by a plant site immediately after excavation of the material. This product would be unique in nature and produced from the material mined. This specialized processing or manufacturing facility might not be part of the mining process, and thereby, not included in the permit area requested in the application.

If "yes" was indicated, please provide ODM with a detailed narrative of the activity. The location of the specialized processing facility will need to be disclosed on the mining map. The description of the activity should include the product manufactured, the point at which the mining process ceases, and the manufacturing begins, (specialized process). The description should include the equipment used and a flow chart showing the process. Once the description of the process is reviewed, a determination of applicability will be made by the Department. If the Department finds that the process is not directly associated with the mining, this area may be removed from permit consideration.

LIST OF OTHER LICENSES & PERMITS NEEDED FOR THIS MINING OPERATION

Unisand, LLC has obtained the necessary permits to begin mining operations. Other federal, state and/or local permits, licenses, and/or approvals will be applied for as part of the planning, construction, and operation of this facility as needed and/or when required. Copies of any documents will be forwarded to the ODM when applied for and/or when issued.

TYPE OF PERMIT	ISSUING AGENCY/ENTITY	PERMIT NAME/NUMBER	COMMENT/STATUS
Air Permit	Department of Environmental Quality (DEQ) PO Box 1677, Oklahoma City, OK 73101	Minor Source General Permit For Nonmetallic Mineral Processing Facilities (or other) (Construction)	Will be applied for once activities requiring an air permit are initiated
Storm Water Permit	Department of Environmental Quality (DEQ) PO Box 1677, Oklahoma City, OK 73101	OKR05 Storm Water Industrial General Permit	**Industrial Permit Authorization OKR054285** (Issued – 1/10/2024)
Process Water Permit	Department of Environmental Quality (DEQ) PO Box 1677, Oklahoma City, OK 73101	OKG950000 General Wastewater Permit For Rock, Sand And Gravel Quarries	Will be applied for once activities requiring a process water permit are initiated
Pit Water	Oklahoma Water Resources Board (OWRB) 3800 N Classen Blvd. Oklahoma City, OK 73118	Pit Water Use Determination	**Concurrence Letter** (Submitted 12/21/2023)
Floodplain Permit	Marshall County	Floodplain Development Permit	Will be applied for once activities requiring a floodplain development permit are initiated (if at all)

Form PNR & OP; Sec.3/Rev. 07-18

DEQ Form 606-002B July 5, 2022

Oklahoma Department of Environmental Quality
Notice of Intent (NOI)
for Stormwater Discharges Associated with Industrial Activity under the OPDES Multi-Sector General Permit OKR05

Submission of this NOI constitutes notice that the party identified in Section I of this form intends to be authorized by DEQ for Stormwater Discharges Associated with Industrial Activity in the State of Oklahoma. Becoming a permittee obligates such discharger to comply with the terms and conditions of the OKR05 permit. To obtain an authorization from DEQ, this form must be completed with all the pertinent information.
See instructions for completing the NOI on pages 4 and 5 of this form.

☑ NEW APPLICATION ☐ MODIFICATION or ☐ RENEWAL of current permit, enter the authorization number: OKR05_____

I. Operator Information

Operator Name: UNISANDS, LLC Phone: 3148084006

Mailing Address: 404 WARRIOR ROAD City: MCLOUD

State: OK Zip Code: 74851 Web Address (URL): _____

Operator's Point of Contact : DEE JAY HUCKIE Title: PRESIDENT

Phone: 3148084006 E-mail: HUCKIE.DEEJAY@GMAIL.COM

II. Facility Information

Facility Name: OTEKA QUARRY Phone: 3148084006

Facility Address: SECTIONS 15, 16 & 22, T5S, R4E

City: MADILL County: MARSHALL Zip Code: 73446

Facility's Point of Contact : DEE JAY HUCKIE Title: PRESIDENT

Phone: 3148084006 E-mail: HUCKIE.DEEJAY@GMAIL.COM

Facility's Type of Ownership: ☐ Federal ☐ State ☐ Municipal ☐ Public ☑ Private

Latitude: 34.121689 ° N Longitude: -96.881036 ° W at the entrance of the Facility in decimal degrees

Facility's Legal Location: ____ ¼, ____ ¼, ____ ¼ of the Section: 16 Township: 5S N/S Range: 4E E/W, Indian Meridian

SIC or Designated Activity Code and Sector: Primary: 1422 Sector: J Secondary: _____ Sector: _____

Total Area of the Facility: 627 (acres) Total Impervious Area at the Facility: 3 (acres)

Estimated Area of Industrial Activity at your Facility exposed to Stormwater: 627 (acres)

Endangered Species Eligibility

a. ☑ My facility is not located in or draining to Federal and/or State sensitive waters and/or watersheds.

b. ☐ My facility is located in or drains to Federal and/or State sensitive waters and/or watersheds and I agree to implement the control measures specified in Step 2 of Appendix A.

c. ☐ I am relying on another permittee's certification of eligibility and agree to comply with any conditions of that certification.

III. Facility Discharge Information

Does the facility discharge stormwater into an MS4? ☐ Yes ☑ No, If yes, name of the MS4 Operator: N/A

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Is the facility's stormwater discharge covered by a separate individual or general permit? ☐ Yes ☑ No, If yes, enter the OPDES Permit Number: N/A

Is the facility's stormwater discharge subject to impaired water monitoring? ☐ Yes ☑ No

Is the facility required to submit an electronic Discharge Monitoring Report due to a sector-specific requirements? ☑ Yes ☐ No

If yes, what is your applicable sector? Mark one of the following sectors applicable to your facility:

Sector	40 CFR Part/ Subpart	Do you have one of the following discharges?	Mark Your Response
☐ A	Part 429 Subpart I	Discharges resulting from spray down or intentional wetting of logs at wet deck storage areas	☐ Yes ☐ No
☐ C	Part 418 Subpart A	Runoff from phosphate fertilizer manufacturing facilities that comes into contact with any raw materials, finished product, by-products or waste products	☐ Yes ☐ No
☐ D	Part 443 Subpart A	Runoff from asphalt emulsion facilities	☐ Yes ☐ No
☐ E	Part 411 Subpart C	Runoff from material storage piles at cement manufacturing facilities	☐ Yes ☐ No
☒ J	Part 436 Subparts B, C, & D	Mine dewatering discharges at crushed stone, construction sand and gravel, or industrial sand mining facilities	☑ Yes ☐ No
☐ K	Part 445 Subpart A & B	Runoff from hazardous waste landfills and non-hazardous waste landfills	☐ Yes ☐ No
☐ L			☐ Yes ☐ No
☐ O	Part 423	Runoff from coal storage piles at steam electric generating facilities	☐ Yes ☐ No
☐ S	Part 449	Runoff from airfield pavement areas where deicing/anti-icing activities occur	☐ Yes ☐ No

Outfall and Receiving Water Information

Outfall ID	Latitude/ Longitude	Name of the Receiving Waterbody	Is this waterbody impaired? If so, what are its impairments?	Is there a TMDL for that impairment?
001	34.128964°	UNNAMED TRIB TO TURKEY CREEK	☐ Yes ☑ No	☐ Yes ☑ No
	-96.877125°			
002	34.126269°	UNNAMED TRIB TO TURKEY CREEK	☐ Yes ☑ No	☐ Yes ☑ No
	-96.870097°			
003	34.125083°	UNNAMED TRIB TO TURKEY CREEK	☐ Yes ☑ No	☐ Yes ☑ No
	-96.868067°			
004	34.122975°	UNNAMED TRIB TO TURKEY CREEK	☐ Yes ☑ No	☐ Yes ☑ No
	-96.877439°			
005			☐ Yes ☐ No	☐ Yes ☐ No
006			☐ Yes ☐ No	☐ Yes ☐ No
007			☐ Yes ☐ No	☐ Yes ☐ No

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Note: use additional sheet of paper if the facility has more than 7 outfalls.

IV. Stormwater Pollution Prevention Plan (SWP3) Information

Has the SWP3 been prepared in accordance with 2022 OKR05 Permit in advance of filing this NOI? ☑ Yes ☐ No

Is the SWP3 properly certified and available at the Facility? ☑ Yes ☐ No

SWP3 Preparer Contact Information:

Is your facility's point of contact also your SWP3 preparer? ☐ Yes ☑ No, If no, enter the contact information of your SWP3 Preparer:

Full Name : GEOFF CANTY Title: ENVIRONMENTAL MGR

Company Name: CC ENVIRONMENTAL Address: P.O. BOX 1292

City: NORMAN State: OK Zip Code: 74851

Phone: 4053218181 E-mail: geoff@ccenviro.net

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SWP3 Availability: You must maintain your SWP3 up-to-date and make it available at the site.

Did you post your current SWP3 on your Company/Business's website? ☐ Yes ☑ No

If yes, provide the web address (URL) of your SWP3 location: _____

Proposed **Best** Management Practices to control pollution in the stormwater discharges, check all that apply:

☐ Sediment Basin	☒ Sediment Trap	☒ Ret/Detention Pond	☐ Vegetated Buffer
☐ Vegetative Swale	☐ Runoff Infiltration	☒ Runoff Diversion/Berm	☐ Inlet Protection
☒ Secondary Containment	☐ Dust Collection System	☐ Covered Material Storage	☐ Indoor Vehicle Maint.
☒ Good housekeeping	☒ Employee Training	☒ Spill Prevention Plans	☐

V. Required Documents and Fees

☑ A general location map of your facility showing all the features required by Part 6.2.24 of the OKR05 permit

☑ A site map or series of maps showing all the features required by Part 6.2.2.5 of the OKR05 permit

☑ Applicable fees (application fee and annual fee) in accordance with DEQ Regulation OAC 252:606

VI. Certification

I certify under penalty of law that I have read and understand Part 1 of the permit eligibility requirements for coverage under the Industrial Stormwater General Permit OKR05, including those requirements relating to the protection of endangered or threatened species or critical habitat in Appendix A of the OKR05 permit. Furthermore, this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations. I understand that continued coverage under the Stormwater Multi-Sector Industrial General Permit OKR05 is contingent upon maintaining eligibility as provided for in Part 1 of the Permit.

Print Name: DEE JAY HUCKIE Title: PRESIDENT

E-mail: HUCKIEDEEJAY@GMAIL.COM

Signature: _____ Date: 12/8/2023

For DEQ use only: Assigned Authorization Number: OKR05_____

CC Environmental, LLC

December 20, 2023

VIA EMAIL

Mr. Matt Cogburn
OWRB – Planning & Management Division
3800 N Classen Blvd
Oklahoma City, OK 73118

Re: Arbuckle-Simpson Aquifer Determination
Unisands, LLC – Oteka Quarry

Mr. Cogburn:

On behalf of my client, Unisands, LLC, (Unisands) I am asking for your concurrence that the property described below is not located within the Arbuckle-Simpson Aquifer boundary and, therefore, would not be subject to 82 O.S. §1020.2 or 82 O.S. §1020.9C or any rules associated with those statutes. Please confirm the following:

- Unisands is ***not*** considered to be a "subject mine" as per 82 O.S. §1020.9C (A);
- Unisands is ***not*** subject to the moratorium regarding any permitting, regulatory, or compliance issues as per 82 O.S. §1020.9C.
- Unisands is ***not*** subject to the provisions spelled out in 82 O.S. §1020.2 as per 82 O.S. §1020.2 (B);
- Unisands does ***not*** need an OWRB permit for the taking, using and/or disposing of water that becomes trapped within its mine pit as per OAC 785:30-13-2 and;
- Unisands is allowed to take, use, and/or dispose of water that becomes trapped within its mine pit independent of the rules set forth in OAC 785:30-15 as per 785:30-15-1(b);

Please find attached general location maps to assist you with your review.

LEGAL DESCRIPTION:
Parts of Sections 15, 16, & 22 all within Township Five (5) South, Range four (4) East, Indian Base and Meridian, Marshall County, Oklahoma.

LAT/LONG: (at gate)
34.121889 / -96.881036

Your written response within the next 30 days would be greatly appreciated. Please feel free to contact me (geoff@ccenviro.net, 405/761-1225) if you need additional information.

Sincerely,

Geoffrey A. Canty

cc: File

enclosures

3533 National Drive, Norman, OK 73069 | PO Box 1292 Norman, OK 73070
Phone: (405) 321-8181 | Fax: (405) 307-9290

State of Oklahoma
Department of Mines
2915 N. Classen Blvd., Ste. 213
Oklahoma City, OK 73106

BLASTING PLAN
For Non-Coal Mining Blasting

DATE **JANUARY 5, 2024**

OPERATOR **UNISANDS, LLC**

STATE MINING PERMIT # **PENDING** 2841 **MINE NAME** **OTEKA QUARRY**

LEGAL DESCRIPTION **PARTS OF SECTIONS 15, 16 & 22, T5S, R4E IM, MARSHALL COUNTY TOTALING 627 ACRES MOL**

PHYSICAL LOCATION **~11 MILES WEST OF MADILL ON US-70 & SIMPSON RD.**

MAILING ADDRESS **404 WARRIOR RD., MCLOUD, OK 74851**

Is Contract Blast Service Utilized? **X** Yes or ☐ No

NAME OF CONTRACT SERVICE **BUCKLEY POWDER COMPANY, INC.**

MAILING ADDRESS OF CONTRACTOR **PO BOX 59, MILL CREEK, OK 74856**

DISCLOSURE OF STRUCTURES AND EASEMENTS – BLASTING PLAN ATTACHMENT must be included with Blasting Plan. A list of all structures and their current uses should be provided on this form. All easements and utilities should be listed including all liquid, gas and electric transmission lines. A plan to protect these structures must be provided, including but not limited to, prohibitive distances as outlined in the rules.

BLASTERS' CERTIFICATIONS – OAC 460:10-31-11 (h) states "The blaster certification shall be carried by the blaster or a copy shall be on file at the blasting area during the blasting operation."

Time of Blasting: All Blasting shall be conducted between sunrise and sunset pursuant to OAC 460:10-31-8 (a). If a blast occurs outside these hours, a written report must be submitted to ODM as required by OAC 460:10-31-8 (b). It is ODM's intent that blasting shall be conducted to prevent injury to any person or damage to any property. **NOTICE:** OAC 460-10-31-8 (a) (1) states, *"The Department may specify more restrictive time periods, based upon public requests or other relevant information, according to the need to adequately protect the public from adverse noise".*

In compliance with Section 460:10-31-6, the following detailed Blasting Plan is submitted:

ABBREVIATION OF RULES

460:10-31-6(1): Type of Explosives used:

ELECTRONIC DETONATORS, NON-ELECTRIC DETONATORS, CAST BOOSTERS, DETONATING CORD, ANFO, EMULSION, AND ANFO/EMULSION BLENDS.

460:10-31-6(1): Appropriate Amount Explosives:

THE BLAST WILL BE DESIGNED TO PREVENT INJURY TO PERSONS AND/OR DAMAGE TO PUBLIC OR PRIVATE PROPERTY OUTSIDE THE PERMIT AREA. THE AMOUNT OF EXPLOSIVE WILL VARY DEPENDING ON THE BENCH HEIGHT, HOLE DIAMETER, AND SURROUNDING STRUCTURES. THE AMOUNT OF EXPLOSIVES USED WILL MEET THE REQUIREMENTS OF 460:10-31-8. IN ORDER TO ENSURE THAT THE REQUIREMENTS OF 460:10-31-8 ARE MET, A SEISMOGRAPH WILL BE SET AT THE NEAREST DWELLING.

460:10-31-6(2): Description of Procedure:

BUCKLEY POWDER CO. WILL ADHERE TO ALL BUCKLEY POWDER CO.'S PROCEDURES AND ALL STATE AND FEDERAL REGULATIONS FOR QUARRY BLASTING. PROCEDURES INCLUDE A SAFETY MEETING WHICH WILL COVER ALL SAFETY PROCEDURES FOR HANDLING EXPLOSIVES BEFORE ANY SHOT LOADING BEGINS.

460:10-31-6(2): Plans for Recording and Retention:

A COPY OF THE RECORD FOR EACH BLAST WILL BE RETAINED FOR A MINIMUM OF THREE YEARS. ALL RECORDS WILL HAVE THE INFORMATION REQUIRED BY 460:10-31-10 (RECORDS FOR BLASTING OPERATIONS) AND WILL BE AVAILABLE FOR INSPECTION BY THE AUTHORITY HAVING JURISDICTION.

460:10-31-6(3): Blasting Warning:

PRIOR TO BLASTING, THE QUARRY SUPERVISOR WILL BE NOTIFIED. ROADS WILL BE BLOCKED AND ALL ADJACENT AREAS INCLUDING PIT AREA CHECKED. THREE (3) SHORT SIRENS OR AIR HORN BLAST WILL BE DONE ONE (1) MINUTE PRIOR TO BLASTING. AFTER THE SHOT, THE BLASTER IN CHARGE WILL CHECK THE BLAST SITE FOR UNFIRED EXPLOSIVES OR UNSAFE CONDITIONS. AFTER CHECKING, A LONG SIREN OR AIR HORN BLAST WILL BE CONDITIONS FOR THE CLEAR SIGNAL.

460:10-31-7: Control Procedures for Blasting Site:

BLASTING SIGNS WILL BE POSTED AT THE ACCESS POINTS TO THE BLAST SITE. NO MINING OR QUARRYING ACTIVITY WILL BE ALLOWED WITHIN FIFTY (50') FEET OF THE BLAST SITE. ONLY EQUIPMENT AND PERSONNEL THAT ARE REQUIRED FOR BLASTING OPERATIONS WILL BE ALLOWED AT THE BLAST SITE. AFTER THE SHOT HAS BEEN FIRED AND THE DUST HAS SETTLED, THE BLASTER IN CHARGE WILL APPROACH THE BLAST SITE FROM THE REAR OR SIDE. THE BLASTER IN CHARGE WILL CHECK THE FACE AND MUCK PILE TO VERIFY THAT ALL HOLES HAVE FIRED. IF ALL HOLES HAVE FIRED, HE WILL ANNOUNCE ON THE RADIO: "ATTENTION ALL UNITS. WE HAVE AN ALL CLEAR." THE BLASTER IN CHARGE WILL RECEIVE AN ALL CLEAR RESPONSE FROM EACH GUARD BEFORE PEOPLE AND MACHINERY ARE ALLOWED TO RE-ENTER THE BLAST AREA.

460:10-31-9: Seismograph Use:

Will a seismograph be utilized for compliance purposes? **X** Yes or ☐ No.

If yes is indicated, a copy of the seismographic records will be retained and made part of each blasting record in accordance with 460:10-31-10 (11).

State Mining Permit # _____.

BLASTING PLAN
ATTACHMENT

1. List all buildings on the proposed permit area and adjacent area and indicate their current use:

	BUILDING	DESCRIPTION	LAT/LONG
1	Future Unisands Office & Shop Buildings	Proposed Administration & Operations	TBA
2	Austin Williams Farmstead (Residence & Barn)	Residence & Agriculture	34.1549° -96.88474°
3	Chris & Linda Bradshaw Farmstead (Residence & Barns)	Residence & Agriculture	34.12754° -96.88404°
4	Bradley Dodd Farmstead (Residence & Barns)	Residence & Agriculture	34.11920° -96.86354°
5	Randall & Cynthia Rushing Farmstead (Residence & Barns)	Residence & Agriculture	34.11393° -96.86475°
6	Randall & Cynthia Rushing Barn	Agriculture	34.10832° -96.86738°
7	Tabatha Scasta Residence	Residence	34.10771° -96.86721°
8	Jeffrey Landgraf Residence	Residence	34.10274° -96.86670°
9	Cody & Kelli Bradshaw	Commercial	34.09860° -96.86690°
10	Mary & Ray Robertson Farmstead (Residence & Barns)	Residence & Agriculture	34.09840° -96.87739°
11	Prudence Little Living Trust Farmstead (Residence & Barns)	Residence & Agriculture	34.10070° -96.87818°
12	Jed Hoppers (Lucky Pup Lodge)	Commercial	34.09921° -96.88386°
13	Cell Tower	Utility	34.10193° -96.88012°
14	Doug Schneider Farmstead	Agriculture	34.10404° -96.88425°
15	Fred Huebsch Barn	Agriculture	34.11484° -96.88120°
16	Cell Tower	Utility	34.10442° -96.88656°

2. (A) Indicate which of the following structures and/or easements for such structures are located within the proposed permit area: **(OVERHEAD ELECTRIC LINES ARE WITHIN, BUT GAS, WATER AND OTHERS ADJOIN THE PERMIT BOUNDARY.)**

XX Electric transmission lines
☐ Gas or oil pipelines
☐ Water or sewer pipelines
☐ Oil, gas or water wells
☐ Railroads
☐ Telephone cables or lines

(B) Show the location of all structures indicated above on a Location Map. A section grid map may be utilized. **SEE ATTACHED**

(C) Describe the measures to be taken to minimize damage, destruction, or disruption of services provided by any of the above structures: **WILL DESIGN SHOTS TO KEEP VIBRATIONS LOW AND USE SMALLER DIAMETER HOLES TO REDUCE AMOUNT OF POWDER USED.**

State of Oklahoma
Department of Mines
2915 N. Classen Blvd., Ste. 213
Oklahoma City, OK 73106

CERTIFIED BLASTERS

FOR INFORMATIONAL PURPOSES ONLY

OAC 460:10-31-11 (h) states "The blaster certification shall be carried by the blaster or a copy shall be on file at the blasting area during the blasting operation."

BLASTER'S STATE CERTIFICATION #: 1413

ISSUED DATE: 08/19/2022 **EXPIRATION DATE:** 08/31/2024

FRANK J. SMITH — 580-504-0177
Name of Certified Blaster — Telephone Number

BLASTER'S STATE CERTIFICATION #: 1880

ISSUED DATE: 11/18/2022 **EXPIRATION DATE:** 11/30/2024

CHRIS A. LUCKINBILL — 580-369-1865
Name of Certified Blaster — Telephone Number

BLASTER'S STATE CERTIFICATION #: 1868

ISSUED DATE: 11/17/2023 **EXPIRATION DATE:** 11/30/2025

TAYLER J. SMITH — 580-219-0209
Name of Certified Blaster — Telephone Number

BLASTER'S STATE CERTIFICATION #: 1750

ISSUED DATE: 08/19/2022 **EXPIRATION DATE:** 08/31/2024

JESSIE J. SCOTT — 580-224-7308
Name of Certified Blaster — Telephone Number

BLASTER'S STATE CERTIFICATION #: 1751

ISSUED DATE: 08/19/2022 **EXPIRATION DATE:** 08/31/2024

TODD A. SMITH — 580-220-8451
Name of Certified Blaster — Telephone Number

State of Oklahoma
Department of Mines
2915 N. Classen Blvd., Ste. 213
Oklahoma City, OK 73106

CERTIFIED BLASTERS

FOR INFORMATIONAL PURPOSES ONLY

OAC 460:10-31-11 (h) states "The blaster certification shall be carried by the blaster or a copy shall be on file at the blasting area during the blasting operation."

BLASTER'S STATE CERTIFICATION #: 1457

ISSUED DATE: 02/17/2023 **EXPIRATION DATE:** 02/28/2025

RICKY J. BUCHANAN — 580-224-7656

Name of Certified Blaster — **Telephone Number**

Date: 08/19/2022
Expires: 08/31/2024

OMTI ID: 10830
Certificate NO: 1413

STATE OF OKLAHOMA
MINING COMMISSION
BLASTER CERTIFICATE

This certifies that **FRANK J. SMITH**
has completed the requirements of a Certified Blaster
as prescribed by the Oklahoma Department of Mines.

Michael Reed
Director

Date: 11/18/2022
Expires: 11/30/2024

OMTI ID: 4
Certificate NO: 1880

STATE OF OKLAHOMA
MINING COMMISSION
BLASTER CERTIFICATE

This certifies that **CHRIS LUCKINBILL**
has completed the requirements of a Certified Blaster
as prescribed by the Oklahoma Department of Mines.

Michael Reed
Director

Date: 11/17/2023
Expires: 11/30/2025

ONITI ID: 16259
Certificate NO: 1969

STATE OF OKLAHOMA
MINING COMMISSION
BLASTER CERTIFICATE

This certifies that **TAYLER J SMITH**
has completed the requirements of a Certified Blaster
as prescribed by the Oklahoma Department of Mines.

Director

Date: 08/19/2022
Expires: 08/31/2024

OMTI ID: 8317
Certificate NO: 1750

STATE OF OKLAHOMA
MINING COMMISSION
BLASTER CERTIFICATE

This certifies that **JESSIE SCOTT**
has completed the requirements of a Certified Blaster
as prescribed by the Oklahoma Department of Mines.

Michael Reed
Director

Date: 08/19/2022
Expires: 08/31/2024

OMTI ID: 7973
Certificate NO: 1751

STATE OF OKLAHOMA
MINING COMMISSION
BLASTER CERTIFICATE

This certifies that **TODD SMITH**
has completed the requirements of a Certified Blaster
as prescribed by the Oklahoma Department of Mines.

Director

Date: 02/17/2023
Expires: 02/28/2025

OMTI ID: 7331
Certificate NO: 1457

STATE OF OKLAHOMA
MINING COMMISSION
BLASTER CERTIFICATE

This certifies that **RICKY J. BUCHANAN**
has completed the requirements of a Certified Blaster
as prescribed by the Oklahoma Department of Mines.

Michael Reed
Director

API
3509500001

NOTE 1: THE PROPOSED 500-FOOT BLASTING OFFSET MAY BE REVISED ONCE MORE INFORMATION IS AVAILABLE REGARDING THE GEOLOGIC FORMATION AND ARRANGEMENTS WITH THE PIPELINE COMPANY ARE MADE.

U/G GAS PIPELINE

API
350651463
(NO WELL)

~500'

FUTURE
RESERVES

~500' PIPELINE
BLASTING OFFSET

BONDED
BOUNDARY

3
BRADSHW
FARMSTEAD

2
AUSTIN
FARMSTEAD

1
UNISANDS QUARRY
PROPOSED OFFICE,
SSCALE & SHOP

ENTRANCE

MINE PERMIT
BOUNDARY

SIMPSON RD.

4
DODD
FARMSTEAD

FUTURE
RESERVES

15
HUEBSCH
BARN

STOWERS RD.

5
RUSHING
FARMSTEAD

O/H ELECTRIC

6
BARN

SCASTA
RESIDENCE
7

FUTURE
RESERVES

CELL
TOWER
16

14
SCHNEIDER
FARMSTEAD

8
LANDGRAF
RESIDENCE

CELL
TOWER
13

API
3509520089

11
LITTLE TRUST
FARMSTEAD

U/G WATER PIPELINE

70

U/H ELECTRIC

12
HOPPERS
COMMERCIAL

10
ROBERTSON
FARMSTEAD

BRADSHAW
COMMERCIAL
9

API
3509501285

N

COMMENTS/LEGEND

- PERMIT BOUNDARY
- BONDED AREA
- COUNTY ROAD
- SECTION LINE
- MAPPED STREAM
- UTILITY LINE (UG)
- UTILITY LINE (OH)
- COMMON ACCESS RD
- 500' BLASTING OFFEST
- REPORTED WATER WELL
- POND
- OILFIELD SITE/WELL
- PLUGGED WELLSITE

BLASTING PLAN MAP

Unisands, LLC
Oteka Quarry
Marshall County, Oklahoma

UNISANDS

Figure
BP-1

Environmental
PO BOX 1292 NORMAN OK 73070

DRWN BY: AJC APPRVD BY:
CHKD BY:

1/15/2024

DRAFT

State Mining Permit # _____

VERIFICATION AND EXECUTION OF BLASTING PLAN

It is our desire and intent that blasting shall be conducted to prevent injury to any person or damage to any property. It is also our intent to comply with all regulations set forth under 460:10-31-6 (Blasting and Use of Explosives) of State of Oklahoma, Department of Mines, Non-Coal Surface Mining and Reclamation Rules and Regulations.

We, the undersigned, under penalty of perjury, declare the information in this document and any attachments signed, in accordance with the Oklahoma Mining Statutes and Non-Coal Regulations, to be true and correct to the best of our knowledge and belief.

BLASTER:

Frank Smith
Printed Name of Blaster

1413
State Certificate Number

Frank J Smith
Signature of Blaster

12/19/2023
Date

MINE OFFICIAL (SURFACE SUPERVISOR):

_____
Printed Name of Supervisor

_____
State Certificate Number

_____
Signature of Supervisor

_____
Date

State of Oklahoma
Department of Mines
2915 N. Classen Blvd., Ste. 213
Oklahoma City, OK 73106

NON-COAL OPERATOR'S RECLAMATION PLAN

Section 4

ODM Permit Number 2841
(Office Use Only)

Date JANUARY 18, 2024

UNISANDS, LLC
Name of Company, Corporation, Partnership, Individual

OTEKA QUARRY
Mine Name or No.

Reclamation plan covers: ~582 permitted acres and ~180 bonded acres

General Reclamation Plan

Use of Land when Reclamation is Completed
(Check one or more; show acreage)
Please note: Acreage must total the entire permitted acreage.

☐	1. Pasture		☐	2. Farmland	
☐	3. Forest		☐	4. Water Reservoir	
☒	5. Recreation	~562 ACRES	☒	6. Industrial	~20 ACRES
☐	7. Residential				
☐	8. Other			Explain:	
☐	9. None			Explain:	

What will you do to make land usable for purpose stated above?
(Check one or more)

☐	10. Fill	☒	11. Level	☒	12. Grade
☒	13. Plant Grass	☐	14. Sprig or Sod Grass	☐	15. Set out Trees
☐	16. Build Dam	☐	17. Stock with Fish	☐	18. Stock with Game
☐	19. Other				
☒	20. None (Explain)	AS APPLICABLE PER TITLE 45 SECTION 725 G			

☐ Yes ☒ No 21. Does the mineral seam contain acid-forming materials?
If yes, please complete Question #3 of the Attachment forms.

Reclamation Attachments and Narratives addressing each and every issue as outlined in the Rules & Regulations must be part of your Reclamation Plan and attached to this form.

RECLAMATION PLAN ATTACHMENT

1. Revegetation Plan:

(A) Planned soil tests:

The site will be developed for future "Industrial" and "Recreation" land uses. Vegetation would not be conducive to industrial land use so planned soil tests are not anticipated in those areas. However, it is anticipated that some portions of the recreational area may be vegetated or be reclaimed with vegetation (e.g., banks, slopes). Where applicable, soil tests are anticipated.

Areas that will be returned to vegetation will be assessed as part of the reclamation process. Once the site has been graded and prepared for planting, soil fertility tests will be performed to determine nutrient availability and supplemental need. In general, the number of tests and the methodology will follow NRCS, OSU Extension (e.g., OSU Circular F2207), or other accepted resources.

For areas not vegetated, areas of exposed bedrock, and other areas with deficient chemical and physical characteristics, the re-vegetation plan requirements are not applicable per Title 45 Section 725 G. *"No planting of any kind shall be required on any affected land so long as the chemical or physical characteristics of the soil of such affected land are toxic, deficient in plant nutrients, or composed of sand, gravel, shale, or stone to such an extent as to seriously inhibit plant growth."*

(B) Site preparation and fertilization:

No fertilizers will be applied to the "Industrial" land use area, except in location where vegetation is planted.

"Recreation" land us areas that will be reclaimed with vegetation may include general site preparation (e.g., grading) as well as seed bed prep (e.g., tilling, etc.). The area will be prepared to promote the general survivability of vegetation. Accepted resources (e.g., NRCS, OSU Extension, etc.) will be consulted during the site preparation stage. Established volunteer vegetation will not be disturbed or replanted.

If needed, a fertilization plan will be developed based on the several factors (e.g., soil test results, plant species, soil type, etc.). Accepted resources (e.g., NRCS, OSU Extension, etc.) will be consulted when determining, intra alia, the rate, quantity, timing, and type of fertilizer. Potential resources include OSU Extension publications PSS-2225 and PSS 2263.

(C) Seed and plant selection

When applicable, species selection will be based on the specific location. Important factors include slope, topography, soil type, fertility, moisture availability, etc. Areas may be planted with a mixture of forb and/or grass species. Specific selection will follow NRCS, OSU Extension guidance references (e.g., OSU Extension NREM-2872; NREM-2869, etc.) as well as other accepted resources.

(D) Rate of Seeding or amount of planting per acre:

In general, seeding will follow OSU Extension recommendation of 5-10 lbs/ac for Bermuda grass and 3-8 lbs/ac of native grasses (OSE NREM-2581). Specific rates will be adjusted following NRCS, OSU Extension and other accepted.)

(E) Are there other surface treatments that will be performed to the affected land during reclamation?

☐ Yes ☒ No

If yes, please explain

None

1. Describe the method to prevent or eliminate conditions that could be hazardous to animal or fish life in or adjacent to the permit area.

   While operating and when applicable, the facility will adhere to all federal, state, and local regulations governing air, water, wastes, and hazardous substances. This will greatly reduce potential impact to wildlife. For instance, the DEQ storm water permit authorization and associated storm water pollution prevention plan (SWP3) will be followed during the mining operation. The SWP3 will outline erosion and sediment controls and best management practices (BMPs) to prevent onsite and offsite contamination. A Spill Prevention Control and Countermeasure (SPCC) Plan will be developed (if applicable) and enforced to prevent spills and contamination associated with the storage and use of petroleum products.

   During the reclamation process the applicable DEQ permits would remain in effect. The SWP3 will be updated to address the management of storm water and prevent erosion while controlling sedimentation. This will include additional erosion control and water management BMPs. (These permits will not be terminated until final closure is granted by the ODM and/or the DEQ.) Mining pits (or parts of) may be graded to allow reasonably safe ingress and egress for wildlife while being structurally stable. Berms, buffers, fences, or some type of barrier may be employed to restrict access to steep slopes.

2. Provide, as a separate document, a closure plan of the mine and permitted facilities to prevent a release of contaminants for being harmful to the environment. **A closure plan is not necessary for all mines**, but is required where the possibility exist for (a) acid forming materials handling or drainage; (b) chemically treated tailings or stockpiles (excludes fertilizer or lime for re-vegetation purpose).

   No acid forming materials are anticipated on site and no tailings or stockpiles will be chemically treated. Consequently, a closure plan was not prepared.

3. Method of control and disposal of mine wastes, rock, mineral scrap, tailings, slimes, and other material directly connected with the mining, cleaning, and preparation of mineral substances mined and includes all waste materials deposited on or in the permit area from any source.

   Overburden and off-spec materials will either be sold as product or used during the reclamation phase for grading and stabilization purposes.

   Processing fines associated with the washing (when applicable) and classification will be captured by control equipment or with permitted process water impoundments. Gravel, rock, fines, off-spec and other materials may be sold, used in the reclamation effort, and/or left in-place as part of the impoundment closure process.

Also, overburden, spoil and other materials will be used to create berms at various locations around the facility—including perimeter berms and around pits and ponds. The material will be stored temporarily or may become part of the final access restriction plan. (Refer to #5 below.) These berms may be stabilized and/or vegetated as part of the storm water permit requirements and outlined in the applicable SWP3.

4. Method of reclaiming settling and/or sediment ponds.

If applicable/constructed, all permitted process water impoundments will follow proper DEQ closure protocols as specific in OAC 252:616. The closure process will be overseen by a DEQ Water Quality Division engineer. Overburden, fines, and other materials will be used, as needed, to grade and/or close-out the impoundments. In general, impoundments will be closed "in-place" or may be convert to surface water bodies. Smaller storm water ponds (if constructed) may be left for post-reclamation sediment control or kept open as water features or reclaimed for other uses. Ponds without a sufficient watershed with be closed "in-place".

5. For final reclamation, submit information about practices for safety to persons and to adjoining property in all excavations. Identify area of potential danger and appropriate safety provisions. These provisions can but are not limited to setbacks, fencing, signs, benching, guardrails, and boulders.

Reclamation procedures will occur simultaneously (whenever feasible) with the mining effort per OAC 460:10-15-2. Reclamation activities will adhere to Oklahoma Statutes Title 45 Section 725. Direct access to the site, as a whole, may be restricted by fences, signage, locking gates and berms or other barriers. These practices will discourage and prevent access to steep slopes, highwalls, and water features. Fencing, berms, boulders, blocks and/or other barriers will be used where the mining pit is adjacent to travel ways. The berms, barriers and setbacks will prevent vehicles from approaching highwalls or hazardous slopes. Lateral support and set-backs are designed to provide structural stability and access restriction. Access to the mining areas will be designed and maintained after the reclamation process to allow people the ability to access the area in the event of an emergency. For instance, ramps may remain in place to allow ingress and egress to water bodies and excavated areas.

6. Method Identify structures (e.g., buildings, roads) that are proposed to remain as part of the final reclamation.

Overall, the property will be reclaimed to support mixed "Recreation" activities. During the reclamation phase a portion of the property will be developed to support a future "Industrial" land use. Structures, travel ways, piping, buildings, roads, processing equipment, or other items may remain to support this use. (Arrangements will be made with the landowner on what buildings and travel-ways will remain—if any.)

Impoundment areas, sediment ponds, and mine pits that retain water may be closed-out and/or converted to permanent water features, if possible, or they may be converted to other uses including for recreation uses such as open space, hunting, hiking, etc.

Some travel ways and roads will remain after reclamation to allow for site access for both "Industrial" and "Recreation" use areas. Refer to the Reclamation Map for additional information.

OKLAHOMA COOPERATIVE EXTENSION SERVICE [NREM-2581]

Reseeding Marginal Cropland to Perennial Grasses, Forbs, and Legumes

March 2017

Some of the land currently farmed in Oklahoma is poorly suited for cultivation. Cultivation of such highly erodible soils results in severe wind and water erosion and is not economically sound in either the short-term or long-term. This fact sheet is designed to acquaint land managers with options relative to establishing and managing permanent vegetative cover on marginal cropland.

Factors Affecting Grass Selection

Permanent grass plantings are long-term conservation decisions. As such, the choice of which grass species or mixture of species for your operation warrants careful consideration. In terms of evaluating grass plantings, you should consider:

(a) Management Objectives
(b) Regional Adaptation
(c) Stand Characteristics
(d) Seed Availability
(e) Maintenance Needs
(f) Associated Costs and Returns
(g) Invasiveness

When assessing the alternatives for your operation, keep all of these things in mind. Obviously, a grass species cannot be superior in all categories.

Management Objectives

Why are you planting permanent grasses? Compliance with a government program? Livestock grazing? Haying? Wildlife habitat? Erosion control? The objective(s) should be considered before selecting a species or mixture of grasses. If enrolled in the Conservation Reserve Program (CRP), consumptive uses (haying, grazing) are prohibited during the contract. What about after that? Some species offer better grazing than others, some require more maintenance than others. Monocultures (single species) and introduced forage provide poor wildlife habitat. Some introduced forages are invasive such as Old World bluestem, tall fescue, and sericea lespedeza. Invasive plants escape from where they are planted.

If not a part of a government program, you may have specific needs in terms of forage production (amount, quality, and season of production). For grazing purposes, it may be more desirable to have several pastures with different species in each, whereas, if wildlife are an important consideration, a mixture of species native to the site is more desirable.

Regional Adaptation

Some of the common species used in revegetating marginal croplands are listed in Table 1. The two primary considerations when evaluating particular grass species (or mixture) deal with soil and climatic concerns. Many reseeding projects are located in western Oklahoma. This limits the applicability of some species.

Table 1. Recommended Species for Reseeding Croplands.

*Invasive Species

Table 1. Recommended Species for Reseeding Croplands.

Species	Cultivar(s)	Site(s)
Native Grass Mixtures		
Alkali Sacaton	'Saltalk'	Alkaline, Saline
Big Bluestem	'Kaw', local harvest	Loams, Clay Loams
Blue Grama	'Hachita', 'Lovington'	Clays & Clay Loams
Buffalograss	'Texoka' or Sharp's Improved	" "
Canada Wildrye	No Commercial Cultivars	Sandy to Clay Loam
Eastern Gamagrass	No Commercial Cultivars	Bottomlands
Indiangrass	'Cheyenne' (west), 'Osage' (east)	Sandy to Clay Loam
Little Bluestem	'Cimarron', 'Pastura', 'Aldous', local harvest	" "
Sand Bluestem	'Woodward', local harvest	Sandy to Sandy Loam
Sand Lovegrass	'Bend', local harvest	" "
Sideoats Grama	'El Reno', 'Premier', 'Vaughn'	Sandy Loam to Clay
Switchgrass Upland Sites	'Blackwell', 'Caddo' 'Kanlow'	" "
Lowland Sites		
Western Wheatgrass	'Barton'	Loams, Clay Loams
Introduced Grasses		
Bermudagrass	'Guymon', 'Hardie', 'Midland', Common	Loamy Sands to Loamy Clays
Old World Bluestem*	'Plains', 'WW-Spar', 'Caucasian', 'Ganada'	Sandy Loams to Loamy Clays
Tall Wheatgrass	'Jose'	Saline, Sub-irrigated
Weeping Lovegrass	'Morpa'	Sandy to Sandy Loam
Tall Fescue*		Loams, Clay Loams
Forbs		
Maximilian Sunflower	'Aztec'	Loams, Clay Loams
Illinois Bundleflower	'Sabine'	" "
Pitcher's Sage	'Kaneb'	" "
Prairieclover	No Commercial Cultivars	" "

***Invasive Species**

Soil Factors

When evaluating different grass options, the most important consideration deals with agronomic factors, e.g., texture, slope, pH, permeability, fertility. Generally speaking, most reseeding efforts are directed at marginal croplands, i.e., highly erodible soils. In Oklahoma, such sites are typically either (a) coarse-textured (sandy) soils highly susceptible to wind erosion and/or (b) shallow, upland soils, coarse- or fine-textured, with slopes greater than 5 percent. By their

nature, these sites are generally droughty and, following years of cultivation, tend to be low in fertility. Such sites require careful attention to control erosion during seedling establishment and usually call for some type of temporary cover crop.

Generally, upland soils in western Oklahoma are neutral to slightly alkaline and deficient in phosphorus (P), but sufficient in potassium (K). In Eastern Oklahoma both P and K are usually deficient. A soil test of the area to be seeded is always recommended prior to seeding, so that deficiencies in phosphorus and potassium can be corrected and other problems (e.g., pH, salinity) can be identified. Assistance in soil testing is available from your local County Extension office.

Different grasses have different soil preferences. For example, weeping lovegrass is well adapted to sandy soils but does poorly on heavy clay soils with slow permeability. Species like blue grama are better adapted to clay soils and do not grow well on sandier sites. Other species, like little bluestem and sideoats grama, do well on almost any soil texture. The best source of information regarding your soils is the Standard Soil Survey for your county. In addition to a physical description of your soils, this guide will also outline yield potentials, management considerations, and use limitations. Copies of the Soil Survey can be obtained at most Natural Resource Conservation Service (NRCS) and OSU County Extension offices.

Site factors like soil depth and moisture relations should also be considered. For example, bermudagrass may be a good choice for a bottomland site, but it is less desirable on a more droughty upland soil. Some grasses, especially some of the Old World bluestem cultivars are better than others for iron-deficient soils where chlorosis can be a problem.

Problem sites sometimes encountered in reseeding involve saline or alkaline soils often accompanied with high water tables. Salt-tolerant grasses like alkali sacaton, tall wheatgrass, or bermudagrass are usually the best candidates for these problem sites.

Climatic Factors

Climatic factors important in choosing a grass species include such things as precipitation (both annual and seasonal) and temperatures. Western Oklahoma is characterized by extremes in each of these. Seeded grasses should be able to establish quickly and be both drought and cold tolerant. These requirements restrict the use of many alternative species from the outset. With few exceptions, most of the grass species discussed in Table 1, or at least certain cultivars of these species, have demonstrated good winterhardiness in western Oklahoma.

Some species which are not well adapted for most of western Oklahoma include kleingrass, tall fescue, and bahiagrass. Some particular cultivars of adapted species which lack winterhardiness for most of western Oklahoma include 'King Ranch' bluestem, 'Renner' weeping lovegrass, and 'Coastal' bermudagrass. Keep in mind that management can play a key role in determining drought- and winterhardiness.

Stand Characteristics

Stand characteristics conducive to successful to plantings include ease of establishment, low risk of failure, and good stand longevity. In addition to these, the ability to hold the soil, either by providing good ground cover and/or dense root systems, is a desirable trait from a conservation standpoint. Some new grasses are being promoted but lack a long-term track record. Use only species that have an established record.

Ease of Establishment

Ease of establishment is affected by many factors, including the species of grass, weather, establishment practices (seedbed preparation, seed germinability), and others. Generally speaking, it takes two years to obtain a good stand of native perennial grasses. However, by following certain guidelines outlined below, productive stands can be obtained in one or two years if rainfall is adequate and/or irrigation is available.

Some species are more "weedy" than others, i.e., they tend to establish quickly such as Old World bluestems and tall fescue. Note that bermudagrass planted early, well fertilized with normal rainfall, can establish in one year. Introduced plants are easier to establish because of the fertilizer response. Stands of native grasses can be obtained in two years when conditions are good.

Risk of Seeding Failure

At best, seeding failure is a calculated risk and there is always the possibility of stand failure. This risk may run as high as 70 percent in drought years, but is generally in the range of 10 to 30 percent. As mentioned previously, a host of factors dictate whether or not a stand is attained. To give your stand its best odds for success, try to incorporate as many "advantages," i.e., weed control, proper seedbed, quality seed, etc., as possible.

Because grasses are often slow to establish, some landowners become impatient and declare their stand a "failure" after only one growing season. Always give a stand at least two growing seasons before declaring it a failure and plowing it up. Being able to recognize the desirable grasses as seedlings will help you determine the degree of

success of your plantings.

Stand Longevity

How long will a stand of grass remain productive? The answer depends on several factors, including the species of grass, growing conditions, and subsequent management. In most situations adapted perennial grasses can remain met. This may mean periodic weed control, burning, fertilization, and always includes good grazing management if the stand is being grazed.

The "no-use" clause of the CRP may present a problem in some instances. Under such conditions of abandonment, some grasses may accumulate such a load of herbage to be detrimental to the vigor of the grass stand. In a production situation, this "stagnation" is prevented by grazing, haying, or burning.

Seeding Considerations

Proper prior planning prevents poor product performance. These seven "P's" should always be remembered when contemplating establishment of permanent grasses. Regarding seeding, you should remember these points:

(a) seedbed preparation
(b) select adapted species (or mixtures)
(c) buy quality seed
(d) seeding rates and dates
(e) use the proper equipment
(f) follow-up maintenance

As you try to "cut corners" here and there to keep costs down, keep in mind that each corner you cut will increase the risk of stand failure.

If the seeding is conducted in conjunction with a government program, certain guidelines must be followed relative to seeding establishment in order to qualify for government cost-sharing. This may include certain restrictions as to the types of seedbed preparation, allowable species and/or mixtures, seeding rates, and other factors. Check with your local NRCS office for the specifications for your particular area.

Seedbed Preparation

Proper seedbed preparation is second in importance only to favorable weather in grass establishment. Grass seeds are typically very small and need every establishment advantage they can get. A well prepared seedbed ensures good soil-seed contact which is essential for moisture relations. Several types of seedbeds can be prepared, but the two most common involve either (a) clean-tilled or (b) non-competitive cover crop (Figure 1).

Figure 1. On highly erodible croplands, planting into a non-competitive cover crop like sorghum is more desirable than using a clean-filled seedbed. Photo courtesy of Soil Conservation Service.

Clean-tilled, well-prepared seedbeds are used only when wind and water erosion during establishment are not a problem. The seedbed should be firm, but not hard. Cultipacking may be necessary prior to seedling if the seedbed is too soft, otherwise the grass seed may be placed to deep. Likewise, cultipacking following the drill, wither by press

wheels or a separate cultipacker, helps to ensure good soil contact with the seeds.
Since much of the acreage seeded to grass is on more or less "critical" areas, i.e. highly erodible, clean-tilled seedbeds are not always feasible. On this type of site, the role of temporary cover is especially important. Cover crops may be either annual sorghums or millets grown the previous year and left standing or small grains that are killed chemically prior to seeding. When forage sorghums are used, do not allow the plant to mature and produce seedheads. Ideally, about 12 inches of stubble should remain to plant into the following spring.
A popular technique recently developed involves planting the grasses into "graze-out" wheat. This technique provides a good, firm seedbed and standing cover for emerging seedlings. However, new seedlings may be more susceptible to drought during the year of establishment, as the small grains tend to deplete much of the soil moisture prior to planting.
When planting into small grains, it's generally best to kill or suppress the standing cover with a herbicide prior to planting. Paraquat and glyphosate can be used for this purpose. See the labels of these herbicides for specific rates and other precautions.

Plant Quality Seed

Always purchase your seed from a reputable seed dealer. If there is any doubt about seed purity or germination, ask to see the seed analysis. The seed analysis is an unbiased way of ascertaining seed quality, pure seed content, germination, inert material, weed seeds, and finally the pure live seed (PLS) content.
Always try to obtain seed (or sprigs) with known areas of adaptation. Sprigs should be kept cool and planted within 24 hours. This can be done by buying either (a) locally grown seed and/or (b) a "named" cultivar, e.g., 'Kaw' big bluestem or 'WW Spar' Old World bluestem. Many times, especially with native grass mixtures, seed are sold as "native mix." When purchasing such seed, try to limit your purchase to locally produced seed (generally within a 100-mile radius of your location).
In recent years, two different "forms" of grass seed havebeen available: (a) the "chaffy" seed, and (b) the "naked grain" or "caryopsis" (Figure 2). The caryopsis represents the grass seed without its attached awns and subtending appendages (glumes). Which of these forms of seeds is best is open to debate. The caryopses offer lower seeding rates and more uniform emergence when conditions are optimal. However, such seeds may also be more susceptible to fungal diseases in the soil. When planting early in the season (February – April), it's probably best to go with the chaffy seed, whereas either type may be used when planting later (May-June).

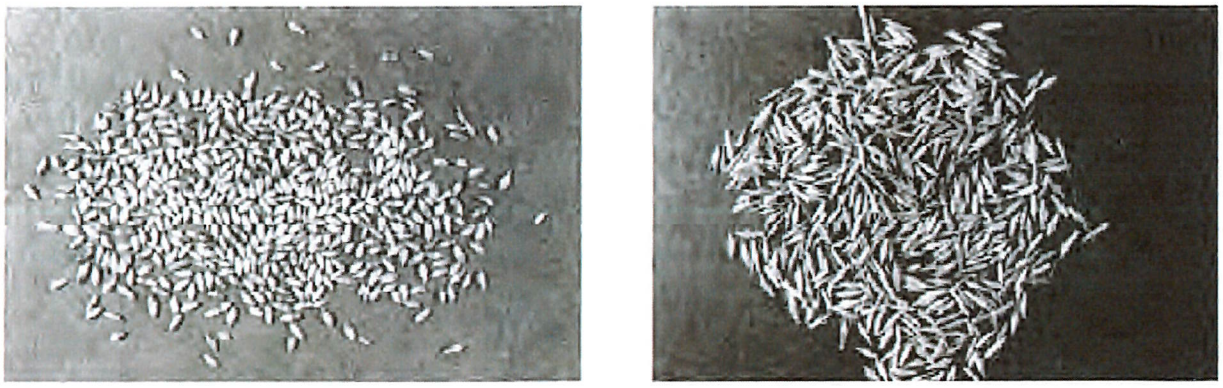

Figure 2. Equal number of caryopses (left) and "chaffy" (right) seed of indiangrass.

Seeding Rates and Dates

Planting rates will vary with species (Table 1). For native grasses, the rate ranges from about 3 to 8 pounds PLS per acre. For Old World bluestem, rates of 2 to 3 pounds PLS per acre are recommended. Weeping lovegrass should be planted at 2 to 5 pounds PLS per acre. Bermudagrass should be sprigged with about 15 to 25 bushels of sprigs per acre or seeded at the rate of 5 to 10 pounds PLS per acre for seeded bermudagrass. Keep in mind that most of the sites are less than optimal, so you may wish to lean toward the heavier seeding rates to ensure a quicker stand. Also, if using modified seed (caryopses), seeding rates may be reduced by 50-75%, depending on the species involved.
Warm season grasses should be seeded between March 15 and May15 in order to capitalize on favorable moisture patterns. Some successful seedings have been obtained after June 1, but the chances for success decrease rapidly after that date. Cool-season grasses (wheatgrasses) should be planted in September or October.

Use the Proper Equipment

Grass seeds, because of their small size and often "chaffy" nature, can pose problems for common seeding implements like grain drills. All types of equipment ranging from modified cotton planters to homemade drills to fertilizer spreaders have been used successfully. However, the most effective, efficient equipment is that which has been specifically designed for seeding grasses (Figure 3). This means commercial drills like Truax, Horizon, Nesbitt, Tye, Brillion, and others. These drills have special attachments like double-disc openers, depth bands, packer wheels, seedbox agitators, and other items which help to ensure a uniform planting rate and depth. In some areas, such drills are available for rental from the local Conservation District.

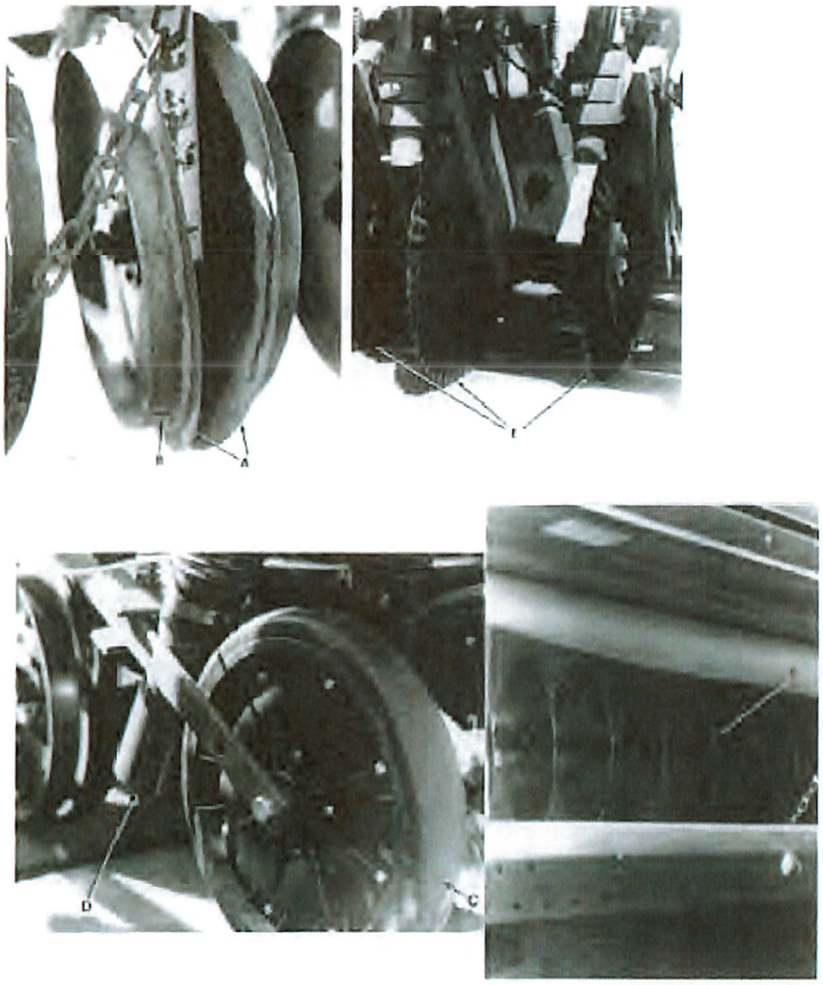

Figure 3. Specially modified drills are preferred for planting grasses. Desirable features include (a) double-disc openers, (b) depth bands, (c) press wheels, (d) large drop tubes, (e) cutting coulters, and (f) seedbox agitators.

Follow-up Maintenance

Weeds (forbs and grasses) are very competitive with seedling grasses and can be a serious problem in establishing a stand. Broadleaf weeds like kochita, Russian thistle, bindweed, silverleaf nightshade, pigweeds, and others, as well as grasses like animal bromes, annual threeawn, crabgrass, red sprangletop, witchgrass, sand dropseed, silver bluestem, Old World bluestem, and tall fescue can be major problems. It may be necessary to control these weeds, either by herbicides, mowing, or grazing.

Chemical weed control must be approached cautiously with seedling grasses to prevent herbicide injury to the grasses. Broadleaf weeds can be controlled selectively with 2,4-D. It is best to wait until the desirable grasses have at least five leaves and to use a 1/2 to 3/4 lb/A rate of the amine formulation. Spray when weeds are 2-4 inches tall and good growing conditions are present. Special precautions should be taken with bromgrass, buffalograss, and grama grasses since these species are more sensitive to herbicides than most grass seedlings.

Mowing can be helpful in preventing weeds like Russian thistle from shading out a stand. Adjust the mower height so that the weeds are clipped off just above the desirable grasses. Repeat mowings may be necessary the first year.

Grazing can provide some control on weedy grasses and some broadleafs like Russian thistle and kochia. Be careful not to allow livestock to graze the young grass seedlings before they are firmly rooted since they may be pulled out. It's best to "flash" graze the stand for a short period of time, then pull off of the area.
If excess herbage accumulations are decreasing the vigor of the stand, burn the stand in the spring. Burning also provides some weed control and stimulates seed production in native grasses. A good fertility program will be necessary for introduced grasses where high production is desirable.

Costs

Costs may be broken down into establishment-related (seed, seedhead preparation, equipment) and maintenance-related (weed control, fertilizer, labor, fencing). Seedbed costs may include preparation, intermediate crop (if required), starter fertilizer, equipment rental, fuel, and labor costs. Maintenance costs may include weed control, additional fertilizer (if needed), and fencing (if needed to protect the new planting from grazing).

Livestock Grazing

Different grasses, forbs, and legumes offer different levels of production and management requirements from the standpoint of livestock grazing. When considering a forage, look at your available forage and select a planting that fits your needs. The season of forage production varies among different plants, so try to select combinations that provide for year-round forage.

Wildlife Habitat Considerations

The advantage of planting a mixture of native range plants (native grasses, forbs, legumes, and shrubs) is that they provide excellent livestock forage and plant diversity that many wildlife species require. In contrast, introduced grasses have little food value for wildlife and are usually planted as monocultures or with one other kind of plant (e.g. legumes). The lack of diversity makes these plantings poor wildlife habitat. Since each species of wild animal has different requirements in terms of the kind, amount, and condition of the plant community, the size of the planting and its location in relationship to other habitat types (i.e. upland prairie, upland forest, bottomland forest, cropland, etc.) is very important. An overriding consideration when planning the seed mixture to be used is what species of wildlife are you interested in and what kind of forage does your operation need to balance the needs of livestock and wildlife. Remember, most introduced grass plantings provide very little plant diversity in the form of food or cover. In addition, a planting of native grasses that do not contain native forbs and legumes will also have much less value than a mixture high in diversity of plants native to the site.
The basis for making a decision of what to plant can be made by identifying the soil to be planted. Then obtain the Ecological Site Guide (Old Range Site Guide) from your local Natural Resources Conservation Office. The Site Guide will give you a detailed list of the native plants best suited to the site.

Summary

Reseeding marginal croplands to perennial grasses is a long-term investment. For best seeding success, follow these steps:

- Select the proper species or species mixture based on soil type and ecological site
- Prepare an adequate seedbed
- Seed at the right rate and date
- Use seeding equipment designed for perennial grasses
- Practice weed control as necessary
- Use good grazing management and prescribed fire to keep the stand productive

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Issued in furtherance of Cooperative Extension work, acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, Director of Oklahoma Cooperative Extension Service, Oklahoma State University, Stillwater, Oklahoma. This publication is issued by Oklahoma State University as authorized by the Vice President, Dean, and Director of the Division of Agricultural Sciences and Natural Resources.

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OKLAHOMA COOPERATIVE EXTENSION SERVICE [NREM-2869]

Management Strategies for Rangeland and Introduced Pastures

March 2017

Oklahoma is blessed with an abundance of excellent forage resources. Many Oklahoma producers enjoy the benefits of operating livestock production systems on both rangeland and introduced-forage pastures. However, some producers may not be aware of the need for different management strategies for the two ecosystems. Improper management generally results in decreased profitability of the livestock operation and reduces the sustainability of the production system.

The net return per acre from rangeland ecosystems can be rewarding due to the lower input costs associated with extensive management practices. Net return per acre to the producer using introduced forages can also be rewarding due to the higher carrying capacity per acre generally realized when using introduced forages. Higher carrying capacity results in more beef gain per acre and reduced land costs per animal.

The cost of using either introduced forages or rangeland (native) plants can be high if not properly managed. This publication discusses the differences in rangelands and introduced-forage pastures and management strategies required for each.

Rangeland

Oklahoma's rangeland has evolved as a result of the collective influence of climate, fire, and grazing. Rangeland is comprised of native plants, including grasses, forbs, and shrubs. Forests also respond similarly to fire and grazing. Examples of some of the major rangeland vegetation types found in Oklahoma include tall-grass prairie, mixed-grass prairie, short-grass prairie, post oak-blackjack oak savannah, sand sagebrush grasslands, and mesquite grasslands.

Rangeland communities are usually diverse and made up of many species of plants and animals. Historically, Oklahoma was a haven for native grazing animals and other wildlife species. Today, most of the large native herbivores have been replaced by cattle or other domestic livestock.

Rangeland management is characterized by extensive, rather than intensive strategies. Foremost among the management strategies for rangelands is grazing management and prescribed fire. Herbicides are used particularly on areas with a history of poor management (i.e., lack of fire and overgrazing).

Introduced Pasture

Introduced-forage management is characterized by the use of inputs not normally associated with rangeland management. Most notable among these inputs is the use of fertilizer. Herbicides are generally used to a greater extent on introduced-forage pastures than on rangeland. Herbicide application, however, is generally a response to symptoms and does not alleviate the underlying management problems that produced the weed infestation in the first place.

Introduced forages used for forage/livestock production systems have generally been selected for one or more of the following attributes:

a)high dry matter yield potential

b)high nutritive value

c)the ability to withstand close and/or continuous grazing

d)the ability to grow during cool months when most Oklahoma rangeland plants are dormant

Producers who choose to take advantage of the high productive capability of introduced forages, by default, have decided to provide the necessary fertility inputs required by the various forages. Bear in mind that many of the lands currently in introduced pasture are areas that were once farmed, but experienced serious erosion during the 1930s. These lands were abandoned and allowed to go back to plant species adapted to eroded, infertile conditions. Much of this once-abandoned farmland was reclaimed by reseeding to forage grasses. These areas require special attention to fertility inputs.

Grazing Management

Proper grazing management is the key element of successful livestock production. The most important aspect of grazing management is to use the proper stocking rate. Overstocking livestock can lead to an overgrazed condition. Overgrazing results in a decline in desirable species coupled with an increase in weed infestation, and a reduction in both animal performance and carrying capacity of management units. The net result of overgrazing is decreased profitability of the operation. Understocking the operation (undergrazing), while not as detrimental to desirable forage species, generally results in somewhat decreased forage production and under- utilization (low harvest efficiency) of the forage base. Undergrazing will generally result in patch or spot grazing where livestock repeatedly graze forage regrowth when it is available, while ignoring areas of forage that become increasingly mature. Mature forage is both less palatable and of lower nutritive value to livestock. Undergrazing, thus, results in wasted forage and less than maximum net return per acre to the operation.

An important aspect in grazing management is to control the forage harvest to maintain forage in a relatively immature stage of growth. Immature forages are higher in crude protein and digestibility than those in more advanced stages of maturity. A compromise is necessary to balance dry matter yield and an acceptable nutritive value. A conceptual model of the interaction between forage nutritive value, dry matter yield, and forage stage of maturity is shown in Figure 1.

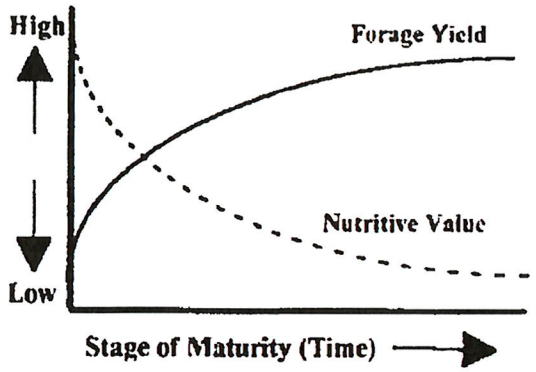

Figure 1. Effect of stage of maturity on forage yield and forage nutritive value.

Dry matter yield is enhanced by allowing forage to advance in maturity. The rapid decline in forage nutritive value (primarily for grass species) makes dry matter yield alone a poor production goal. Yield of nutrients (e.g., crude protein) is a better goal for most forage production systems since, given adequate forage intake, nutrients are the key determinant to animal performance.

Producers should consider the use of grazing systems designed to improve the control of forage harvest efficiency and maintain high nutritive value.

While maintaining forage in a relatively short, immature stage is important regarding animal performance, enough forage residue must remain to ensure the plant's ability to carry out basic metabolic processes and persist at the site. The level of residue required to maintain forage stands will differ according to species. A list of different forage species and recommended forage heights are listed in Table 1.

Overgrazed rangeland is dominated by early successional stage plants such as annual grasses and forbs. If the area has not been plowed, such that reseeding is required to establish vegetation, good grazing management can be used to improve forage conditions for cattle. However, rangeland that is dominated by early successional stage plants in combination with mid- and/or late-successional plant communities can provide desirable habitat for species of wildlife such as bobwhite quail, prairie chicken, and other species. If a change in range condition to a higher successional stage is desired, a deferment for part of the growing season combined with prescribed fire may be necessary to restore vigor to the plants.

Grazing deferment is not required, nor desired, on introduced forage pastures. Most introduced forage species have the ability to tolerate heavier stocking rates than rangelands and have the ability for rapid regrowth. Pastures, however, can be overstocked, even with grasses such as bermudagrass. Overgrazed conditions will reduce forage vigor, animal performance, and create weed problems, thus creating the need for an expensive herbicide application. Proper attention to stocking rate is just as essential on introduced forage pastures as on rangeland.

One problem in pasture grazing management is the low harvest efficiency and patch grazing that occurs under typical continuous stocking systems. Livestock producers should consider some form of rotational stocking system with cow/calf operations to encourage a compromise of forage utilization, animal performance, and forage persistence. Producers that use one pasture and continuous stocking, unless special management techniques are utilized, have little flexibility or control over the harvest efficiency of the forage resource.

Table 1. Suggested residue height of selected forages for optimum animal performance and stand persistence.

Species	Residue Height (inches)
Alfalfa	4 to 6"
Annual ryegrass	3 to 4"
Arrowleaf clover	3 to 4"
Bermudagrass	1.5 to 3"
Intermediate wheatgrass	4 to 6"
Native (rangeland)	
Shortgrass prairie	2 to 3"
Mixed-grass prairie	4 to 6"
Tallgrass prairie	6 to 8"
Oat	4 to 6"
Old World bluestem	3 to 4"
Pubescent wheatgrass	4 to 6"
Red clover	4 to 6"
Rye	4 to 6"
Tall fescue	3 to 4"
Tall wheatgrass	6 to 8"
Wheat	4 to 6"
White clover	2 to 3"

Fertility

Fertility inputs are generally not used on rangelands. Proper use of fertilizer on introduced-forage pastures is critical for optimum forage production and animal performance.

The first step in the soil fertility program is to obtain a soil sample for analysis. A soil analysis is used to determine the levels of nitrogen, phosphorus, and potassium in the soil and the soil pH (soil acidity). Because of the potential for high dry matter yield, most introduced forages (grasses) have a high nitrogen requirement. Nitrogen is second only to moisture in relative importance for maximum plant growth and is positively correlated with both dry matter production and nutritive value. The data contained in Table 2 indicate the response of various forages to increased application rates of nitrogen.

Industrially supplied nitrogen sources, such as ammonium nitrate, ammonium sulfate, and urea are commonly used forms of nitrogen fertilizer. Additional sources of nitrogen include poultry litter and swine effluent. Animal waste products (i.e., poultry litter, swine lagoon effluent) can provide inexpensive sources of nitrogen if located close to forage production systems. Economy of animal waste must be based on a soil test.

An alternative method for supplying nitrogen is through the use of legumes. Legumes are plants (such as clovers) that have a symbiotic relationship with host-specific Rhizobia bacteria. In the symbiotic relationship, the legume serves as a host plant for the bacteria, while the bacteria fixes atmospheric nitrogen into a form readily used by the plant. Forage legumes have the ability to provide the equivalent of 50 to 200 pounds of actual nitrogen per acre to other non-nitrogen-fixing plants under good growing conditions, thus reducing the need for nitrogen fertilizer. Legumes also contribute to the overall nutritive value of the forage and help to maintain animals on a high nutritional plane, even when nutritive value of grasses is declining.

Many soils are also low in phosphorus and potassium and must be amended to optimize growth. Where legumes are utilized, a near-neutral soil pH becomes increasingly important, and in many cases, lime must be applied to acid soils. Acid soils generally do not have direct negative effects on the growth of most forage plants; however, indirect effects can hamper plant production. Soil nutrients, particularly phosphorus, are most available at near-neutral pH levels. Many producers, therefore, apply crushed limestone (lime) to increase soil pH to enhance nutrient availability for optimum forage production.

When fertilizer and ag lime are applied according to soil test recommendations and proper attention is paid to grazing management, input costs to introduced pastures generally yield a good return on their investment. If fertility inputs are not applied properly and/or grazing management practices are not sound, introduced pastures can become a black hole into which a lot of money is poured, but little income is realized. Introduced forages yield no more than native forages if not fertilized.

Table 2. Estimated Annual Forage yields With and Without Nitrogen Fertilization (Tons Per Acre).

(dry matter basis)

Forage	Nitrogen rate (lbs. per acre)				
Species	0	50	100	150*	200*
Bermudagrass	1	1.8	2.8	3.4	3.9
Weeping lovegrass (sandy soil)	1	2	2.9	3.6	4
Plains or Caucasian Bluestem	1	1.9	2.7	3.3	3.7
Tall Fescue (eastern Oklahoma)	0.8	1.7	2.4	3	3.5
Native hay	1	1.5	1.6		
Sudangrass	1.5	2.5	3.5	4.3	5
Small grain	1	1.5	2.1	2.6	3

Forage	Nitrogen rate (lbs. per acre)
Alfalfa	3.0-5.0

*Forage production at nitrogen rates of 150 lbs. per acre or greater may be limited by soil depth and lack of rainfall during the growing season.

Herbicides

Generally, the need for herbicide application indicates a history of poor management. Weed infestation, in many instances, may be a symptom of overgrazing of rangelands. Overgrazing combined with a poor fertility program on introduced-forage pastures can also lead to weed problems. Prior to spending money on herbicide application, it is imperative that producers examine present management practices and determine what is creating the conditions that allow weed species to dominate the current management units. Until these deficiencies are identified and corrected, producers will be caught in a perpetual cycle of applying herbicides when that expense could be better spent on other inputs.

If the decision to use a herbicide has been made, it is essential that producers correctly identify the target species and follow the label directions regarding application and cleanup/disposal of the herbicide following use. It should be obvious that if the target weed species is incorrectly identified, the herbicide may be ineffective. Following label directions is critical because of safety concerns for both the operator and the environment. It is also a violation of the law to do otherwise.

Herbicides have been and continue to be used on rangelands. Many rangelands, due to past practices of overgrazing and exclusion of prescribed fire, have become dominated by woody species. Generally, herbicides cleared specifically for rangelands and/or mechanical treatments (root plowing, chaining, roller chopping, disking, or shredding) are used to kill woody species. Defoliation of the woody species allows sunlight to reach the rangeland soil and provide opportunity for native grasses and forbs to re-establish themselves. A prescribed burning program in combination with proper grazing management will keep most woody species in check.

For less serious weed problems, grazing management or prescribed fire can be used for weed control. In many instances, herbaceous species may be effectively controlled by congregating cattle in a small area to provide heavy grazing pressure on weeds in late winter and early spring.

The above comments apply equally to herbicide use on introduced-forage pastures. A critical assessment of past management strategies that have contributed to the weed problem should be conducted and a decision made to correct inappropriate or incorrect actions. The target weed species should be correctly identified and label directions followed regarding herbicide use. Typically, more herbicides are used in Oklahoma on introduced-forage pasture. Again, grazing management and fertility can be used in many instances to achieve good control of certain herbaceous weed species.

Many producers consider the use of herbicides a routine management practice. Under a good management program of proper soil fertility and the appropriate stocking rate for the forage species and season of use, herbicide use on most grazing lands should not be necessary.

Prescribed Fire

Rangelands and forests evolved under the influence of both grazing and fire. The role of fire in maintaining rangelands has been misunderstood by the public in general; thus, over time the use of fire has been reduced. This is unfortunate because prescribed fire is an effective means for controlling unwanted and undesirable plant species on rangelands and forests. Applied appropriately and under specific conditions, prescribed fire is a safe and inexpensive management tool that is available to the rangeland manager.

Prescribed fire is used to accomplish specific goals. The fire is used at a certain time of the year and under specific levels of relative humidity, air temperature, and wind speed to help control target weed species. Although generally responsible for improvements in both forage quantity and nutritive value, fire during a dry season can eliminate

standing dormant forage that could be useful for emergency grazing. If soil moisture is not adequate at the time of the fire or replaced soon after, areas that are subjected to prescribed fire may actually produce less forage than unburned areas. Soil moisture is a critical aspect of the fire prescription and should be carefully considered in conjunction with other elements of the fire plan, even in eastern and central Oklahoma where moisture is normally adequate.

Besides the beneficial effects of controlling undesirable plant species, prescribed fire also enhances growing cattle performance. Data from many studies in the southern Great Plains indicates that stocker cattle gain an additional 10% or more when grazing burned pastures compared to cattle on unburned areas (Table 3).

Prescribed fire eliminates standing dead forage and provides livestock with green forage of higher nutritive value. Fire releases nutrients from dormant standing forage (phosphorus and potassium) for a brief period of time resulting in somewhat increased nutritive value of subsequent forage. The blackened surface generally greens up earlier than non-burned areas, thus providing earlier grazing. In summary, the beneficial effects of controlling unwanted weeds and the economic benefit realized from the increase in cattle performance warrants careful consideration of using prescribed fire as a management tool on rangelands and forests.

Prescribed fire is not used in introduced forage pastures to the same extent as rangelands. However, some producers have discovered that burning standing dormant forage can be beneficial to pastures. Some previously mentioned benefits include the earlier green-up of pastures compared with unburned pastures and a short-term release of phosphorus and potassium. An additional application for prescribed fire would be to clean up a hay meadow so that the first hay cutting was clean of dormant forage and other undesirable components of the pasture. Prescribed fire also helps reduce the level of insect problems in pastures such as spittle bugs in bermudagrass.

Producers who have not used prescribed fire in the past may want to consider the benefits provided by this inexpensive management tool. For more information see OSU Circulars E-926 Grazing Management on Rangeland for Beef Production and E-947 Invasion of Oklahoma Rangelands and Forests by Eastern Redcedar and Ashe Juniper and various OSU Extension Fact Sheets on prescribed fire.

Table 3. Steer gain response to prescribed fire on tallgrass prairie, Stillwater, OK 1985 to 1990.

	Unburned	Burned
Early season (May to mid July)		
Daily gain (lbs)	2.04	2.24
% difference		+10
75-day gain difference (lbs)		+150
Daily gain (lbs)	1.81	1.97
% difference		+9
150-day difference (lbs)		+24

Complementary Forage Systems

Almost every farm or ranch in Oklahoma has the potential to develop both introduced pastures suited to intensive management and rangeland suited to extensive management in what is known as a complementary forage system. The use of both types of forage systems increases flexibility, spreads producer risk, and enhances the potential for profitability from livestock production systems. Introduced forages, in general, increase the carrying capacity of the farm or ranch. Cool-season introduced forages improve the seasonal distribution of forage with the ability to provide fall-through-spring forage of good nutritive value. Warm-season introduced forages provide pasture for livestock to spend part of the summer on, thus allowing rangelands to recover from grazing events. Rangeland plants, on the other hand, offer good animal performance during spring through early summer and provide a buffer for fall and

winter during periods of drought when cool-season introduced forages may be in short supply. Rangeland also provides habitat for wildlife where as introduced forages generally do not. Introduced forages can increase carrying capacity while protecting our remaining range resources. Provides alternative source of grazing at key times.

Wildlife Habitat

Recreational leasing for hunting is rapidly becoming a major source of income for Oklahoma ranchers. Wildlife require food, cover, and water for survival. Native plant communities provide the best wildlife habitat for the greatest number of species. Ranchers should realize that the use of introduced forages generally precludes other types of land use such as recreational leasing for wildlife.

Likewise, breaking up large areas (fragmentation) of contiguous land types (native forest, shrubland, or prairie) can result in decreased habitat and numbers of certain wildlife species. If alternative sources of income from wildlife use is desired, whether consumptive (sport hunting) or non-consumptive (watchable wildlife), ranchers should remember that introduced forages do not provide good wildlife habitat. Under these circumstances the use of introduced forages may reduce ranch income.

If there are presently areas of native plants species in association with introduced species on your property, you still have the potential for good wildlife production. The preservation of wildlife habitat should receive high priority when management practices are considered. Areas of native woody plants and forbs that are necessary for wildlife food and cover should be maintained, and these areas should receive limited herbicide or mechanical treatments.

Wildlife and livestock are usually compatible. For example, maintaining plum thickets on rangeland would have little effect on livestock carrying capacity, but would have a positive impact on bobwhite quail and white-tailed deer. We recommend a careful evaluation of your ranch's resources for alternative sources of income before any land use changes are made.

Summary

Both native (rangeland) and introduced forages have strengths and weaknesses for cattle production. Native plant communities are necessary for most wildlife. The use of both systems in a complementary manner can enhance the flexibility of the livestock production system and improve net income. There are similarities in management of the systems; however, there are important differences that should be noted by ranchers.

Differences in management practices relate to the intensive inputs (fertilizer, herbicides) associated with introduced-forage pastures. Introduced forage species are able to withstand heavier grazing pressure. Heavy grazing of an introduced forage is not the same as heavy grazing on native forage. Native forage stocking rates should be based on the productivity of the range site. Rangelands can tolerate heavy grazing pressure before July 10, but should be deferred so that native plants may recover from grazing. The use of prescribed fire is generally used more on rangeland than on introduced forage pastures. Understanding the subtle differences in management strategies between rangelands and introduced forage pastures can mean the difference in making a profit or losing money.

Common to managing both systems is the use of proper stocking rate and the need to provide forage of high nutritive value. Close attention to basic soil fertility fundamentals of introduced forage pastures will also ensure that the dry matter production and forage nutritive value are adequate. Poor grazing management of either system and a lack of soil fertility in introduced forage pastures will result in a decline of desirable forage species, an increase in weed species, decreased livestock performance, and reduced net income.

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Issued in furtherance of Cooperative Extension work, acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, Director of Oklahoma Cooperative Extension Service, Oklahoma State University, Stillwater, Oklahoma. This publication is issued by Oklahoma State University as authorized by the Vice President, Dean, and Director of the Division of Agricultural Sciences and Natural Resources.

TEXT LINK

OKLAHOMA COOPERATIVE EXTENSION SERVICE NREM-2872

A Checklist of Prairie, Shrubland, and Forest Understory Plants of Oklahoma

Characteristics and Value to Deer, Quail, Turkey, and Cattle

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Oklahoma has more than 2,600 species of vascular plants, of which 90% are native. In this Fact Sheet, we have listed those commonly found in prairies, shrublands, and forest understories throughout the state and described their characteristics and resource values.

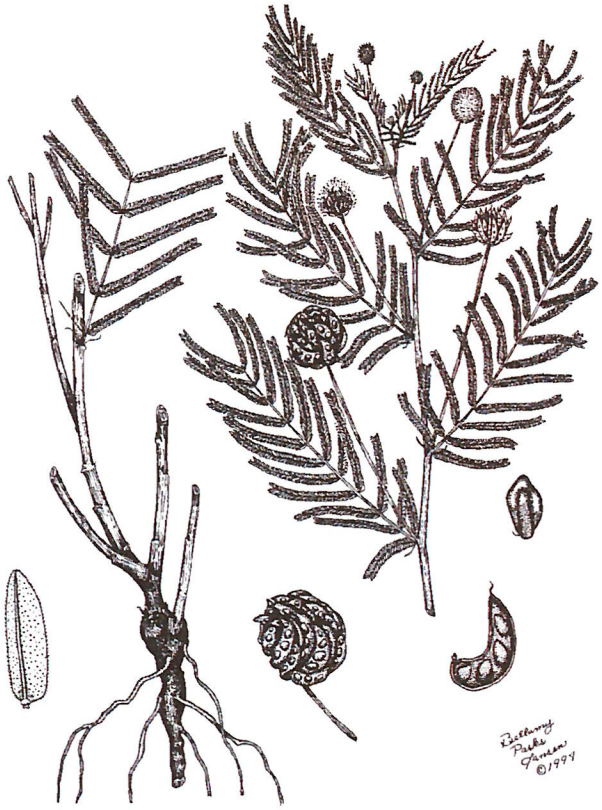
Characteristics of plant growth can be useful in determining where species occur and under what environmental conditions they exist. The life span of each plant in the following table is recorded as either perennial or annual. Annual plants complete their life cycle in one growing season and perpetuate through seed production. Perennials, in addition to producing seeds, store energy reserves in their root systems for use the following year. A species' principal time of growth is described as either cool season or warm season. Cool-season plants complete the majority of their growth in the fall, winter, and spring. Warm-season plants grow during the summer.

A number of species have been brought here from other continents, either intentionally or by accident. These plants are termed *introduced species*. They often become undesirable because they lack natural enemies and may thrive at the cost of native species. Some introduced plants are invasive and noxious weeds and thus should be controlled. Some native plants, like eastern redcedar, become invasive because of the reduction in natural ecological processes such as fire. Whether each plant has a tendency to be invasive, such as *Sericea lespedeza*, is the final plant characteristic listed.

Because animals depend on plants for food and cover, the value of each species for deer, quail, wild turkey, and cattle has been rated as desirable or undesirable. It is important to note that the value of a plant to different wildlife species may be the same. Species also do not have to be a desired food item to be important. Cover provides necessary protection from weather and predators. Use of some species is seasonal. It is important to note that some species designated undesirable for food or cover may have other resource values and thus be considered important.

This table is intended to serve as a quick reference for determining the attributes of common plants in Oklahoma and their value to wildlife and indirectly to the land manager's interests or needs. The species are grouped into four categories: graminoids, legumes, forbs, and woodies. For detailed discussions and drawings of these plants, obtain a copy of the Field Guide to Oklahoma Plants. Contact Rangeland Ecology and Management at 405.744.6421.

For information on all species of plants, visit http://plants.usda.gov/



Illinois bundleflower.

PLANT CHARACTERISTIC, ECOLOGICAL AND RESOURCE RATING GUIDE				RESOURCE VALUE RATING							
Perennial = P Annual = A Biennial = B Introduced = IN	Cool Season = C Warm Season = W Invasive = IV Native = N	PLANT CHARACTERISTICS LH = Life History SG = Season of Growth OR = Origin			Desirable = De Limited = LM Undesirable = Un							
					WT Deer		BW Quail		Cattle		Turkey	
		LH	SG	OR	Food	Cover	Food	Cover	Food	Cover	Food	Cover
GRAMINOIDS												
1 Jointed goatgrass (*Aegilops cylindrica*)		A	C	IN, IV	UN	UN	UN	UN	UN	UN	UN	UN
2 Big or Sand bluestem (*Andropogon gerardii*)		P	W	N	UN	DE	UN	DE	DE	UN	UN	DE
3 Splitbeard bluestem (*Andropogon ternarius*)		P	W	N	UN	UN	UN	LM	UN	UN	UN	LM
4 Broomsedge bluestem (*Andropogon virginicus*)		P	W	N	UN	UN	UN	DE	UN	UN	UN	DE
5 Annual threeawn (*Aristida oligantha*)		A	W	N	UN	UN	UN	UN	UN	UN	UN	UN
6 Perennial threeawn (*Aristida purpurea*)		P	W	N	UN	UN	UN	UN	UN	UN	UN	UN
7 Giant cane (*Arundinaria gigantea*)		P	W	N	LM	DE	DE	DE	DE	DE	UN	DE
8 Old World bluestem (*Bothriochloa ischaemum*)		P	W	IN, IV	UN	UN	UN	UN	DE	UN	UN	UN
9 Silver bluestem (*Bothriochloa laguroides*)		P	W	N	UN	UN	UN	DE	UN	UN	UN	DE
10 Sideoats grama (*Bouteloua curtipendula*)		P	W	N	LM	UN	UN	DE	DE	UN	DE	DE
11 Blue grama (*Bouteloua gracilis*)		P	W	N	LM	UN	UN	UN	DE	UN	UN	UN
12 Hairy grama (*Bouteloua hirsuta*)		P	W	N	LM	UN	UN	UN	DE	UN	UN	UN
13 Rescuegrass (*Bromus catharticus*)		A	C	IN, IV	UN	UN	UN	UN	LM	UN	UN	UN
14 Japanese brome (*Bromus japonicus*)		A	C	IN, IV	UN	UN	UN	UN	UN	UN	UN	UN
15 Downey brome (*Bromus tectorum*)		A	C	IN, IV	UN	UN	UN	UN	UN	UN	UN	UN
16 Buffalograss (*Buchloe dactyloides*)		P	W	N	UN	UN	UN	UN	DE	UN	DE	UN
17 Giant sandreed (*Calamovilfa gigantea*)		P	W	N	UN	DE	UN	DE	DE	UN	UN	DE
18 Prairie sedge (*Carex festucaea*)		P	C	N	DE	UN	DE	UN	DE	UN	DE	UN
19 Sandbur (*Cenchrus incertus*)		A	W	N	UN	UN	UN	UN	UN	UN	UN	UN
20 Broadleaved uniola (*Chasmanthium latifolium*)		P	C	N	DE	UN	UN	DE	UN	UN	UN	DE
21 Windmillgrass (*Chloris verticillata*)		P	W	N	UN	UN	UN	UN	UN	UN	UN	UN
22 Rattail grass (*Coelorachis cylindrica*)		P	W	N	UN	UN	UN	UN	UN	UN	UN	UN
23 Bermudagrass (*Cynodon dactylon*)		P	W	IN,IV	UN	UN	UN	UN	DE	UN	UN	UN
24 False flatsedge (*Cyperus strigosus*)		P	W	N	DE	UN	UN	UN	DE	UN	DE	UN
25 Poverty oatgrass (*Danthonia spicata*)		P	C	N	UN	UN	UN	UN	DE	UN	UN	UN
26 Inland saltgrass (*Distichlis spicata*)		P	W	N	UN	UN	UN	UN	UN	UN	UN	UN
27 Canada wildrye (*Elymus canadensis*)		P	C	N	UN	UN	UN	DE	DE	UN	UN	DE
28 Western wheatgrass (*Elymus smithii*)		P	C	N	UN	UN	UN	DE	DE	UN	UN	DE
29 Weeping lovegrass (*Eragrostis curvula*)		P	W	IN	UN	UN	UN	DE	DE	UN	UN	UN
30 Plains lovegrass (*Eragrostis lugens*)		P	W	N	UN	UN	UN	UN	DE	UN	UN	DE
31 Red lovegrass (*Eragrostis secundiflora*)		P	W	N	UN	UN	UN	UN	DE	UN	UN	DE
32 Purple lovegrass (*Eragrostis spectabilis*)		P	W	N	UN	UN	UN	DE	DE	UN	UN	DE
33 Sand lovegrass (*Eragrostis trichodes*)		P	W	N	UN	UN	UN	UN	DE	UN	UN	DE
34 Prairie cupgrass (*Eriocholoa contracta*)		P	W	N	UN	UN	UN	UN	DE	UN	UN	UN
35 Hairy tridens (*Erioneuron pilosum*)		P	W	N	UN	UN	UN	UN	UN	UN	UN	DE
36 Tall fescue (*Festuca arundinacea*)		P	C	IN, IV	UN	UN	UN	UN	DE	UN	UN	UN
37 Bearded skeletongrass (*Gymnopogon ambiguus*)		P	W	N	UN	UN	UN	DE	UN	UN	UN	UN
38 Tobosagrass (*Hilaria mutica*)		P	W	N	UN	UN	UN	DE	UN	UN	UN	UN
39 Little barley (*Hordeum pusillum*)		A	C	IN, IV	UN	UN	UN	UN	UN	UN	UN	UN
40 Rush (*Juncus tenuis*)		P	C	N	UN	UN	UN	UN	UN	UN	UN	UN
41 Fall witchgrass (*Leptoloma cognatum*)		P	W	N	UN	UN	DE	UN	UN	UN	UN	UN
42 Nimblewell (*Muhlenbergia schreberi*)		P	W	N	UN	UN	UN	DE	UN	UN	UN	DE
43 Indian ricegrass (*Oryzopsis hymenoides*)		P	C	N	UN	UN	UN	UN	DE	UN	DE	DE
44 Vine mesquite (*Panicum obtusum*)		P	W	N	UN	UN	DE	DE	DE	UN	DE	UN
45 Scribner panicum (*Panicum oligosanthes*)		P	C	N	DE	UN	DE	UN	DE	UN	DE	UN
46 Switchgrass (*Panicum virgatum*)		P	W	N	UN	DE	DE	DE	DE	UN	DE	DE
47 Florida paspalum (*Paspalum floridanum*)		P	W	N	DE	UN	DE	DE	DE	UN	DE	DE
48 Texas bluegrass (*Poa arachnifera*)		P	C	N	UN	UN	UN	UN	DE	UN	DE	UN
49 Tumblegrass (*Schedonnardus paniculatus*)		P	W	N	UN	UN	UN	UN	UN	UN	UN	UN

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Perennial = P Annual = A Biennial = B Introduced = IN	Cool Season = C Warm Season = W Invasive = IV Native = N	PLANT CHARACTERISTICS LH = Life History SG = Season of Growth OR = Origin			Desirable = De Limited = LM Undesirable = Un							
					WT Deer		BW Quail		Cattle		Turkey	
		LH	SG	OR	Food	Cover	Food	Cover	Food	Cover	Food	Cover
50 Little bluestem (*Schizachyrium scoparium*)		P	W	N	UN	UN	UN	DE	DE	UN	UN	DE
51 Nutrush (*Scleria ciliata*)		P	C	N	DE	UN	DE	UN	DE	UN	DE	UN
52 Knotroot bristlegrass (*Setaria gracilis*)		P	W	N	UN	UN	DE	DE	DE	UN	DE	UN
53 Indiangrass (*Sorghastrum nutans*)		P	W	N	UN	DE	UN	DE	DE	UN	UN	DE
54 Johnsongrass (*Sorghum halepense*)		P	W	IN, IV	UN	UN	UN	UN	DE	UN	UN	UN
55 Prairie cordgrass (*Spartina pectinata*)		P	W	N	UN	UN	UN	DE	DE	UN	UN	DE
56 Prairie wedgescale (*Sphenopholis obtusata*)		P	W	N	DE	UN	UN	UN	UN	UN	UN	UN
57 Alkali sacaton (*Sporobolus airoides*)		P	W	N	UN	UN	UN	DE	DE	UN	UN	DE
58 Tall dropseed (*Sporobolus asper*)		P	W	N	UN	UN	DE	DE	UN	UN	UN	DE
59 Sand dropseed (*Sporobolus cryptandrus*)		P	W	N	UN	UN	DE	DE	DE	UN	UN	UN
60 Annual dropseed (*Sporobolus neglectus*)		A	W	N	UN	UN	UN	UN	UN	UN	UN	UN
61 Texas wintergrass (*Stipa leucotricha*)		P	C	N	UN	UN	UN	UN	DE	UN	UN	UN
62 Purpletop (*Tridens flavus*)		P	W	N	UN	UN	UN	DE	DE	UN	UN	DE
63 Longspike tridens (*Tridens strictus*)		P	W	N	UN	UN	UN	UN	DE	UN	UN	UN
64 Eastern gamagrass (*Tripsacum dactyloides*)		P	W	N	DE	DE	DE	DE	DE	UN	DE	DE
65 Cattail (*Typha latifolia*)		P	W	N	UN	DE	UN	UN	UN	UN	UN	UN
66 Sixweeks fescue (*Vulpia octoflora*)		A	C	N	UN	UN	UN	UN	UN	UN	DE	UN
LEGUMES												
67 Prairie acacia (*Acacia angustissima*)		P	W	N	DE	UN	DE	DE	DE	UN	DE	UN
68 Leadplant (*Amorpha canescens*)		P	W	N	UN	UN	UN	DE	DE	UN	DE	UN
69 Groundplum (*Astragalus crassicarpus*)		A	C	N	DE	UN	UN	UN	UN	UN	DE	UN
70 Woolly loco (*Astragalus mollissimus*)		A	C	N	UN	UN	UN	UN	UN	UN	DE	UN
71 Blue wild indigo (*Baptisia australis*)		P	C	N	UN	UN	UN	DE	UN	UN	DE	UN
72 Plains wild indigo (*Baptisia bracteata*)		P	C	N	UN	UN	UN	DE	UN	UN	DE	UN
73 Showy partridgepea (*Chamaecrista fasciculata*)		A	W	N	UN	UN	DE	UN	UN	UN	DE	UN
74 Butterfly pea (*Clitoria mariana*)		A	W	N	DE	UN	DE	UN	DE	UN	DE	UN
75 Slender dalea (*Dalea enneandra*)		P	W	N	DE	UN	UN	DE	DE	UN	DE	UN
76 Illinois bundleflower (*Desmanthus illinoensis*)		P	W	N	DE	UN	DE	DE	DE	UN	DE	DE
77 Sessile-leaved tickclover (*Desmodium sessilifolium*)		P	W	N	DE	UN	DE	DE	DE	UN	DE	UN
78 Downey milk pea (*Galactia regularis*)		P	W	N	DE	UN	DE	UN	DE	UN	DE	UN
79 Roundhead lespedeza (*Lespedeza capitata*)		P	W	N	DE	UN	DE	DE	DE	UN	DE	UN
80 Sericea lespedeza (*Lespedeza cuneata*)		P	W	IN, IV	UN	UN	UN	UN	UN	UN	UN	UN
81 Trailing lespedeza (*Lespedeza procumbens*)		P	W	N	DE	UN	DE	UN	DE	UN	DE	UN
82 Korean lespedeza (*Lespedeza stipulacea*)		A	W	IN, IV	UN	UN	UN	UN	DE	UN	UN	UN
83 Slender lespedeza (*Lespedeza virginica*)		P	W	N	DE	UN	DE	DE	DE	UN	DE	UN
84 Catclaw sensitivebriar (*Mimosa quadrivalis*)		P	W	N	UN	UN	DE	DE	DE	UN	DE	UN
85 Yellow neptune (*Neptunia lutea*)		P	W	N	DE	UN	DE	UN	DE	UN	DE	UN
86 Lambert's crazyweed (*Oxytropis lambertii*)		P	C	N	UN	UN	UN	UN	UN	UN	DE	UN
87 Purple prairieclover (*Petalostemon purpureus*)		P	W	N	DE	UN	DE	DE	DE	UN	DE	UN
88 Scurfpea (*Psoralidium tenuiflorum*)		P	C	N	UN	UN	DE	DE	UN	UN	DE	UN
89 Trailing wildbean (*Strophostyles helvola*)		P	W	N	DE	UN	DE	DE	DE	UN	DE	UN
90 Goat's rue (*Tephrosia virginiana*)		P	W	N	DE	UN	UN	DE	DE	UN	DE	UN
91 White clover (*Trifolium repens*)		P	C	IN	DE	UN	UN	UN	DE	UN	DE	UN
92 Hairy vetch (*Vicia villosa*)		A	C	IN	DE	UN	UN	UN	UN	UN	DE	UN
FORBS												
93 Three-seeded mercury (*Acalypha virginica*)		A	W	N	DE	UN	UN	UN	UN	UN	UN	UN
94 Common yarrow (*Achillea millefolium*)		P	C	N	UN	UN	UN	DE	DE	DE	UN	UN
95 Prostate pigweed (*Amaranthus blitoides*)		A	W	N	UN	UN	DE	UN	UN	UN	UN	UN
96 Redroot pigweed (*Amaranthus retroflexus*)		A	W	IN, IV	UN	UN	DE	DE	UN	UN	UN	UN
97 Lanceleaf ragweed (*Ambrosia bidentata*)		A	W	N	UN	UN	DE	DE	UN	UN	UN	UN
98 Western ragweed (*Ambrosia psilostachya*)		P	W	N	UN	UN	DE	DE	UN	UN	UN	DE
99 Giant ragweed (*Ambrosia trifida*)		A	W	N	UN	DE	DE	DE	UN	UN	UN	DE

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					WT Deer		BW Quail		Cattle		Turkey	
		LH	SG	OR	Food	Cover	Food	Cover	Food	Cover	Food	Cover
100 Pussytoes (*Antennaria parlinii*)		P	C	N	DE	UN	UN	UN	UN	UN	DE	UN
101 Sagewort (*Artemisia ludoviciana*)		P	W	N	DE	UN	UN	DE	UN	UN	UN	DE
102 Antelopehorn milkweed (*Asclepias viridis*)		P	C	N	UN	UN	UN	DE	UN	UN	UN	UN
103 Heath aster (*Aster ericoides*)		P	W	N	DE	UN	UN	DE	UN	UN	UN	UN
104 Spanish needles (*Bidens bipinnata*)		A	W	N	UN	UN	UN	DE	UN	UN	UN	DE
105 Halfshrub sundrop (*Calyophus serrulatus*)		P	W	N	DE	UN	UN	DE	UN	UN	UN	DE
106 Musk thistle (*Carduus nutans*)		B	C	IN, IV	UN	UN	UN	UN	UN	UN	UN	UN
107 Indian paintbrush (*Castilleja indivisia*)		P	W	N	UN	UN	UN	DE	DE	UN	UN	UN
108 Basketflower (*Centaurea americana*)		A	W	N	UN	UN	UN	DE	UN	UN	UN	UN
109 Lambsquarters (*Chenopodium album*)		A	W	IN	UN	DE	DE	DE	DE	UN	UN	UN
110 Horseweed (*Conyza canadensis*)		A	W	N	DE	UN	UN	DE	UN	UN	UN	DE
111 Plains coreopsis (*Coreopsis tinctoria*)		A	W	N	UN	UN	DE	DE	UN	UN	UN	UN
112 Texas croton (*Croton texensis*)		A	W	N	UN	UN	DE	DE	UN	UN	DE	UN
113 Rushfoil (*Crotonopsis ellipitica*)		A	W	N	UN	UN	UN	UN	UN	UN	DE	UN
114 Poor Joe (*Diodia teres*)		A	W	N	UN	UN	DE	UN	UN	UN	DE	UN
115 Black Sampson (*Echinacea angustifolia*)		P	W	N	UN	UN	UN	DE	UN	UN	UN	UN
116 Leafy elephant's foot (*Elephantopus carolinianus*)		P	W	N	DE	UN	DE	DE	DE	UN	DE	DE
117 Engelmann's daisy (*Engelmannia pinnatifida*)		P	C	N	DE	UN	DE	DE	DE	UN	UN	UN
118 Daisy fleabane (*Erigeron strigosus*)		A	C	N	DE	UN	UN	DE	UN	UN	UN	UN
119 Leavenworth's eryngo (*Eryngium leavenworthi*)		P	W	N	UN	UN	UN	DE	UN	UN	UN	UN
120 Yuccaleaf eryngo (*Eryngium yuccifolium*)		P	W	N	UN	UN	UN	DE	UN	UN	UN	UN
121 White snakeroot (*Eupatorium rugosum*)		P	W	N	UN	UN	UN	DE	UN	UN	UN	DE
122 Snow-on-the-mountain (*Euphorbia marginata*)		A	W	N	UN	DE	DE	DE	UN	UN	DE	DE
123 Indian blanket (*Gaillardia pulchella*)		A	C	N	UN	UN	UN	DE	UN	UN	UN	UN
124 Woods bedstraw (*Galium circaezans*)		P	C	N	DE	UN	UN	UN	UN	UN	DE	UN
125 Carolina cranesbill (*Geranium carolinianum*)		A	C	N	UN	UN	UN	UN	UN	UN	UN	UN
126 Fragrant cudweed (*Gnaphalium obtusifolium*)		A	W	N	UN	UN	UN	DE	UN	UN	UN	DE
127 Curlycup gumweed (*Grindelia squarrosa*)		P	W	N	UN	UN	DE	DE	UN	UN	UN	UN
128 Common broomweed (*Gutierrezia dracunculoides*)		A	W	N	UN	UN	UN	DE	UN	UN	UN	DE
129 Broom snakeweed (*Gutierrezia sarothrae*)		P	W	N	UN	UN	UN	DE	UN	UN	UN	DE
130 Wax goldenweed (*Haplopappus ciliatus*)		A	W	N	UN	UN	DE	DE	UN	UN	DE	DE
131 Bitter sneezeweed (*Helenium amarum*)		A	W	N	UN	UN	UN	DE	UN	UN	UN	UN
132 Annual sunflower (*Helianthus annuus*)		A	W	N	DE	DE	DE	DE	DE	UN	DE	DE
133 Maximilian's sunflower (*Helianthus maximiliani*)		P	W	N	DE	UN	DE	DE	DE	UN	DE	DE
134 Ashy sunflower (*Helianthus mollis*)		P	W	N	UN	UN	DE	DE	DE	UN	DE	DE
135 Sump weed (*Iva annua*)		A	W	N	UN	UN	UN	UN	UN	UN	UN	UN
136 Summer cypress (*Kochia scoparia*)		A	W	IN, IV	UN	UN	UN	UN	UN	UN	UN	UN
137 Pepperweed (*Lepidium virgincum*)		A	C	N	UN	UN	UN	UN	DE	UN	UN	UN
138 Dotted gayfeather (*Liatris punctata*)		P	W	N	UN	UN	UN	LM	UN	UN	UN	UN
139 Yellow puccoon (*Lithospermum incisum*)		P	C	N	DE	UN	DE	LM	UN	UN	DE	UN
140 Lemon beebalm (*Monarda citriodora*)		A	C	N	DE	UN	UN	LM	UN	UN	UN	UN
141 Prickly pear (*Opuntia macrorhiza*)		P	W	N	UN	UN	UN	DE	UN	UN	UN	UN
142 Violet wood sorrel (*Oxalis violacea*)		A	C	N	DE	UN	DE	UN	UN	UN	DE	UN
143 Prairie phlox (*Phlox pilosa*)		P	C	N	DE	UN	UN	UN	DE	UN	DE	UN
144 Pokeweed (*Phytolacca americana*)		A	W	N	DE	UN	DE	DE	DE	UN	DE	DE
145 Pennsylvania smartweed (*Polygonum pensylvanicum*)		A	W	N	UN	UN	DE	LM	UN	UN	DE	DE
146 Self-heal (*Prunella vulgaris*)		A	W	N	UN	UN	UN	UN	UN	UN	UN	UN
147 Slender-leaved mountain mint (*Pycnathemum tenuifolium*)		P	W	N	UN	UN	UN	DE	UN	UN	UN	DE
148 Mexican Hat (*Ratibida columnifera*)		P	W	N	DE	UN	UN	DE	UN	UN	DE	UN
149 Blackeyed Susan (*Rudbeckia hirta*)		A	W	N	DE	UN	DE	DE	UN	UN	DE	UN
150 Wild petunia (*Ruellia humilis*)		P	C	N	DE	UN	UN	UN	UN	UN	DE	UN
151 Curly dock (*Rumex crispus*)		P	C	IN, IV	DE	UN	DE	LM	UN	UN	DE	UN
152 Russian-thistle (*Salsola tragus*)		A	W	IN, IV	UN	UN	UN	UN	UN	UN	UN	UN
153 Pitcher sage (*Salvia azurea*)		P	W	N	DE	UN	UN	UN	DE	UN	UN	UN
154 Threadleaf groundsel (*Senecio flaccidus*)		P	W	N	DE	UN	UN	UN	UN	UN	UN	UN

PLANT CHARACTERISTIC, ECOLOGICAL AND RESOURCE RATING GUIDE				RESOURCE VALUE RATING							
Perennial = P Annual = A Biennial = B Introduced = IN	Cool Season = C Warm Season = W Invasive = IV Native = N	PLANT CHARACTERISTICS LH = Life History SG = Season of Growth OR = Origin			Desirable = De Limited = LM Undesirable = Un							
					WT Deer		BW Quail		Cattle		Turkey	
		LH	SG	OR	Food	Cover	Food	Cover	Food	Cover	Food	Cover
155 Compass plant (*Silphium laciniatum*)		P	W	N	DE	DE	DE	DE	DE	UN	DE	DE
156 Silverleaf nightshade (*Solanum elaeagnifolium*)		P	W	N	UN	UN	UN	UN	UN	UN	UN	UN
157 Buffalo bur (*Solanum rostratum*)		A	W	N	UN	UN	UN	UN	UN	UN	UN	UN
158 Canada goldenrod (*Solidago canadensis*)		P	W	N	DE	UN	UN	DE	UN	UN	DE	DE
159 Goat's beard (*Tragopogon pratensis*)		A	C	IN	UN	UN	DE	UN	UN	UN	UN	UN
160 Mullein (*Verbascum thapsus*)		A	C	IV	UN	UN	UN	UN	UN	UN	UN	UN
161 Western ironweed (*Vernonia baldwinii*)		P	W	N	UN	UN	UN	DE	UN	UN	UN	LM
162 Cocklebur (*Xanthium strumarium*)		A	W	IN, IV	UN	UN	UN	LM	UN	UN	UN	UN
163 Yucca (*Yucca glauca*)		P	C	N	UN	UN	UN	UN	UN	UN	UN	UN
WOODIES												
164 False indigo (*Amorpha fruticosa*)		P	W	N	DE	DE	DE	DE	DE	LM	DE	DE
165 Sand sagebrush (*Artemisia filifolia*)		P	W	N	UN	DE	UN	DE	UN	UN	UN	DE
166 Chittamwood (*Bumelia lanuginosa*)		P	W	N	DE	DE	DE	DE	DE	UN	DE	DE
167 American beautyberry (*Callicarpa americana*)		P	W	N	DE	DE	DE	DE	UN	UN	DE	DE
168 Pecan (*Carya illinoensis*)		P	W	N	DE	DE	UN	UN	UN	UN	DE	DE
169 New Jersey Tea (*Ceanothus americanus*)		P	W	N	DE	DE	UN	DE	DE	UN	UN	DE
170 Sugarberry (*Celtis laevigata*)		P	W	N	DE	DE	DE	DE	DE	DE	DE	DE
171 Buttonbush (*Cephalanthus occidentalis*)		P	W	N	UN	DE	UN	DE	UN	UN	UN	DE
172 Redbud (*Cercis canadensis*)		P	W	N	UN	DE	DE	DE	DE	DE	DE	DE
173 Carolina snailseed (*Cocculus caroliniana*)		P	W	N	DE	UN	DE	UN	DE	UN	DE	DE
174 Rough-leaf dogwood (*Cornus drummondii*)		P	W	N	DE	DE	DE	DE	UN	UN	DE	DE
175 Green hawthorn (*Crataegus viridis*)		P	W	N	DE	DE	LM	DE	UN	UN	DE	DE
176 Persimmon (*Diospyros virginiana*)		P	W	N	DE	DE	DE	DE	UN	UN	DE	DE
177 Honey locust (*Gleditsia triacanthos*)		P	W	N	DE	DE	UN	UN	UN	UN	UN	UN
178 St. Andrew's cross (*Hypericum hypercoides*)		P	W	N	UN	UN	UN	UN	UN	UN	UN	DE
179 Eastern redcedar (*Juniperus virginiana*)		P	C	N, IV	UN	UN	UN	UN	UN	LM	UN	UN
180 Osage orange (*Maclura pomifera*)		P	W	N	LM	DE	UN	DE	UN	UN	UN	DE
181 Virginia creeper (*Parthenocissus quinquefolia*)		P	W	N	DE	DE	DE	DE	DE	UN	DE	DE
182 Eastern cottonwood (*Populus deltoides*)		P	W	N	LM	DE	UN	UN	DE	DE	UN	DE
183 Honey mesquite (*Prosopis glandulosa*)		P	W	N, IV	DE	DE	LM	DE	UN	DE	UN	DE
184 Sand plum (*Prunus angustifolia*)		P	W	N	DE	DE	UN	DE	UN	LM	DE	DE
185 Shinnery oak (*Quercus havardii*)		P	W	N	DE	DE	DE	DE	UN	DE	DE	DE
186 Blackjack oak (*Quercus marilandica*)		P	W	N	DE	DE	DE	DE	UN	DE	DE	DE
187 Postoak (*Quercus stellata*)		P	W	N	DE	DE	DE	DE	UN	DE	DE	DE
188 Black oak (*Quercus velutina*)		P	W	N	DE	DE	DE	UN	UN	DE	DE	DE
189 Carolina buckthorn (*Rhamnus caroliniana*)		P	W	N	DE	DE	DE	DE	UN	LM	DE	DE
190 Lemon sumac (*Rhus aromatica*)		P	W	N	DE	DE	DE	DE	UN	LM	DE	DE
191 Smooth sumac (*Rhus glabra*)		P	W	N	DE	DE	DE	DE	UN	LM	DE	DE
192 Black locust (*Robinia pseudoacacia*)		P	W	N, IV	LM	DE	DE	DE	UN	DE	DE	DE
193 Prairie rose (*Rosa setigera*)		P	W	N	DE	UN	UN	DE	UN	UN	UN	DE
194 Oklahoma blackberry (*Rubus oklahomus*)		P	W	N	DE	UN	DE	DE	UN	UN	DE	DE
195 Willow (*Salix nigra*)		P	W	N	UN	DE	UN	DE	DE	DE	UN	DE
196 Elderberry (*Sambucus canadensis*)		P	W	N	DE	DE	DE	DE	DE	LM	DE	DE
197 Soapberry (*Sapindus drummondii*)		P	W	N	UN	DE	UN	DE	UN	DE	UN	DE
198 Greenbrier (*Smilax bona-nox*)		P	W	N	DE	DE	DE	DE	DE	UN	DE	DE
199 Buckbrush (*Symphoricarpos orbiculatus*)		P	W	N	DE	DE	LM	DE	UN	UN	LM	DE
200 Saltcedar (*Tamarix chinensis*)		P	W	IN, IV	UN	UN	UN	UN	UN	UN	UN	UN
201 Poison-ivy (*Toxicodendron radicans*)		P	W	N	DE	UN	DE	DE	UN	UN	DE	DE
202 Winged elm (*Ulmus alata*)		P	W	N	DE	DE	UN	DE	DE	UN	DE	DE
203 American elm (*Ulmus americana*)		P	W	N	DE	DE	UN	UN	DE	DE	DE	DE
204 Farkleberry (*Vaccinium arboreum*)		P	W	N	DE	DE	DE	DE	DE	LM	DE	DE
205 Southern blackhaw (*Viburnum rufidulum*)		P	W	N	DE	DE	DE	DE	DE	LM	DE	DE
206 Muscadine (*Vitis rotundifolia*)		P	W	N	DE	DE	DE	DE	DE	UN	DE	DE

The Oklahoma Cooperative Extension Service
Bringing the University to You!

The Cooperative Extension Service is the largest, most successful informal educational organization in the world. It is a nationwide system funded and guided by a partnership of federal, state, and local governments that delivers information to help people help themselves through the land-grant university system.

Extension carries out programs in the broad categories of agriculture, natural resources and environment; family and consumer sciences; 4-H and other youth; and community resource development. Extension staff members live and work among the people they serve to help stimulate and educate Americans to plan ahead and cope with their problems.

Some characteristics of the Cooperative Extension system are:

- The federal, state, and local governments cooperatively share in its financial support and program direction.
- It is administered by the land-grant university as designated by the state legislature through an Extension director.
- Extension programs are nonpolitical, objective, and research-based information.
- It provides practical, problem-oriented education for people of all ages. It is designated to take the knowledge of the university to those persons who do not or cannot participate in the formal classroom instruction of the university.
- It utilizes research from university, government, and other sources to help people make their own decisions.
- More than a million volunteers help multiply the impact of the Extension professional staff.
- It dispenses no funds to the public.
- It is not a regulatory agency, but it does inform people of regulations and of their options in meeting them.
- Local programs are developed and carried out in full recognition of national problems and goals.
- The Extension staff educates people through personal contacts, meetings, demonstrations, and the mass media.
- Extension has the built-in flexibility to adjust its programs and subject matter to meet new needs. Activities shift from year to year as citizen groups and Extension workers close to the problems advise changes.

Issued in furtherance of Cooperative Extension work, acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, Robert E. Whitson, Director of Cooperative Extension Service, Oklahoma State University, Stillwater, Oklahoma. This publication is printed and issued by Oklahoma State University as authorized by the Vice President, Dean, and Director of the Division of Agricultural Sciences and Natural Resources and has been prepared and distributed at a cost of 42 cents per copy. 0704 JA

OKLAHOMA COOPERATIVE EXTENSION SERVICE [PSS-2207]

How to Get a Good Soil Sample

February 2017

Soil tests provide a scientific basis for evaluating available plant nutrients in cropland, pastures, lawns, and gardens. Analyses of soil samples can help farmers and homeowners fine-tune nutrient applications from fertilizers, biosolids, and animal manure. Properly managing the amount of nutrients added to the soil can save money and protect the environment.

Soil nutrients vary by location, slope, soil depth, soil texture, organic matter content, and past management practices, so getting a good soil sample stands out as a major factor affecting the accuracy and usefulness of soil testing. This fact sheet outlines some specific considerations which should be taken into account to get the greatest benefit from soil testing.

Sample Soil at the Right Time

Fields used for production of cultivated crops may be sampled any time after harvest or before planting. Generally, two weeks should be allowed for mailing, analysis, and reporting of results. Additional time may need to be allotted for ordering and application of fertilizers, manure, or lime materials. Noncultivated fields should be sampled during the dormant season. In either case, do not sample immediately after lime, fertilizer, or manure applications because those samples do not represent the true soil fertility.

Fields should be tested annually to measure the available nitrogen pool or as frequently as necessary to gain an understanding of how soil properties may be changing in relation to cultural practices and crop production.

Collect a Representative Sample

Getting a representative sample is simple, but not easy. Research at OSU and other universities has clearly shown that a minimum of 20 cores or small samples taken randomly from the field or area of interest are necessary to obtain a sample which will represent an average of the soil in the field (Figure 1). These cores should be collected in a clean plastic bucket (to avoid metal contamination) and mixed thoroughly by hand. The sample bag should be filled from the mixture. A one pint (OSU soil sample bag full) sample is usually adequate for all tests which might be required. If the sample is too wet to mix, it should be spread out to dry some and then mixed, or sampling should be delayed until the field is drier.

It is important to remember that the sample obtained by the above procedure will be an average of the area sampled. If the area sampled is extremely variable in the soil properties which are going to be tested, then it may be better to separate the field into smaller areas, and get a representative (20 cores) sample from each of these areas in order to determine how variable the field is (Figure 2). In this way, it may be possible to treat some areas of the field differently from others and remove variability so that the field can be sampled and treated as a unit in the future. Variability in a field can often be noted by differences in surface soil color and crop growth or yield.

Using only one sample for a large variable field can be very costly. Since the sample represents an average of the soil in that field, recommendations based on the soil test will likely cause the field to be overfertilized on some parts and underfertilized on other parts. Failure to obtain uniform response to treatments based on a soil test is frequently a result of one sample being used to represent a large variable field.

An example of field variability is shown in Table 1. The range of test values was obtained by testing 40 individual cores taken at random from an "apparently uniform " 80-acre field. The variation is great enough so that for some analyses the average is not a good representation of the field. Areas of the field with the lowest pH, phosphorus, and potassium values will not receive adequate lime or fertilizer if recommendations are based on the average test values.

A single core sample, or spadeful, is extremely risky because it may test anywhere in the range shown for each of the analyses. For example, deficiencies for wheat could range from zero to 37 pounds of P_2O_5 and zero to 34 pounds of K_2O. For alfalfa, which has much greater nutrient requirements, deficiencies could range from zero to 94 pounds of P_2O_5 and zero to 120 pounds of K_2O. This would also affect the amount of nitrogen and lime required. Obviously, unless the 80 acres is divided into less variable units for testing, some areas of the field will receive either too much or too little fertilizer and lime.

In deciding how large an area can be represented by one composite sample (20 cores), the determining factor is not the number of acres involved, but rather, the variability of the area. Some large, uniform fields can be represented well by a single 20-core sample, while some highly variable fields need to be split into two or more smaller areas for testing. Regardless of the field size or main area being sampled, unusual spots in the field (salty or wet spots) should be avoided during the initial random sampling. When unusual spots make up a significant area, they should be sampled separately.

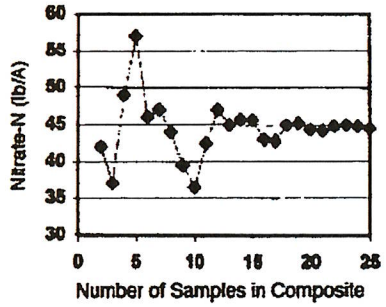

Figure 1. The minimum number of core samples needed to make a representative composite sample is about 20.

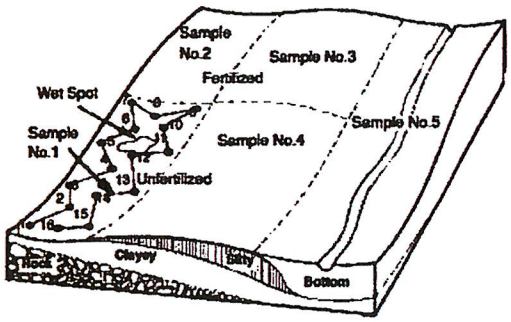

Figure 2. Divide field into uniform sampling areas and follow a random pattern when sampling. Avoid unusual spots and try to obtain a representative sample.

Table 1. Variability of an 80 Acre Field Based on Soil Tests of 40 Individual Soil Cores .

	Soil Test Values	
Analysis	Range	Average

	Soil Test Values	
pH	4.9-6.3	5.6
Buffer Index	7.1-7.4	7.3
Nitrogen	1-34	11
Phosphorus	23-114	36
Potassium	149-770	306

Sampling Where Nutrients are Banded

It is a challenge to sample fields where fertilizers have been band applied. Research has shown that soil test P values are not increased beyond 2 inches from the band of fertilizer placement. If a soil sample is collected from the banding zone, it has the risk to greatly skew the results of a soil test, ultimately leading to under-fertilization and yield loss. Some soils though, have very high P fixing capabilities, and the amount of available P is very small a year after application. This is commonly seen in soils with very low or high soil pH. In these conditions, where row spacing is less than 12 inches (e.g., winter wheat), it is not necessary to change sampling procedures discussed earlier.

The primary concern with banding fertilizer is with no-till production of row crops. There are three situations you may encounter: 1) planting over existing rows, 2) knowing the location of rows but not planting over them, and 3) previous rows are unknown. All three situations require a different sampling strategy. When you are planting over past rows, it is important to know the residual of past bandings, so it is recommended to sample in the area around the rows.

When sampling where band location is known, but new row placement is unknown, there is a sampling scheme that can be used to give a more accurate result. A minimum number of sub-samples are required from the area between two bands for every one sub-sample collected from the band. Table 2 shows how many sub-samples between bands need to be collected for one sub-sample from the band for different row spacing.

Table 2. The number of sub-samples to collect from between bands for each sub-sample within band.

Band Spacing (in)	Sub-samples between bands
15	10
24	16
30	20
40	27

When collecting soil samples from a field where previous bands are unknown, the common recommendation is that for every core taken, collect an extra sample half the distance of the row spacing away from the first core. For example, sampling a field that was previously in corn on 30-inch row spacing, when you collect one core sample, move over 15 inches and collect a second sample before moving on. Therefore, instead of 15 cores total, you need to collect 15 pairs, or 30 cores to make a composite sample. This method has shown to improve the accuracy of the soil sample greatly. The most important thing to keep in mind is that the greatest error occurs when too few samples are taken. By increasing the number of soil samples collected per composite the accuracy of the soil test results are improved.

Sample at Proper Depth

Cultivated Fields

For most soil tests the sampling depth is the tillage depth. The reason for this is because most crops have their greatest root activity in the tillage depth. Obtaining a representative sample with regard to depth means that each of the 20 cores taken from an area should be from similar depth, tillage, or six inches. Soil tests are generally calibrated on the basis of an acre furrow slice, approximately two million pounds of soil in the top six inches.

For deep-rooted nonlegumes such as wheat, bermudagrass, sorghum, and cotton, a separate sample representative of the subsoil should be taken in addition to the tillage depth or six-inch sample. This subsoil sample should represent the layer of soil from 6 to 18 inches below the surface. Because nitrate-nitrogen is mobile in the soil, a test of available nitrogen (and/or chloride and sulfate) in the subsoil sample will provide a more complete picture of available mobile nutrients for these crops (Figure 3) and can save fertilizer expenses.

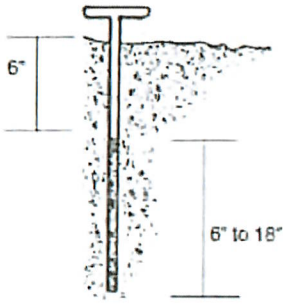

Figure 3. A soil probe is a good tool for obtaining soil samples. Push the tube to the six-inch depth and remove the core. Then take the 6- to 18-inch core through the same hole for the subsoil test.

No-till Fields

Noncultivated fields should be sampled to a depth of six inches, again because this is the effective depth of most treatments and the depth of most root activity. Nutrients from fertilizer, animal manure, and lime can be accumulated on the surface if they are surface applied without incorporation. A set of samples from the top two inches will help identify stratification of nutrients and is especially important for pH determination for no-till fields. If nutrient loss in runoff is the main concern, the two-inch sample is better than a six-inch sample because only the surface inch or two is in direct contact with surface runoff.

Salinity Diagnosis

When salt accumulation is suspected as a cause of poor stand establishment and the sample is being taken after planting, then the depth of sampling should approximate the seeding depth (one to three inches). This is especially important when conditions have been favorable for soluble salts to move upward and accumulate near the surface after planting. Since excess salts are most harmful to germination and seedling vigor, it is this shallow depth which should be tested. At other times during the year, a sample of the entire tillage depth may be most useful to test for salt accumulation.

Send Samples for Analysis

Soil sample bags are available at local county Extension offices. Extension offices will mail your samples to the OSU Soil, Water and Forage Analytical Laboratory and assist you to interpret test results.

Hailin Zhang

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Oklahoma Cooperative Extension Service

Other Oklahoma Cooperative Extension Fact Sheets are available on our website at: factsheets.okstate.edu

Issued in furtherance of Cooperative Extension work, acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, Director of Oklahoma Cooperative Extension Service, Oklahoma State University, Stillwater, Oklahoma. This publication is issued by Oklahoma State University as authorized by the Vice President, Dean, and Director of the Division of Agricultural Sciences and Natural Resources.

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OSU Soil Test Interpretations

October 2017

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Oklahoma Cooperative Extension Fact Sheets are also available on our website at: **facts.okstate.edu**

The following tables are soil test interpretations of major crops for the most commonly deficient plant nutrients in Oklahoma. These relationships are valid for interpreting soil test values from the OSU Soil, Water, and Forage Analytical Laboratory and are not intended for use with soil test results from other laboratories due to differences in testing procedures and field calibration. Nitrogen and sulfur requirements are based on yield goal. Other nutrient requirements are based on soil test values and their corresponding sufficiency levels. Requirements for phosphorus and potassium are annual amounts that must be applied each year to prevent deficiencies until another soil test is performed. Read the text following the tables before determining fertilizer rates. See HLA-6036 for soil test interpretations of vegetable crops.

Table 1. Primary Nutrient Soil Test Interpretations for Selected Small Grains and Row Crops.

Nitrogen Requirements

SMALL GRAIN Yield Goal (bu/A)			N	GRAIN SORGHUM		CORN		COTTON		CANOLA	
Wheat	Barley	Oats	(lbs/A)	Yield Goal (lbs/A)	N (lbs/A)	Yield Goal (bu/A)	N (lbs/A)	Yield Goal (bales/A)	N (lbs/A)	Yield Goal (lbs/A)	N (lbs/A)
15	20	25	**30**	2000	**30**	40	**40**	1.0	**50**	1000	**50**
20	25	35	**40**	2500	**40**	50	**50**	1.5	**75**	1500	**75**
30	35	55	**60**	3000	**50**	60	**60**	2.0	**100**	2000	**100**
40	50	70	**80**	4000	**70**	85	**85**	2.5	**125**	2500	**125**
50	60	90	**100**	4500	**85**	100	**110**	3.0	**150**	3000	**150**
60	75	105	**125**	5000	**100**	120	**130**	3.5	**175**	3500	**175**
70	90	125	**155**	7000	**160**	160	**190**	>3.5	**175**		
80	100	140	**185**	8000	**195**	180	**215**				
100	125	175	**240**	9000	**230**	200	**240**				

Phosphorus Requirements

P SOIL TEST INDEX	SMALL GRAINS		GRAIN SORGHUM		CORN		COTTON		CANOLA	
	Percent Sufficiency	P_2O_5 (lbs/A)	Percent Sufficiency	P_2O_5 (lbs/A)	Percent Sufficiency	P_2O_5 (lbs/A)	Percent Sufficiency	P_2O_5 (lbs/A)	Percent Sufficiency	P_2O_5 (lbs/A)
0	25	80	40	60	30	80	55	75	25	80
10	45	60	60	50	60	60	70	60	45	60
20	80	40	80	40	80	40	85	45	80	40
40	90	20	95	20	95	20	95	30	90	20
65+	100	0	100	0	100	0	100	0	100	0

Potassium Requirements

K SOIL TEST INDEX	SMALL GRAINS		GRAIN SORGHUM		CORN		COTTON		CANOLA	
	Percent Sufficiency	K_2O (lbs/A)	Percent Sufficiency	K_2O (lbs/A)	Percent Sufficiency	K_2O (lbs/A)	Percent Sufficiency	K_2O (lbs/A)	Percent Sufficiency	K_2O (lbs/A)
0	50	60	40	100	40	120	40	110	50	60
75	70	50	65	75	60	80	60	80	70	50
125	80	40	80	50	75	60	75	60	80	40
200	95	20	95	30	90	40	90	40	95	20
250+	100	0	100	0	100	0	100	0	100	0

* The soil test index is two times the ppm (parts per million) value reported by many labs.

Table 2. Primary Nutrient Soil Test Interpretations for Selected Grasses and Silage.

Nitrogen Requirements

COOL SEASON GRASSES (FESCUE, ORCHARD, RYE)		WEEPING LOVEGRASS		BLUESTEM		BERMUDAGRASS		FORAGE SORGHUM OR CORN SILAGE		
Yield Goal (tons/A)	N (lbs/A)	**Yield Goal (tons/A)**	N (lbs/A)	**Yield Goal (tons/A)**	N (lbs/A)	**Yield Goal (tons/A)**	N (lbs/A)	**Yield Goal (tons/A) Silage**	**(tons/A) Hay**	N (lbs/A)
1	60	**1**	35	**1**	35	**1**	50	**5**	**2.5**	45
2	120	**2**	70	**2**	70	**2**	100	**10**	**5.0**	90
3	180	**3**	110	**3**	110	**3**	150	**15**	**7.5**	135
4	240	**4**	160	**4**	150	**4**	200	**20**	**10.0**	185
5	300	**5**	220	**5**	200	**5**	260	**25**	**12.5**	240
						6	320	**30**	**15.0**	300
						7	400			

Phosphorus Requirements

P SOIL TEST INDEX	COOL SEASON GRASSES (FESCUE, ORCHARD, RYE)		WEEPING LOVEGRASS		BLUESTEM		BERMUDAGRASS		FORAGE SORGHUM OR CORN SILAGE	
	Percent Sufficiency	P_2O_5 (lbs/A)	Percent Sufficiency	P_2O_5 (lbs/A)	Percent Sufficiency	P_2O_5 (lbs/A)	Percent Sufficiency	P_2O_5 (lbs/A)	Percent Sufficiency	P_2O_5 (lbs/A)
0	30	80	50	60	50	60	50	75	30	100
10	50	60	70	40	70	40	65	60	60	75
20	70	40	85	30	85	30	80	40	80	45
40	95	30	95	20	95	20	95	20	95	25
65+	100	0	100	0	100	0	100	0	100	0

Potassium Requirements

K SOIL TEST INDEX	COOL SEASON GRASSES (FESCUE, ORCHARD, RYE)		WEEPING LOVEGRASS		BLUESTEM		BERMUDAGRASS		FORAGE SORGHUM OR CORN SILAGE	
	Percent Sufficiency	K_2O (lbs/A)	Percent Sufficiency	K_2O (lbs/A)	Percent Sufficiency	K_2O (lbs/A)	Percent Sufficiency	K_2O (lbs/A)	Percent Sufficiency	K_2O (lbs/A)
0	60	70	40	80	40	80	50	140	40	180
75	70	60	60	60	60	60	65	80	60	130
125	80	50	80	40	80	40	80	50	75	90
200	95	30	95	20	95	20	95	30	90	60
250+	100	0	100	0	100	0	100	0	100	0

Table 3. Primary Nutrient Soil Test Interpretations for Selected Forages.

Nitrogen Requirements

SMALL GRAINS FOR GRAZING		*LEGUMES IN PASTURE*	*NEW SEEDING OF INTRODUCED GRASSES*	*VIRGIN NATIVE HAY MEADOWS*	
Yield Goal (tons/A)	N (lbs/A)	Legumes will produce nitrogen for their growth. Very little nitrogen remains for the grasses after legume growth stops unless the legume growth is not harvested but allowed to decay.	40 lbs of nitrogen is needed to establish a grass. Refer to other table for nitrogen requirement for production.	**Yield Goal (tons/A)**	N (lbs/A)
0.5	30			**1.0**	0
1.0	60			**1.5**	50
1.5	90			**1.6**	100
2.0	120				
2.5	150				
3.0	180				

Phosphorus Requirements

P SOIL TEST INDEX	*SMALL GRAINS FOR GRAZING*		*LEGUMES IN PASTURE*		*NEW SEEDINGS OF INTRODUCED GRASSES*		*VIRGIN NATIVE HAY MEADOWS*	
	Percent Sufficiency	*P_2O_5 (lbs/A)*	*Percent Sufficiency*	*P_2O_5 (lbs/A)*	*Percent Sufficiency*	*P_2O_5 (lbs/A)*	*Percent Sufficiency*	*P_2O_5 (lbs/A)*
0	25	80	50	75	30	80	50	40
10	45	60	65	60	50	60	80	20
20	80	40	80	40	70	40	95	0
40	90	20	95	20	95	20	100	0
65+	100	0	100	0	100	0	100	0

Potassium Requirements

K SOIL TEST INDEX	*SMALL GRAINS FOR GRAZING*		*LEGUMES IN PASTURE*		*NEW SEEDINGS OF INTRODUCED GRASSES*		*VIRGIN NATIVE HAY MEADOWS*	
	Percent Sufficiency	*K_2O (lbs/A)*	*Percent Sufficiency*	*K_2O (lbs/A)*	*Percent Sufficiency*	*K_2O (lbs/A)*	*Percent Sufficiency*	*K_2O (lbs/A)*
0	50	60	50	80	50	80	40	40
75	70	50	65	60	65	60	70	30
125	80	40	80	40	80	40	85	20
200	95	20	95	20	95	20	95	0
250+	100	0	100	0	100	0	100	0

Table 4. Primary Nutrient Soil Test Interpretations for Selected Legumes.

Nitrogen Requirements

ALFALFA	*PEANUTS*	*SOYBEANS*	*MUNGBEANS, COWPEAS, & GUAR*
10-20 lbs/A for establishment. None needed for maintenance.	10-20 lbs/A with P & K.	10-20 lbs/A with P & K. Inoculate seed.	10-20 lbs/A with P & K. Inoculate seed.

Phosphorus Requirements

P SOIL TEST INDEX	*ALFALFA*		*PEANUTS*		*SOYBEANS*		*MUNGBEANS, COWPEAS, & GUAR*	
	Percent Sufficiency	*P_2O_5 (lbs/A)*	*Percent Sufficiency*	*P_2O_5 (lbs/A)*	*Percent Sufficiency*	*P_2O_5 (lbs/A)*	*Percent Sufficiency*	*P_2O_5 (lbs/A)*
0	20	200	40	80	40	70	40	70
10	50	150	60	60	60	50	60	50
20	70	100	80	40	80	30	80	30
40	90	60	90	20	90	20	90	20
65+	100	0	100	0	100	0	100	0

Potassium Requirements

K SOIL TEST INDEX	*ALFALFA*		*PEANUTS*		*SOYBEANS*		*MUNGBEANS, COWPEAS, & GUAR*	
	Percent Sufficiency	*K_2O (lbs/A)*	*Percent Sufficiency*	*K_2O (lbs/A)*	*Percent Sufficiency*	*K_2O (lbs/A)*	*Percent Sufficiency*	*K_2O (lbs/A)*
0	20	280	40	80	40	100	50	80
75	50	210	60	60	60	70	60	60
125	70	140	75	40	75	60	80	45
200	90	80	90	30	90	40	90	30
275	95	40	100	0	100	0	100	0
350+	100	0						

Notes for Nitrogen (N) Interpretations

The nitrogen fertilizer rate is calculated by subtracting the soil test nitrogen value from the nitrogen requirement for a selected crop and yield goal. For deep rooted non-legume crops such as wheat or bermudagrass, a sample representing the 6 to 18 inch subsoil layer should accompany the surface soil for a separate available nitrogen test. If the subsoil sample depth is other than 6 to 18 inches, the actual depth should be recorded on the sample bag and the test result adjusted for the difference. The subsoil only needs to be tested for nitrate-nitrogen. If sulfate and chloride are tested in the surface, subsoil sample should also be included. Yield goals should be sufficiently greater than long-term average yields to insure nitrogen will not be the factor limiting crop production during years with better than average growing conditions. As a rule of thumb, the average yield from the last five years plus 20 percent is an appropriate yield goal.

Forage production under grazing conditions can be roughly estimated by assuming 1000 pounds of small grain forage, or 1500 to 2000 pounds of other types of forage, will be required to produce 100 lbs of beef. The actual conversion rate varies depending on the quality and condition of the pasture and livestock. If small grain is used for grazing and grain production, additional N needs to be considered to replace N removed as beef. Two pounds of N are still needed to produce one bushel of grain, but 30 lbs. N are needed to produce 100 lbs. of beef or 1000 lbs. of forage grazed. Therefore, N requirement for dual purpose wheat is:

N (lbs./acre) = 2 x yield goal (bu./A) + 0.3 x beef (lbs./A) – soil test N (lbs./A)

Seasonal nitrogen requirements for actively growing sorghum sudans and bermudagrass pastures may be split to provide 50-60 lbs of actual nitrogen every 4-6 weeks. The same split application should be made for each cutting of sorghum sudan hay. For bermudagrass hay, the total seasonal nitrogen requirement can be applied in early spring except for very deep sandy soils under high rainfall or irrigation where split application is needed.

Small grains following alfalfa will generally not need nitrogen for one year. Credits should be given to available nutrients from animal manure and biosolids applications.

Table 5. N, P and K Soil Test Interpretations for Lawn and Garden.

Nitrogen Recommendation	
Soil Test N (lbs/A)	*N (lbs/1000sq. ft)*
0-15	1.0
15-30	0.7
30-45	0.3
>45	0.0

Phosphorus Recommendations	
P Soil Test Index	*P_2O_5 (lbs/1000 sq. ft)*
0-20	2.5
20-40	2.0
40-65	1.0
>65	0

Potassium Recommendations	
K Soil Test Index	*K_2O (lbs/1000 sq. ft)*
0-100	6
100-200	3
200-300	1
>300	0

Secondary Nutrient Interpretations

Calcium (Ca)

Calcium deficiency has not been observed on any crop except peanuts. Gypsum may be applied over the pegging zone during early bloom stage to correct the deficiency for peanut. Appropriate rates are listed in Table 6.

Magnesium (Mg)

Magnesium deficiencies are indicated by soil test index values less than 100 lbs/A. Deficiencies can be corrected by applying 30-40 lbs of magnesium fertilizer per acre or by using dolomitic limestone if lime is needed.

Table 6. Recommended Gypsum Rates to Alleviate Calcium Deficiency in Peanuts.

Calcium Soil Test Index (lb/A)	*Gypsum Needed (lb/A)*
0-150	750
150-300	500
300-450	400
450-600	300
600-750	200
750+	0

Sulfur (S)

Sulfur is a mobile nutrient in the soil and therefore plant requirements are based on yield goals similar to that of nitrogen. Sulfur requirements for non-legumes are calculated by dividing the nitrogen requirement by 10. The available S measured by the S soil test for both the surface and subsoil is subtracted from the S requirement to determine the fertilizer rate. The rate may also be reduced by an additional 6 lbs/acre due to sulfur supplied through rainfall and other incidental additions such as N, P, and K fertilizer impurities. The following is an example for bermudagrass:

Crop: bermudagrass

1) Yield goal: 6 tons/acre
2) N requirement (Table 2) = 320 lbs/acre
3) S requirement = N req/10 = 320/10 = 32 lbs/acre
4) Sulfur soil test values: surface = 5 lbs/acre
   subsoil = 12 lbs/acre
   total = 5 + 12 = 17 lbs/acre
5) Incidental sulfur additions: 6 lbs/acre
6) Sulfur fertilizer rate = 32 - 17 - 6 = 9 lbs S/acre

A similar calculation is used to determine the sulfur fertilizer rate for legumes, with the exception that the sulfur requirement is obtained from Table 7 rather than dividing the nitrogen requirement by 10.

Table 7. Sulfur Requirements for Legumes.

ALFALFA		*PEANUTS*		*SOYBEANS*	
Yield Goal (tons/A)	*S (lbs/A)*	***Yield Goal (cwt/A)***	*S (lbs/A)*	***Yield Goal (bu/A)***	*S (lbs/A)*
2	12	**6**	4	**10**	6
4	22	**12**	6	**20**	12
6	34	**18**	10	**30**	18
8	44	**24**	14	**40**	24
10	56	**30**	18	**50**	30
		36	22	**60**	36

MUNGBEANS		*COWPEAS*	
Yield Goal (tons/A)	*S (lbs/A)*	***Yield Goal (cwt/A)***	*S (lbs/A)*
5	3	**5**	3
10	6	**10**	5
15	9	**15**	8
20	12	**20**	11

Micro-Nutrient Interpretations

Zinc (Zn)

The soil test interpretation for zinc is presented in Table 8. Zinc soil test index values less than 0.30 ppm are considered deficient for all crops except small grains, cool season grasses (fescue, orchardgrass, and ryegrass) and new seedings of introduced grasses. The recommended rates are enough to correct a deficiency for several years. Applications should not be repeated until a new soil test is taken. Some producers may wish to apply 2 pounds of zinc per year until the total recommended amount is applied. Zinc can be toxic to peanut, so caution should be used when application is made.

Table 8. Zinc Soil Test Interpretation.

Zinc Soil Test Index (ppm)	*Interpretation*	*Zinc Requirement (lbs/A)*
0.0-0.3	Deficient for all crops except small grains, cool season grasses (fescue, orchard, and rye), and new seedings of introduced grasses.	6-10
0.3-0.8	Deficient for corn and pecans only.	2-5
0.8-2.0	Deficient for pecans only.	Foliar only.
2.0+	Adequate for all crops.	0

Iron (Fe)

Iron soil test values less than 2.0 ppm are considered low and may cause iron chlorosis in crops which are moderately sensitive such as wheat, soybeans, and peanuts. Soil test values in the medium range, 2.0-4.5 ppm, may cause chlorosis in sensitive crops such as sorghum and sudan. Levels above 4.5 ppm are usually adequate for all crops. Crop sensitivity is increased when soil pH increases above 8.2 and soil test manganese levels are high (above 50 ppm). Foliar application of a 3% ferrous sulfate (or ammonium ferrous sulfate) solution is effective for correction. Severe chlorosis may require several applications and may not be economic to correct. Effective control can be obtained by applying 2 lbs of iron per acre in chelated form or 8 lbs of ferrous sulfate per acre with ammonium polyphosphate solution in a band near the seed. It is important to apply polyphosphate and ferrous sulfate solutions in the same band (Table 9).

Table 9. Iron Soil Test Interpretation.

Iron Soil Test Value (ppm)	*Interpretation*	*Iron Requirement lbs/A*
< 2.0	Deficient for moderate sensitive crops, e.g., Wheat, soybean, peanuts.	2 foliar 8 banding
2.0 - 4.5	Def. for sensitive crops, e.g., sorghum and sudan.	2 foliar 8 banding
> 4.5	Adequate for all crops.	0

Manganese (Mn)

Soil test index levels less than 1.0 ppm manganese are considered deficient and levels above 1.0 ppm are considered adequate. To date, no deficient levels have been reported in Oklahoma. Levels above 50 ppm may be harmful; however, this problem can easily be corrected by a good liming program.

Boron (B)

Boron deficiency in Oklahoma is uncommon but may occur in legumes, particularly alfalfa and peanuts. The soil test interpretation for boron is presented in Table 10.

Table 10. Recommended Fertilizer Rates to Alleviate Boron Deficiency in Peanuts and Alfalfa.

Boron Soil Test Index (ppm)	*Boron Requirement --------(lbs/A)--------*	
	Peanuts	*Alfalfa*
0.0-0.25	1.0	2.0
0.25-0.50	0.5	1.0
0.50+	0.0	0.0

Chloride (Cl)

Some research has shown that small grains responded to Cl fertilization, especially in sandy soils. Collect both surface and sub-surface (6-18") soil samples if Cl nutrition is in questions. Current Cl recommendation is:

Cl (lbs/A) needed = 35 – soil Cl

Lime Requirements

The following should be considered when determining lime requirements:

1. A buffer index (BI) reading will be determined on all soils having a pH less than 6.3.
2. Refer to Table 11 for the lime requirement for each buffer index.
3. If the soil pH is less than 6.1, a minimum of 1.0 tons ECCE lime should be applied to alfalfa regardless of the buffer index. Apply higher rates of lime if indicated by the buffer index, using split applications for established alfalfa.
4. A minimum of 0.5 tons ECCE lime should be applied whenever the soil pH is 0.5 units less than the low end of the pH range shown for the crop in the table of pH preferences of common field crops (Table 12).

Table 11. Lime Required to Raise Soil pH to 5.5 for Continuous Wheat and to pH 6.8 for Other Crops in the 6 Inch Acre Furrow Slice.

Soil Buffer Index	*All Crop but Continuous Wheat ECCE* Lime (tons/A)*	*Continuous Wheat ECCE* Lime (tons/A)*	*Lawn and Garden ECCE* Lime (lbs/1000sq. ft.)*
6.2	4.2	2.1	193
6.3	3.7	1.9	170
6.4	3.1	1.6	142
6.5	2.5	1.3	115
6.6	1.9	1.0	87
6.7	1.4	0.7	64
6.8	1.2	0.6	55
6.9	1.0	0.5	46
7.0	0.7	0.5	32
7.1	0.5	0.5	23
7.2+	0.0	0.0	0

* Effective Calcium Carbonate Equivalent - Pure calcium carbonate ground fine enough to be 100% effective. The rate of ag-lime to apply can be determined from the ECCE requirement using the following formula: Tons of ag-lime / A = Tons ECCE lime required / %ECCE x 100.

Table 12. Soil pH Preference of Selected Field Crops.*

Legumes	*pH Range*
Cowpeas, crimson clover, mungbeans, vetch	5.5-7.0
Peanuts, soybeans	5.8-7.0
Alsike, red, and white (ladino) clovers, arrowleaf clover	6.0-7.0
Alfalfa, sweet clover	6.3-7.5

Non-legumes	*pH Range*
Bluestem, fescue, native hay, weeping lovegrass	4.5-7.0
Buckwheat	5.0-6.5
Corn, guar, oats, orchardgrass, ryegrass, sorghum, sudan, wheat	5.5-7.0
Bermudagrass	5.7-7.0
Barley	6.3-7.0
Cotton	5.7-7.0

* Most legumes will tolerate a pH 0.5 units less and 1.0 units higher than indicated above, but production may be significantly reduced. Non-legumes tend to tolerate a pH 0.5 to 1.0 units less (but not less than 4.0) and 1.0 to 2.0 units higher than indicated.

5. It usually is not economical to apply less than 1 ton of ag-lime per acre due to cost of application.
6. When the recommended rate exceeds 5 tons/A, the application should be split to improve spreading and mixing with the soil. No more than 4 tons/A of ag-lime should be applied to established alfalfa or pasture at any one time.
7. When the recommended rate has been applied, it will take several weeks for the soil pH to change, but it should not be necessary to reapply lime for several years.
8. When liming for continuous wheat, it is only necessary to raise the pH not over 6.0 because higher pH may favor some root rot diseases. The minimum amount of lime to apply is 0.5 ton ECCE lime or 1/2 the amount recommended to raise soil pH to 6.8, whichever is greater (see Table 11).

Useful Conversion Factors

$K_2O = K \times 1.2$
$P_2O_5 = P \times 2.29$
lbs./A = ppm x 2 (6 inch depth)

Other Related Extension Publications

L-241 Test Service and Price List: Soil, Water, & Forage Analytical Laboratory
PSS-2207 How to Get a Good Soil Sample
PSS-2229 Soil pH and Buffer Index
PSS-2237 Sulfur Requirements of Oklahoma Crops
PSS-2240 Managing Acid Soils for Wheat Production
E-1039 Oklahoma Soil Fertility Handbook
E-1003 Oklahoma Homeowners Handbook for Soil and Nutrient Management

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Issued in furtherance of Cooperative Extension work, acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, Director of Oklahoma Cooperative Extension Service, Oklahoma State University, Stillwater, Oklahoma. This publication is printed and issued by Oklahoma State University as authorized by the Vice President for Agricultural Programs and has been prepared and distributed at a cost of 30 cents per copy. Revised 1017 GH.

OKLAHOMA COOPERATIVE EXTENSION SERVICE [PSS-2263]

Fertilizing Bermudagrass Hay and Pasture

October 2016

Bermudagrass is the single most important warm-season forage grass grown in Oklahoma. It is well adapted to the Oklahoma climate and soil types, which makes it relatively easy to maintain. It has the potential to produce high yields of high-quality hay and pasture. Unfortunately, much of the bermudagrass in Oklahoma produces less than its full potential. With adequate fertilization, some of the older bermudagrass varieties have the potential to produce up to 3 to 4 tons of forage per acre. Newer bermudagrass varieties can produce between 6 to 9 tons of forage per acre with a high level of management.

The potential for bermudagrass production in Oklahoma is generally limited first by the amount and distribution of rainfall that occurs during the growing season. However, soil depth also is important because it determines, to a large extent, the amount of water that can be stored. In most soils, one inch to two inches of water can be stored per foot of depth. If there is less than a foot of top soil to store water, bermudagrass yield will be limited regardless of the total rainfall.

Weak or slow growing bermudagrass may result from production on soils that are too shallow, too sandy, or too clayey. The primary reason for low forage yields and poor bermudagrass stands in Oklahoma, however, is inadequate soil fertility resulting from the continued use of improper fertilization and poor harvest management practices. Inadequate fertility can refer to any one or a combination of low soil pH, inadequate nitrogen (N) fertilization, inadequate soil phosphorus (P), and/or inadequate soil potassium (K) supply. All bermudagrass varieties respond to a good fertility program, which supplies adequate amounts of N, P and K. A soil test is the only way to determine if supplemental P or K is needed. Annual soil testing is required for intensively managed bermudagrass hay fields to monitor soil pH and nutrient availability. In grazed pastures, a soil test taken once every three years is adequate, unless there is a borderline nutrient deficiency. In these instances, annual soil testing is beneficial as well.

Actively-growing bermudagrass removes N, P_2O_5, and K_2O in an approximate ratio of 4:1:3. Based on this, yearly nutrient replacement values for P and K can be estimated. As an example, for each 100 pounds of applied N, bermudagrass would remove approximately 25 pounds of P_2O_5 and 75 pounds of K_2O. From a grazing management standpoint, this is not a large concern since the majority of the nutrients will remain in the pasture. For hay production, however, it will be important to replace the nutrients since much of the harvested hay will not be fed on the fields from where it was harvested.

Fertility as a Yield-Limiting Factor

Many recognize the importance of N in the production of bermudagrass. However, we should not forget that P and K fertility are also critical for proper growth and it is important to understand the interaction between N, P and K. It also is important to realize how fertility and nutrient availability interact to determine yield. Water availability and the availability of N determine the potential yield of bermudagrass. For example, if there is enough water to produce 6 tons per acre but only enough N to produce 4 tons per acre, the maximum of 4 tons per acre is all that will be produced. The same situation occurs for P and K. Forage growth potential is reduced if there are inadequate soil nutrient supplies either from the soil and fertilizers.

If there is adequate moisture and N to produce 5 tons per acre, but the soil test indicates a P sufficiency of 75 percent, the greatest attainable yield is 3.75 tons per acre (75 percent of the 5 tons per acre potential). In this case not only is there a loss of forage yield, but the efficiency of N fertilizer is reduced. This means that the 5 tons per acre of bermudagrass production fertilized at 250 pounds N acre (50 pounds N per ton) instead required 66.6

pounds N per ton. In order to achieve the maximum potential yields, about 45 lbs P_2O_5 per acre needs to be applied. Potassium has the similar effect on yield as P, and if insufficient, results in a reduction in forage yield and efficiency of the N fertilizer that was applied.

When both P and K are deficient, there is a multiplicative effect of the nutrients on bermudagrass forage yield. This means that if both nutrients are present at a level that is 75 percent sufficient, then overall sufficiency is 75 percent x 75 percent = 56 percent. Thus, the greatest potential yield without adding additional P and K fertilizer will be only 56 percent of the maximum potential (or about 3 tons peracre).

Forage yield for dryland bermudagrass forage production in Oklahoma is primarily limited by the amount and distribution of rainfall throughout the season. Nitrogen determines yield and is likely the driving factor in irrigated forage production. One must understand that N fertilization rates and recommendations provided by soil testing labs are given as pounds of actual N per acre. Every source of fertilizer sold on the market has a specific concentration of N. For example, 50 pounds of actual N per acre could be supplied by:

275 pounds of diammonium phosphate (18 percent N)
150 pounds of ammonium nitrate (34 percent N)
110 pounds of urea (46 percent N)
160 pounds of 32 percent urea ammonium nitrate (UAN) solution
180 pounds of 28 percent UAN solution

The source of the N fertilizer is another factor to be considered. Depending upon the time of the year and weather conditions, one source may be better than another. In most cases, it is advisable to avoid applying urea in the summer. Many studies have shown that more N from ammonium nitrate and UAN fertilizers are recovered in summer application than from urea. However, N applied in the spring when temperatures are cooler and with a greater probability of rainfall makes urea a better choice than other N forms. This is because the nitrate in the other sources is susceptible to leaching during high rainfall events resulting in increased N loss.

Urea is usually a cheaper source of N on a net N basis and commonly is the only commercially available N source. It is common for urea to be the only commercially available N source. Nitrogen volatilization losses from urea may be as great as 50 percent under a combination of high humidity, hot temperatures, and windy conditions. To reduce potential N volatilization losses from urea, it is best to apply urea fertilizers later in the day after the dew has dried. It also is important to apply urea no more than 7 days prior to an anticipated precipitation event.

Bermudagrass is a luxuriant consumer of K, which means that bermudagrass may extract K from the soil in excess of its physiological needs. If supplemental K fertilizer is needed, it is important to not apply more K than indicated in the soil test. In almost all cases, it is never economical to apply any nutrient above a soil test recommendation.

Yield Expectations

Bermudagrass is a valuable forage for many livestock producers because it offers a wide range of management options. It produces an extensive root system that allows it to be somewhat drought tolerant. Bermudagrass is hardy enough to survive Oklahoma climatic conditions with minimal management inputs, but it responds well to N fertilization and is capable of producing plentiful forage dry matter yields when soil moisture is adequate.

The next most limiting production factor is available N. Also, available soil moisture and available soil N are closely related because both move in the soil. Nitrogen will be moved to the roots as the plant absorbs water. For optimum bermudagrass production, a reasonable N rate appears to be in the range of 150 pounds to 200 pounds actual N per acre to produce 3 tons to 4 tons of forage per acre, although it is common to produce much greater yields ranging from 8 to 10 tons per acre using improved, hay-type varieties with higher levels of N fertilization and adequate moisture (Table 1.)

Table 1. Yield expectations for nonirrigated bermudagrass production[1].

Region	*Yield* ---*tons/acre*---
Eastern	5.0 to 10.0
Central	4.0 to 8.0
Western	3.0 to 6.0
Panhandle	2.0 to 4.0

[1]Yield expectations are based on using modern, tall, hay-type bermudagrass varieties grown under appropriate fertility practices and adequate precipitation.

Sustained moderate to high production from bermudagrass requires at least 150 pounds of actual N per acre per year. Depending on management objectives and soil type, N fertilizer can be applied in one application or in split applications. Applications of P and K should be made annually based on soil test recommendations. Lime applications based on soil test recommendations should be considered before soil pH falls below 5.5.

Dryland Bermudagrass Production

Bermudagrass will produce about 1 ton per acre with no applied N fertilizer. Bermudagrass yield responds in an almost linear manner to applied N according to a simple rule of thumb that each 50 pounds of N applied produces 1 ton of hay (up to 4 tons). Slightly higher amounts of N are needed for higher yields (Figure 1). Nitrogen efficiency is best at rates between 100 pounds and 200 pounds of N per acre.

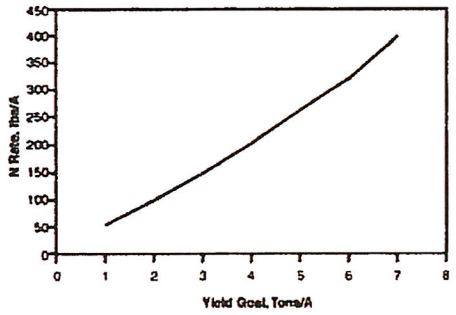

Figure 1. Relationship of bermudagrass forage yield to nitrogen (N) fertilization.

Irrigated Bermudagrass Production

Yield potential is much greater when bermudagrass is irrigated and yield goals can be increased accordingly. Consistent yields ranging from 10 tons to 15 tons per acre have been reported for irrigated bermudagrass in Oklahoma. The seasonal N requirements for irrigated production should be applied in split applications in relation to yield goal per cutting. As an example, four cuttings that total 12 tons per acre for the growing season would require 150 pounds of N for each cutting.

Common Types versus Upright Types

From a management standpoint it is important to realize that not all bermudagrass varieties respond to N fertilization the same. Bermudagrass varieties are often classified into two groups based primarily on their growth habit. The first group is referred to as common or grazing types, whereas the second group is sometimes called upright or hay types. The common types are usually shorter and form a more dense sod. The upright types tend to be taller and more open.

The common type cultivars have lower forage yield potential than the hay type cultivars once mature stands are established. It is important to note that the relation between N and yield is different for the common types than the upright types. The common types reach their maximum yield potential around 200 pounds of N per acre. Even with a higher N application, it is unlikely that the common types will produce greater than 4 tons of bermudagrass forage per acre. On the other hand, it is not uncommon for yields of the hay types to exceed 6 tons to 8 tons per acre.

Fertility Management

New Stands

Bermudagrass establishment can be expensive, so it is important to take management steps to ensure stand

survival. Correcting soil pH prior to establishment will allow for faster emergence and coverage. Early seedling vigor is closely tied to available P and K levels in the soil. Thus, newly seeded and sprigged bermudagrass stands can be negatively affected by inadequate P and K levels, as well as low soil pH. It is critical to correct soil P and K deficiencies prior to planting. On seedling bermudagrass stands, no more than 30 pounds N per acre should be applied at planting so weeds will not compete with the bermudagrass. Once the new plants have become established and have stolons at least 6 inches long, an additional 50 pounds N per acre should be applied to increase stand establishment. If managed properly, it may be possible to harvest hay during the establishment year.

Established Stands

Bermudagrass Hay

Planning for hay production is usually more straightforward when it is managed separately from grazing. The primary reason is because forage yield and quality are difficult to predict in hay harvested from pastures that are also grazed.

In many cases, managing hay separately from grazing may not require additional pastures or more acres. When nutrients and moisture are adequate, bemudagrass growth often exceeds livestock needs early in the season. Hay production can be planned so that some pastures are hayed early and then grazed later in the season.

To maximize fertilizer efficiency, it is important to fertilize bermudagrass according to its yield potential. By fertilizing for higher yields per acre, it may be possible to produce the annual pasture and hay requirement for a farm from fewer acres. This would result in lower equipment costs and P and K fertilizer costs, since fewer acres are required to produce an equivalent quantity of hay. When yield goals are increased, only the N requirement increases. The P and K recommendations remain the same regardless of the desired yield goal.

If the primary forage production goal is dryland (nonirrigated) bermudagrass hay production, split applications of N fertilizer may not be necessary. Research studies conducted at the Eastern Research Station located near Haskell, Okla. found no difference between bermudagrass forage yields with 200 pounds of actual N per acre applied in a single application compared with 100 pounds of actual N per acre applied two times. Based on these results, up to 200 pounds of N can be applied in a single application in mid-May to late-May. It may be best to apply N in split applications under high yield goal when N requirements are greater than 200 pounds of actual N per acre or on coarse soils where nitrates are subject to leaching.

Bermudagrass Pasture

Nitrogen management for grazed bermudagrass pastures is not quite as easy as for hay production. Even though the amount of available N required to produce bermudagrass is the same as for hay production, the amount of forage yield is not as obvious because little forage will accumulate in well-managed pastures. Thus, the actual yield goal will be difficult to identify.

Nitrogen requirements for bermudagrass pasture can be estimated using a general rule of thumb when the forage is utilized by stocker animals. This is to apply 1 pound of N per acre to produce 2 pounds of beef per acre. For example, to produce 300 pounds of beef per acre would require 150 pounds of available N per acre.

A cow-calf production system will require about 6 tons of forage per year or about 1,000 pounds of forage per month. It is possible to graze unfertilized bermudagrass pastures. However, this should not be considered a sustainable, long-term solution.

Carrying capacity of bermudagrass pasture can be increased with N fertilization. For short-term grazing, the first 50 pounds of N per acre appears to be the most beneficial since there is a two-fold reduction in the number of acres required to maintain one cow during the summer grazing period (Table 2). For long-term grazing management using the rules of thumb that about 50 pounds of additional N are required to produce another ton of forage and that a cow needs about 1,000 pounds of forage per month, we can calculate that approximately 300 pounds of N is needed for each additional cow added to the herd each year.

Under grazed conditions, it is advisable to apply N in split applications of between 50 pounds to 75 pounds of actual N per acre at each application. Bermudagrass will maintain more uniform growth and production throughout the summer if N is applied every three to six weeks.

Table 2. Nitrogen and acreage required for summer grazing based on bermudagrass forage yield goal.

Production goal tons/acre	*Nitrogen[1] lbs/acre*	*Summer grazing (90 days) acres/cow*
1	0	3.3
2	50	1.6
3	100	1.1
4	150	0.8

[1] Non-fertilized grass pastures will generally yield about 1 ton of forage per acre over the growing season. However, this will not be sustainable and should not be considered a long term solution.

Summary

In many cases, it may be more economical and efficient to increase N fertilizer on fewer acres of more productive soils. The forage production may be equal to or greater than a low N application rate across all soil types. Also, it is likely that costs associated with N application will be lower.

While it is possible to produce bermudagrass hay or pasture with little or no N fertilizer, there are problems with this approach. First, it will take the entire growing season (May through October) for the forage to be produced. Second, forage quality, especially crude protein, will not likely meet the nutritional requirements for any class of livestock. The key point to remember is that N fertilization has a much greater impact on bermudagrass growth and forage yield than any other management practice.

Key Points to Remember

Bermudagrass stands that have not been fertilized in several years or those with other nutrient deficiencies will not immediately respond to applied N fertilizer.

For bermudagrass grazing, split-apply 50 pounds N per acre beginning in mid May. Apply no more than 150 pounds to 200 pounds total of N during the growing season.

For dryland bermudagrass hay production, a single N application of 200 pounds N per acre in early May appears to be adequate. There is usually no benefit to split N applications in bermudagrass due to variable rainfall distribution that can occur during the season.

In high producing bermudagrass hay fields, applying 100 pounds N per acre in early spring, followed by 50 pounds N per acre following each harvest should result in production of more uniform yield and quality.

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Extension Forage and Pasture Management Specialist

Brian Arnall
Extension Soil Fertility Specialist

Hailin Zhang, Director
Soil, Water, and Forage Analytical Laboratory

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Area Extension Agronomy Specialist

Oklahoma Cooperative Extension Service

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Issued in furtherance of Cooperative Extension work, acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, Director of Oklahoma Cooperative Extension Service, Oklahoma State University, Stillwater, Oklahoma. This publication is issued by Oklahoma State University as authorized by the Vice President, Dean, and Director of the Division of Agricultural Sciences and Natural Resources.

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State of Oklahoma
Department of Mines
2915 N. Classen Blvd., Ste. 213
Oklahoma City, OK 73106

NON-COAL LOCATION MAP by SECTION

The Mining Land Reclamation Act, 45 O.S. 2016 § 721-728

If, for any reason whatsoever, you stop operating at the location you show here, notify the Department of Mines immediately as your liability continues in effect until the Department is notified and/or completed reclamation is approved.

Company: **UNISANDS, LLC**

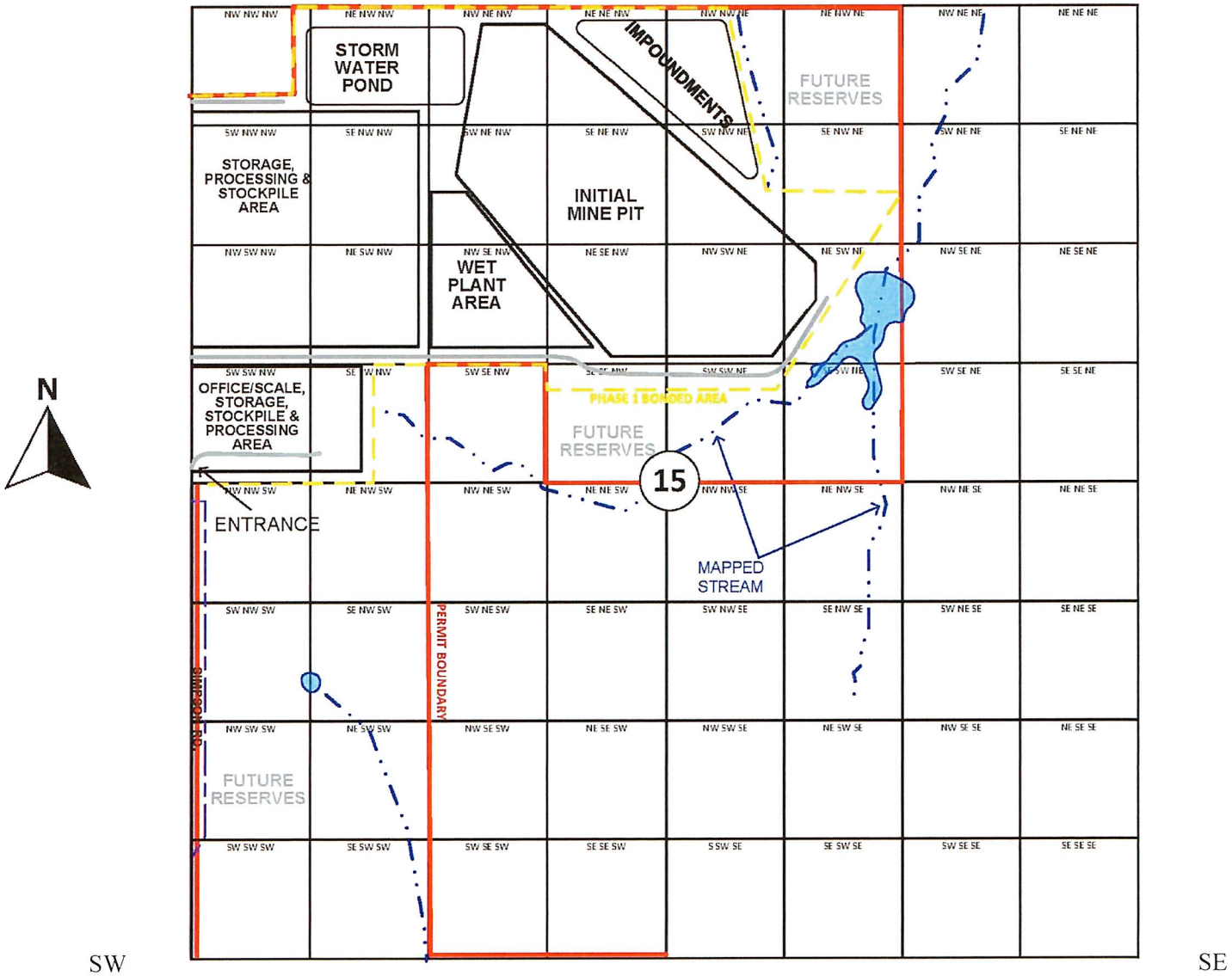
Mineral to be Mined: **SHALE, LIMESTONE, SANDSTONE, SAND, GRAVEL & CLAY**

Acres in this Section that will be covered by permit: **~303** and bond: **~169**

Section: **15** Township: **5S** Range: **4E** County: **MARSHALL**

1. ***A separate page is needed for every Section.***
2. ***Each One Section is divided into 10-acre tracts.***
3. ***Please show all permitted and bonded acreage.***

NW NE



SW SE

PLOT LOCATION as accurately as possible on map.
NOTE: PLOT ALL TRANSMISSION LINES (gas, water, electric, etc.) in accordance with HB 1735 of 1982

Updated 8/2023

State of Oklahoma
Department of Mines
2915 N. Classen Blvd., Ste. 213
Oklahoma City, OK 73106

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Company: **UNISANDS, LLC**

Mineral to be Mined: **SHALE, LIMESTONE, SANDSTONE, SAND, GRAVEL & CLAY**

Acres in this Section that will be covered by permit: **~11** and bond: **~11**

Section: **16** Township: **5S** Range: **4E** County: **MARSHALL**

1. ***A separate page is needed for every Section.***
2. ***Each One Section is divided into 10-acre tracts.***
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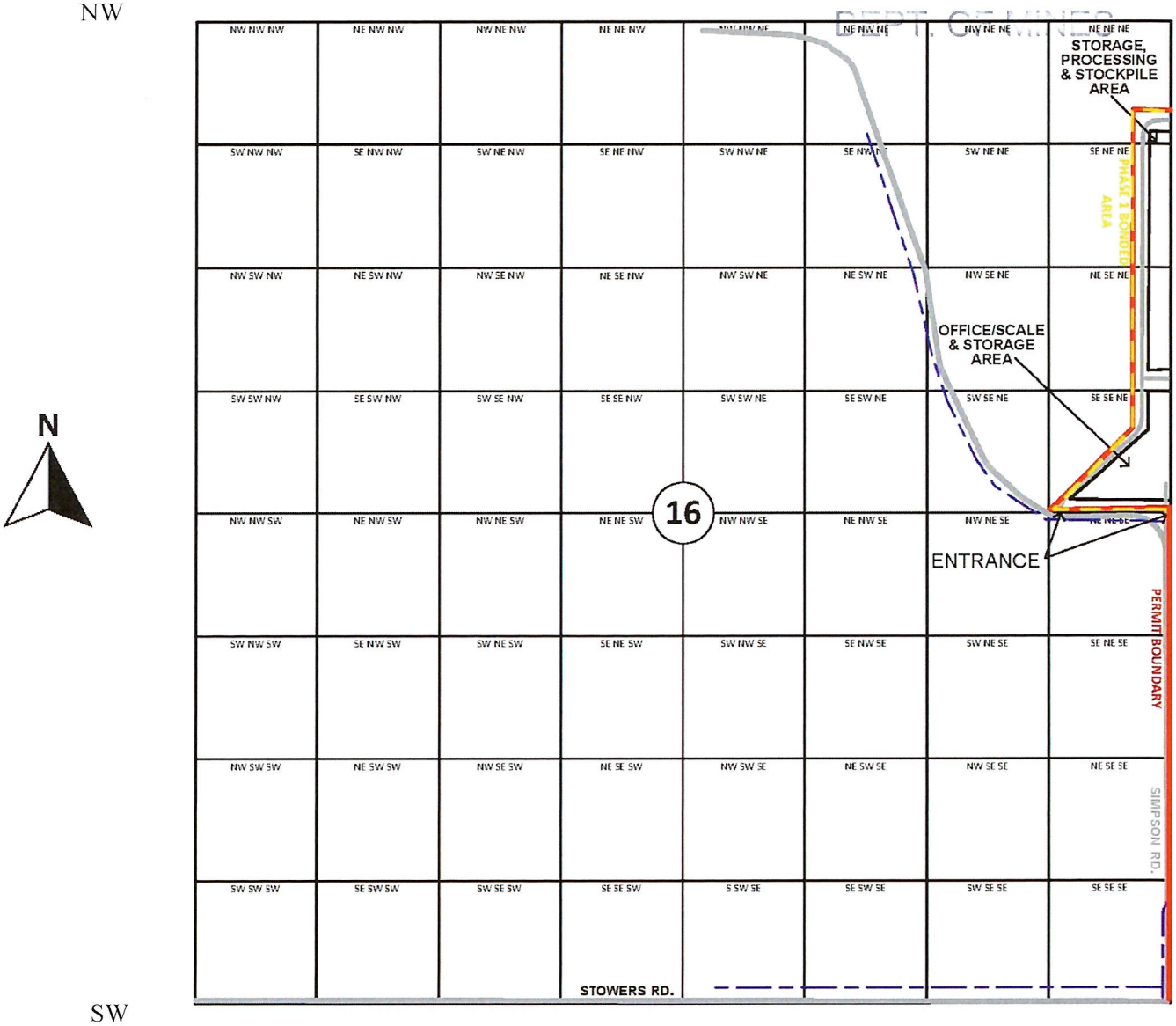
NW NE



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State of Oklahoma
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Company: **UNISANDS, LLC**

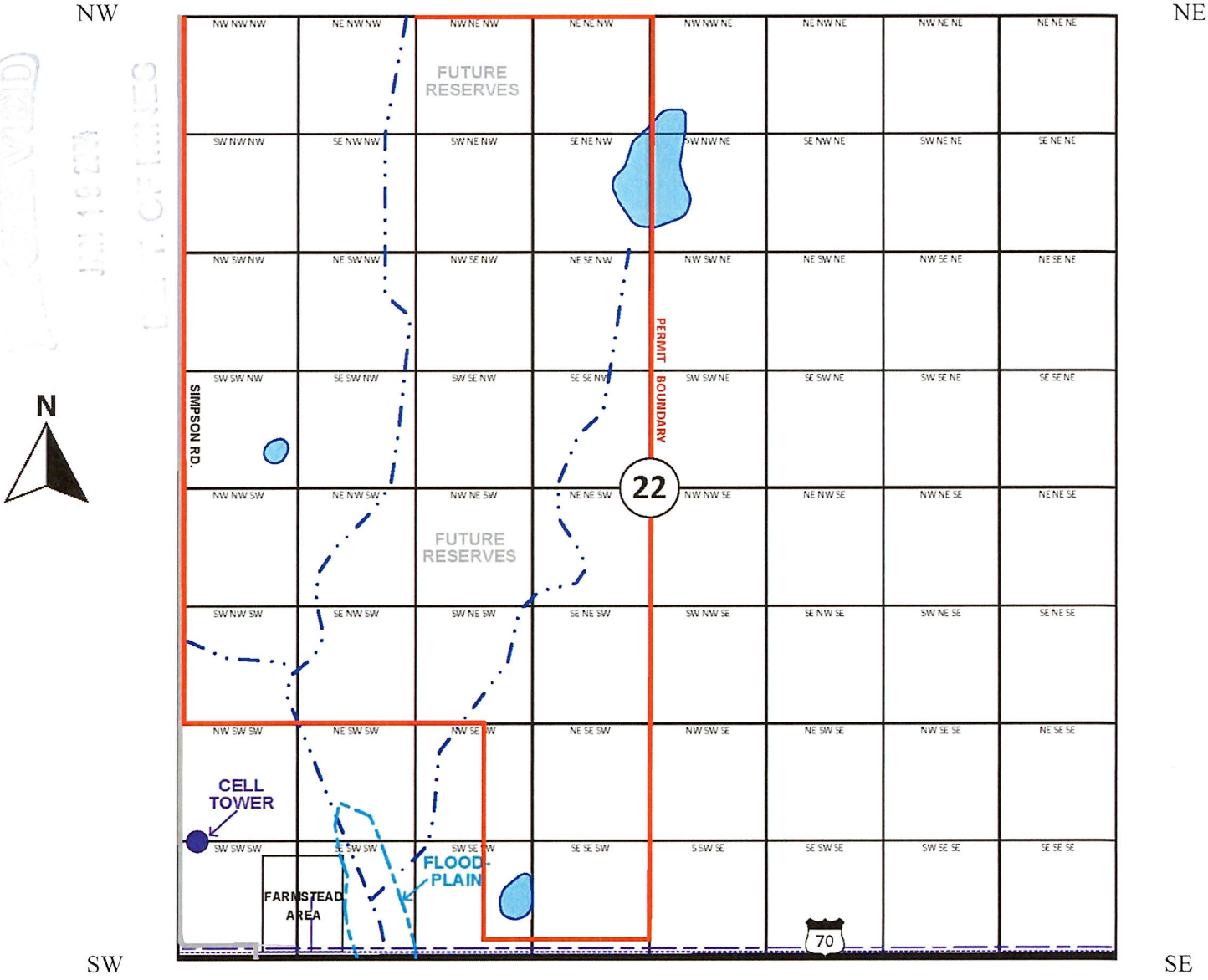
Mineral to be Mined: **SHALE, LIMESTONE, SANDSTONE, SAND, GRAVEL & CLAY**

Acres in this Section that will be covered by permit: **~268** and bond: **0**

Section: **22** Township: **5S** Range: **4E** County: **MARSHALL**

1. ***A separate page is needed for every Section.***
2. ***Each One Section is divided into 10-acre tracts.***
3. ***Please show all permitted and bonded acreage.***

NW NE



SW SE

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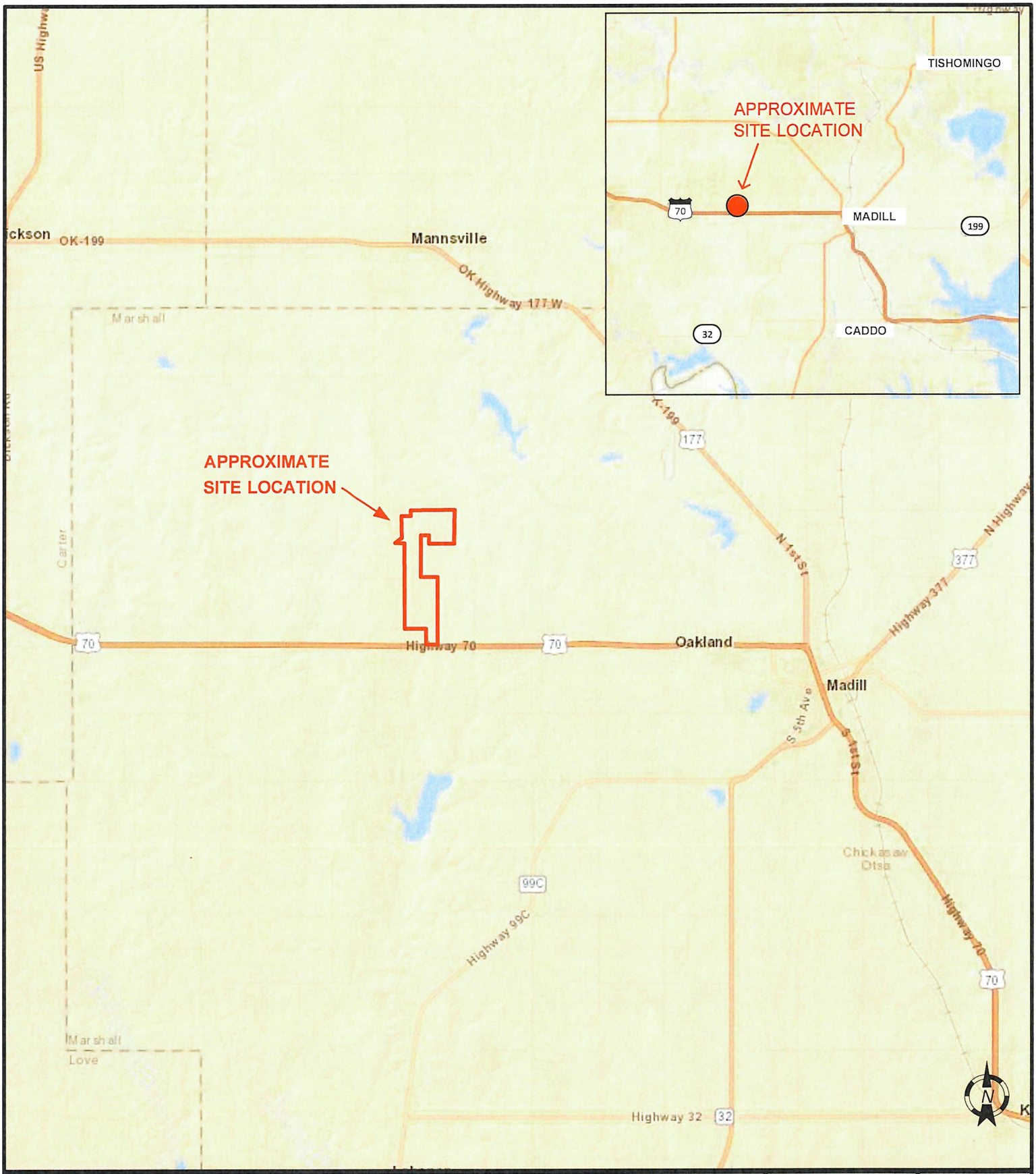
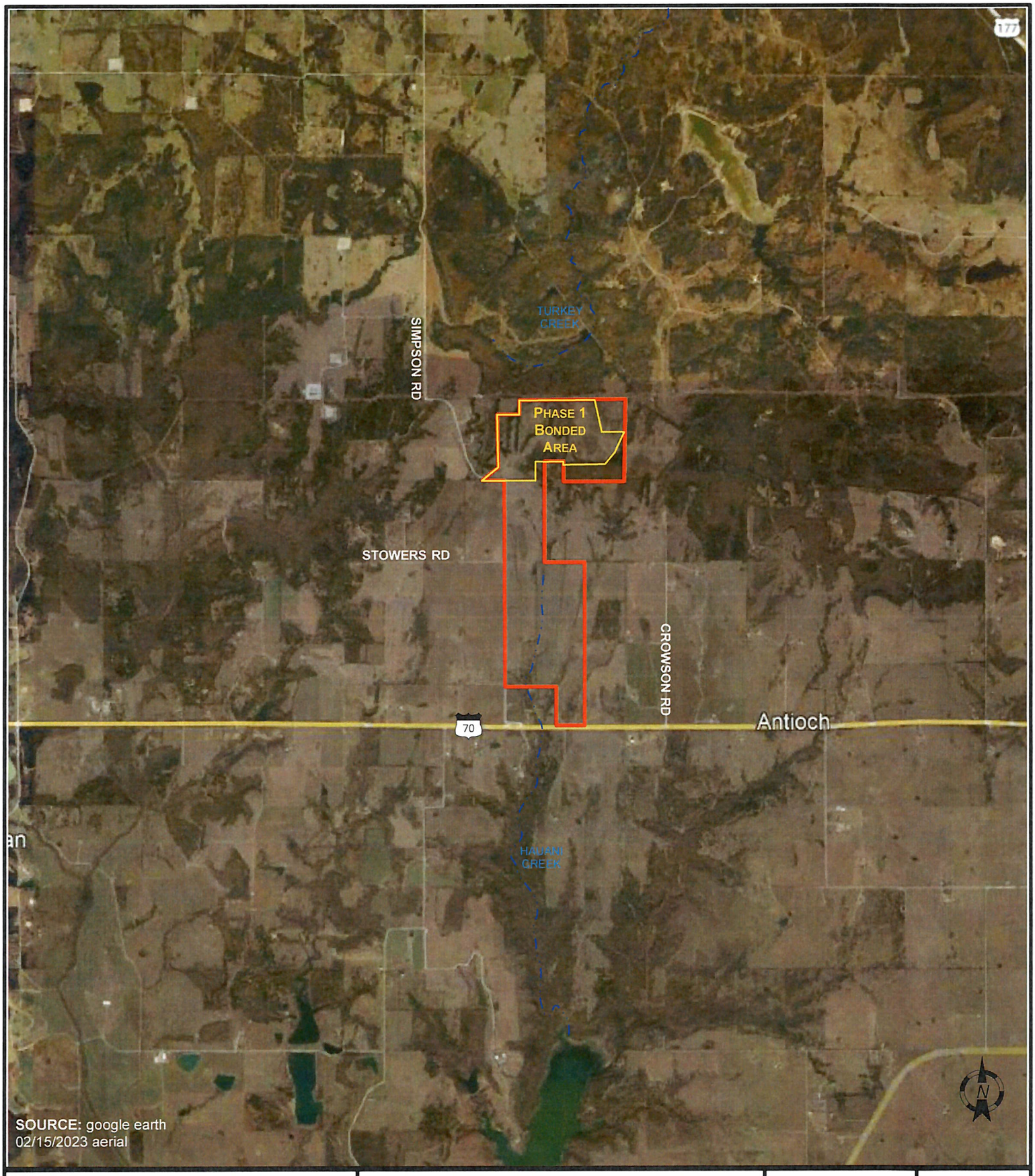
Updated 8/2023



COMMENTS/LEGEND	GENERAL LOCATION MAP		Figure
	Unisands, LLC Oteka Quarry Marshall County, Oklahoma	UNISANDS	A
SOURCE: ODEQ Dataviewer Accessed 12/4/2023	Environmental PO BOX 1292 NORMAN OK 73070	DRWN BY: MRF APPRVD BY: CHKD BY:	1/15/2024 DRAFT



COMMENTS/LEGEND	GENERAL SITE MAP - AERIAL		
FACILITY BOUNDARY	Unisands, LLC Oteka Quarry Marshall County, Oklahoma	UNISANDS	Figure B
Sections 15, 16 & 22-T5S-R4E, Marshall Co. TOTAL PERMIT AREA: ~627 ACRES			
	Environmental PO BOX 1292 NORMAN OK 73070	DRWN BY: MRF APPRVD BY: CHKD BY:	1/15/2024 DRAFT

State of Oklahoma
Department of Mines
2915 N. Classen Blvd., Ste. 213
Oklahoma City, OK 73106

STATEMENT OF CERTIFICATION

I, Dee Jay Huckie, Certify that Unisands, LLC has the right and power by Legal Estate owned to mine the land for which this application is made. We hereby certify that all details contained in this Permit Application are true and correct to the best of knowledge. We fully understand that any willful misrepresentation of facts will be cause for permit revocation.

Signature of Company Official _____

Position President

Subscribed and sworn to before me this 12th day of December 20 23

My Commission expires 5/22/2024 Notary Public _____

WILLIAM F. SHEPHARD NOTARY PUBLIC #08005107 EXP. 05/22/24 STATE OF OKLAHOMA

NOTE: This application must be signed and notarized. This application must include one ORIGINAL copy of the Statement of Certification. Digital signatures will not be accepted. All questions must be addressed and all required documents and information provided before this application can be considered complete. Attach additional sheets as needed.

RECEIVED
JAN - 5 2024
DEPT. OF MINES

U/G GAS PIPELINE

A

A'

SW POND

IMPOUNDMENTS

FUTURE RESERVES

BONDED BOUNDARY

STORAGE, PROCESSING & STOCKPILE AREA

INITIAL MINE PIT

WET PLANT AREA

OFFICE/SCALE, STORAGE, STOCKPILE & PROCESSING AREA

SECT 16, T5S, R4E

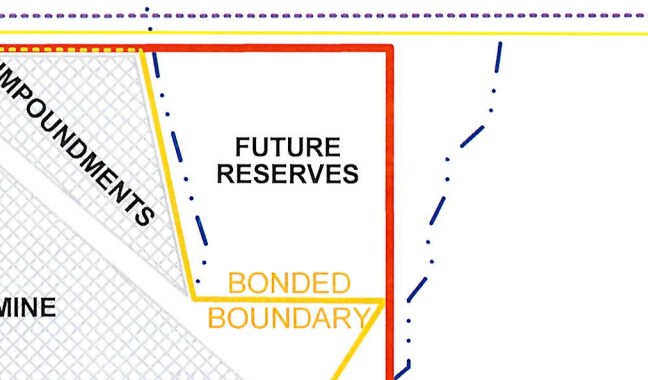
SECT 15, T5S, R4E

ENTRANCE

MINE PERMIT BOUNDARY

SIMPSON RD.

FUTURE RESERVES



A-A' TYPICAL SECTION
(NTS/ILLUSTRATIVE PURPOSES ONLY)

STOWERS RD.

O/H ELECTRIC

SECT 21, T5S, R4E

FUTURE RESERVES

SECT 22, T5S, R4E

CELL TOWER

NOTE 1: THE MINE PERMIT BOUNDARY ALSO REPRESENTS THE TOTAL AFFECTED AREA, THE EXCAVATION BOUNDARY, AND TAILINGS SPOIL & REFUSE DISPOSAL BOUNDARY

NOTE 2: THIS DIAGRAM REPRESENTS A PROPOSED, FUTURE MINING SCENARIO. UNISANDS RESERVES THE RIGHT TO ADD AND/OR MODIFY THESE AND OTHER MINING AND PROCESSING ACTIVITIES. THE ACTUAL LOCATION AND SCALE OF THESE ACTIVITIES IS SUBJECT TO CHANGE.

CELL TOWER

FARMSTEAD AREA

N

0 ~Scale 1320'

U/G WATER PIPELINE

70

U/H ELECTRIC

COMMENTS/LEGEND

- PERMIT BOUNDARY
- BONDED AREA
- COUNTY ROAD
- SECTION LINE
- MAPPED STREAM
- UTILITY LINE (UG)
- UTILITY LINE (OH)
- COMMON ACCESS RD
- FLOODPLAIN
- WELL (W)
- POND

LOCATION MAP – OVERVIEW

Unisands, LLC
Oteka Quarry
Marshall County, Oklahoma

UNISANDS

Figure **1a**

Environmental
PO BOX 1292 NORMAN OK 73070

DRWN BY: AJC APPRVD BY:
CHKD BY:

1/15/2024

DRAFT

U/G GAS PIPELINE

PHASE 1
(~180 AC)

FUTURE RESERVES

BONDED BOUNDARY

SECT 16,
T5S, R4E

SECT 15,
T5S, R4E

ENTRANCE

MINE PERMIT BOUNDARY

SIMPSON RD.

FUTURE RESERVES

PHASE 2
(~402 AC)

STOWERS RD.

O/H ELECTRIC

SECT 21,
T5S, R4E

FUTURE RESERVES

SECT 22,
T5S, R4E

A A'

LATERAL SUPPORT BUFFER ~/>50 FT

TRAVEL-WAY

PERMIT BOUNDARY

OVERBURDEN/BERM

BERM

HIGHWALL

BENCH

A-A' TYPICAL SECTION
(NTS/ILLUSTRATIVE PURPOSES ONLY)

NOTE 1: THE MINE PERMIT BOUNDARY ALSO REPRESENTS THE TOTAL AFFECTED AREA, THE EXCAVATION BOUNDARY, AND TAILINGS SPOIL & REFUSE DISPOSAL BOUNDARY

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CELL TOWER

FARMSTEAD AREA

N

0 ~Scale 1320'

U/G WATER PIPELINE

70

U/H ELECTRIC

COMMENTS/LEGEND

- PERMIT BOUNDARY
- BONDED AREA
- COUNTY ROAD
- SECTION LINE
- MAPPED STREAM
- UTILITY LINE (UG)
- UTILITY LINE (OH)
- COMMON ACCESS RD
- FLOODPLAIN
- WELL (W)
- POND

PHASED BONDING MAP

Unisands, LLC
Oteka Quarry
Marshall County, Oklahoma

UNISANDS

Figure 2

Environmental
PO BOX 1292 NORMAN OK 73070

DRWN BY: AJC APPRVD BY:
CHKD BY:

1/15/2024

DRAFT

U/G GAS PIPELINE

FUTURE RESERVES

RECREATION (~562 AC)

INDUSTRIAL (~20 AC)

SECT 16, T5S, R4E

SECT 15, T5S, R4E

ENTRANCE

SIMPSON RD.

MINE PERMIT BOUNDARY

FUTURE RESERVES

STOWERS RD.

O/H ELECTRIC

FUTURE RESERVES

SECT 21, T5S, R4E

SECT 22, T5S, R4E

NOTE 1: THE MINE PERMIT BOUNDARY ALSO REPRESENTS THE TOTAL AFFECTED AREA, THE EXCAVATION BOUNDARY, AND TAILINGS SPOIL & REFUSE DISPOSAL BOUNDARY

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CELL TOWER

FARMSTEAD AREA

N

0 ~Scale 1320'

U/G WATER PIPELINE

70

U/H ELECTRIC

COMMENTS/LEGEND

- PERMIT BOUNDARY
- BONDED AREA
- COUNTY ROAD
- SECTION LINE
- MAPPED STREAM
- UTILITY LINE (UG)
- UTILITY LINE (OH)
- COMMON ACCESS RD
- FLOODPLAIN
- WELL
- POND

RECLAMATION MAP

Unisands, LLC
Oteka Quarry
Marshall County, Oklahoma

UNISANDS

Figure 3

Environmental
PO BOX 1292 NORMAN OK 73070

DRWN BY: AJC APPRVD BY:
CHKD BY:

1/15/2024

DRAFT