C/015/019 Incoming

MEMORANDUM OF AGREEMENT

BETWEEN THE UTAH DIVISION OF OIL, GAS & MINING AND PACIFICORP REGARDING THE USE OF UNMANNED AERIAL SYSTEMS TO MONITOR MINE RECLAMATION SUCCESS OF THE COTTONWOOD/WILBERG MINE COMPLEX IN EMERY COUNTY, UTAH

This Memorandum of Agreement ("***MOA***") is entered into as of the 24TH day of OCTOBER, 2018 (the "***Effective Date***"), by and between PACIFICORP, an Oregon corporation, having a mailing address of 1407 W. North Temple, Salt Lake City, Utah 84116 ("***PacifiCorp***"), and the UTAH DIVISION OF OIL GAS AND MINING, a division of the Utah Department of Natural Resources ("***DOGM***"), having a mailing address of 1594 W. North Temple, Suite 1210, Salt Lake City, Utah 84116. PacifiCorp and DOGM may be collectively referred to hereinafter as the "***Parties***" or individually as a "***Party***".

RECITALS

A. Whereas, PacifiCorp, an Oregon corporation, is the owner, operator and mine permittee of the Cottonwood/Wilberg mine complex under State of Utah approved mine permit no. C/015/0019;

B. Whereas, the Cottonwood/Wilberg mine complex is situated within a narrow steep canyon at the head of Grimes Wash located approximately 10 miles northwest of the town of Castle Dale, Utah in Emery County;

C. Whereas, the Cottonwood/Wilberg mine complex is located on split estate federal lands that are under lease to PacifiCorp by way of federal coal leases UTU-044025, UTU-040151 and UTSL-064900 issued by the Bureau of Land Management;

D. Whereas, the US Bureau of Land Management ("***BLM***") controls the subsurface and the U. S. Forest Service controls the surface lands;

E. Whereas, on March 22, 2018, PacifiCorp completed the final regrading to the approximate original contours and reseeding of the Cottonwood/Wilberg mine complex in accordance with its state approved mining and reclamation plan;

F. Whereas, the approved final reclamation plan included "pocking" the final regraded hill side slopes for stabilization purposes, to reduce erosion and sediment production, and to enable retention of moisture to contribute to the vegetative success, all of which has become an industry standard for stabilization of steep slopes on land restoration projects within the region of central Utah;

G. Whereas, DOGM has jurisdiction and enforcement responsibility for coal mine permit compliance in the State of Utah, including reclamation success and final bond release;

H. Whereas, DOGM has the opportunity through a grant awarded June 15, 2018 by Utah State University's Public Lands Initiative 2018 RFP to investigate the "*Use of Unmanned Aerial Systems to Monitor Mine Reclamation Success in Central Utah.*" The research will use an Unmanned Aerial System ("***UAS***") to monitor mine reclamation success by using this latest technology to assess the effectiveness of "pocking" as an erosion control measure;

I. Whereas, DOGM has continuing regulatory jurisdiction over the site until bond release and permit termination, and desires its employees, contractors, consultants, cooperating parties or agents (hereinafter, collectively referred to as "***DOGM's Agents***") to temporarily access and use a portion of the Mine Complex consisting of approximately 21 acres, which is generally depicted on the aerial map attached hereto as Exhibit A (the "***Reclamation Area***"), for the purposes of (1) conducting aerial surveying and land reclamation monitoring using a UAS within the Reclamation Area, and (2) conducting ground-based surveys within the Reclamation Area (collectively, the "***Purpose***"). The specified scope of said aerial and ground-based surveying is more accurately described in the "***Scope of Work***," attached hereto as Exhibit B.

AGREEMENT

NOW, THEREFORE, in consideration of the covenants contained herein and for other good and valuable consideration, the receipt and adequacy of which are hereby acknowledged, the Parties hereto agree as follows:

1. Intent. The Parties have entered into this MOA with shared intent of furthering the development of more effective land stabilization, restoration and reclamation methods. The Parties believe the enhanced monitoring of the Reclamation Area, and in particular the evaluation of the effectiveness of the "pocking" as an erosion control measure, will provide valuable insights and information to both Parties, the mining industry, and state and federal government land management agencies.

2. Use of a UAS. PacifiCorp acknowledges DOGM's and/or DOGM's Agents' plan to use a UAS in connection with its monitoring of the Reclamation Area, and PacifiCorp has no objection to the use of a UAS for that Purpose. DOGM's activities conducted in connection with this MOA shall be conducted at no cost or liability to PacifiCorp.

3. Federal Authorization. The Parties acknowledge that the Reclamation Area, along with the entire Cottonwood/Wilberg mine complex, is located on federal lands that are under lease to PacifiCorp by way of federal coal leases UTU-044025, UTU-040151 and UTSL-064900, which leases are administered by BLM. The Parties agree that DOGM shall be responsible for obtaining any authorization from BLM (if any) necessary to undertake the Purpose.

4. Property Conditions. PacifiCorp makes no representations or warranties to DOGM or DOGM's Agents regarding the site conditions of either the Reclamation Area or the Cottonwood/Wilberg mine complex. DOGM's use of the Reclamation Area

is on an "AS IS, WHERE IS" basis without any representation or warranty by PacifiCorp. DOGM or DOGM's Agents enter the Reclamation Area or the Cottonwood/Wilberg mine complex at their own risk.

5. Data Sharing. DOGM shall provide to PacifiCorp electronic copies of all data obtained by DOGM in connection with the activities conducted under this MOA.

6. Indemnification and Release. Except to the extent such claims are directly or indirectly caused by the gross negligence or intentional misconduct of PacifiCorp or any of PacifiCorp's affiliates, DOGM shall defend PacifiCorp and PacifiCorp's affiliates from and against any and all claims suffered or incurred by PacifiCorp or PacifiCorp's affiliates arising directly or indirectly out of or as a consequence of any surveying or monitoring, or other activities conducted on, under or about the Reclamation Area or the Cottonwood/Wilberg mine complex by DOGM or DOGM's affiliates and shall indemnify PacifiCorp for all injury resulting from the negligence of DOGM's Agents.

7. JURY WAIVER. TO THE FULLEST EXTENT PERMITTED BY LAW, EACH OF THE PARTIES HERETO WAIVES ANY RIGHT IT MAY HAVE TO A TRIAL BY JURY IN RESPECT OF LITIGATION DIRECTLY OR INDIRECTLY ARISING OUT OF, UNDER OR IN CONNECTION WITH THIS AGREEMENT. EACH PARTY FURTHER WAIVES ANY RIGHT TO CONSOLIDATE ANY ACTION IN WHICH A JURY TRIAL HAS BEEN WAIVED WITH ANY OTHER ACTION IN WHICH A JURY TRIAL CANNOT BE OR HAS NOT BEEN WAIVED.

[*Signatures on Following Pages*]

IN WITNESS WHEREOF, the Parties have executed this MOA on the day and year first above written.

PACIFICORP

PACIFICORP
an Oregon corporation

By: DANA M. RALSTON
Its: SVP THERMAL GEN + RENEWABLES

DOGM

UTAH DIVISION OF OIL, GAS AND MINING
a division of the Utah Department of Natural Resources

By: John R. Baza
Its: Director

EXHIBIT A

RECLAMATION AREA AERIAL MAP

Cottonwood/Wilberg Mine Location

Depiction of Reclamation Area

EXHIBIT B

SCOPE OF WORK

Use of Unmanned Aerial Systems to Monitor Mine Reclamation Success in Central Utah

Project Narrative

Project Justification

The objective of this proposal is to develop a land reclamation monitoring protocol designed around the use of unmanned aerial systems (UAS) as well as ground-based surveys. The overall goal is to provide a quantitative tool to efficiently and economically evaluate the success of land reclamation activities, specifically the effectiveness of "pocking" as an erosion control measure. Pocking, described in more detail below, is a relatively new hillslope stabilization technique for small to large disturbances ranging from one to 50 acres. This proposal addresses the UAES Public Lands Initiative topics of **evaluation of restoration projects** and use of **creative tools to integrate the management of private, state, and federal lands in Utah**. The outcomes of this work will include **new assessment tools for land managers** as well as **programs to assess the effectiveness of land restoration efforts**.

The use of UAS to efficiently collect ultra-high-resolution imagery to evaluate land cover condition as well as LiDAR (Light Detection and Ranging) data to map microtopography and how that microtopography influences vegetation growth has grown significantly over the past few years (Kunwar et al., 2018, Cruzan et al., 2016, Mandlburger, et al., 2015). Unmanned aerial systems, otherwise known as drones, offer a unique method of collecting timely geospatial data that can be quickly processed and analyzed to evaluate land surface cover. The costs associated with these tools is quickly coming down and basic systems capable of collecting quality imagery can be purchased for under a thousand dollars. Further, the increased user friendliness of these systems allows any land manager with minimal training to launch, guide, collect data, and land. *Our goal, therefore is to not only quantify the effectiveness of pocking as an erosion control measure, but also demonstrate that UASs offer a viable and cost-effective addition to the land managers toolbox to quantitatively document ground cover conditions as well as temporal changes in microtopography in a way that can be quickly incorporated into a geographic information system to aid in the assessment of management prescriptions.*

To accomplish these goals, the Remote Sensing and GIS Laboratory in the Department of Wildland Resources, Quinney College of Natural Resources is partnering with The Utah Division of Oil, Gas and Mining (UDOGM). The UDOGM is tasked with ensuring that surface disturbance associated with mining activities is responsibly developed, maintained during active operations, and subsequently reclaimed. Underground coal mines along the Wasatch Plateau and Book Cliffs regions of Utah are typically located at the head of narrow, sometimes steep canyons and creek drainages. Due to these highly variable topographic locations, surface disturbance associated with these coal mines can be relatively small in area but can present a number of reclamation challenges. These challenges include the prevention of short and long-term sediment erosion as well as revegetation activities designed to match ground cover diversity and density of surrounding undisturbed areas.

Reclamation of mines located within narrow canyons and creek drainages typically involves the excavation of fill pads and backfilling cut-slopes to achieve the approximate original contour of the pre-mine topography. Therefore, the final grade of backfilled hillslopes can be exceedingly steep. In some cases, a 2:1 (horizontal to vertical) or steeper setback is required to cover face

cuts and highwalls or to meet the final reclaimed channel grade elevation. Such steep hillslopes are susceptible to high rates of erosion, especially during summertime monsoon driven short duration high intensity rain storms. This makes it difficult to prevent sediment erosion and, therefore, comply with State and Federal water quality regulations.

Mining companies and the UDOGM implement both short and long-term methods to reduce sediment erosion at reclaimed mine sites. Short-term hillslope stabilization measures include straw- and hydro-mulching, installing straw wattles, straw bale check dams and large fiber mats. Long term stabilization measures often depend on successful revegetation of the disturbed area by seeding or planting starts. Both short and long-term treatments to prevent sediment erosion can be costly and often have mixed results. Runoff from high intensity rainstorms often overwhelm short-term treatments (Fernandez and Vega 2016, Gholami, et al. 2013). Further, past experience by UDOGM shows that smooth or lightly ripped hillslopes are unable to capture and retain moisture to provide adequate water for seeds and young starts.

To address the limitations of common hillslope stabilization measures the UDOGM has developed the technique of "pocking" (extreme surface roughening) of a reclaimed hillslope grade (Utah Division of Oil, Gas and Mining, 2000). Pocking consists of deep gouging the final hillslope grade with 18 to 24-inch depressions. Pocks are constructed using a trackhoe to gouge cups or divots directly adjacent to one-another forming sharp ridges between each gouge. The pocks are irregularly oriented across the hillslope and resemble the surface roughness of a golf ball. Pocks are designed as individual micro catchment basins to retain water and are typically sized to store precipitation resulting from a 100-year/6-hour event. While the cost of pocking is higher than typical hillslope treatments, previous experience by UDOGM shows no additional maintenance costs or upkeep is required. Qualitative evaluation of pocking at multiple reclaimed coal mine sites has shown they are effective at reducing hillslope erosion rates, while encouraging water retention and effective revegetation of the disturbed area. When installed correctly, pocks reduce or eliminate rilling and gullying by drastically reducing slope lengths. Pocked surfaces tend smooth out over time as their high ridges erode into the bottom of the cup and biomass of perennial vegetation accumulates. The image on the right demonstrates a pocked slope at the Cottonwood/Wilberg mine in central Utah.

https://wwclyde.net/project-portfolio/cottonwood-mine-reclamation/#foobox-1/3/WWC-Wilberg-Cottonwood-Mine19.jpg

Pocking reclaimed hillslopes appears to be an effective tool for land reclamation. However, this technique is only commonly known in the small coal mine reclamation community of Utah. While variants of extreme surface roughening exist in the reclamation industry, irregularly spaced pocking as described here seems to be unique. There is, therefore, a dearth of quantitative work to evaluate the effectiveness of pocking and no literature exists on this stabilization technique outside of a General Technical Report within the Division of Oil, Gas and Mining (Utah Division of Oil, Gas, and Mines, 2000).

We propose to use ground based and aerial LiDAR as well as photogrammetric topographic modeling to monitor pocked hillslopes and determine, over a two-year period (2018-2019), how individual pocks fared over the two seasons (decrease in depth, smoothing, etc.), as well as how,

and if, pocks have influenced the spatial distribution and quantity of vegetation growth. We recognize that while two growing seasons may not be sufficient to properly evaluate trends, we are limited by the period of time prescribed by this RFP. Therefore, UDOGM will be collecting Near Infrared (NIR) aerial imagery of historic pocking reclamation projects that were conducted at Willow Creek mine (10 years ago) and Des Bee Dove mine (14 years ago). By utilizing these older site, regrowth data can be collected and leveraged to examine long-term growth and spatial distribution of vegetation. The goal here is to develop the protocol that the UDOGM will follow in subsequent years.

Scope of Work

Map credit: Google Earth

This study will take place at the Cottonwood/Wilberg Mine located southwest of Huntington, Utah and northwest of Castle Dale, Utah. Reclamation activities on this site occurred between October 2017 and March 2018 with extensive use of pocking to stabilize steep slopes.

The reclaimed area includes 21 acres with varying hillslope setbacks ranging from less than 3H:1V to nearly 1.5H:1V. The Cottonwood/Wilberg mine collaborated with the UDOGM to develop a pocking design that would trap precipitation equivalent to a 100-year 6-hour event of 2.25 inches. The final hillslope surface grades at the Cottonwood/Wilberg mine have been mulched, pocked, seeded, and hydro-mulched.

As part of this reclamation effort UDOGM contracted with Juniper Unmanned Technologies from Golden, CO to collect baseline high resolution imagery along with LiDAR data using with a DJI Matrice 600 hexacopter unmanned aerial vehicle. These data were acquired at the commencement of reclamation activities (~October 2017).


Image credit: UDOGM

Airborne imagery of the study site (left) was collected at a nominal 1cm grid-cell resolution while the associated Lidar data was collected at a density of 400 returns per m^2. The Lidar resolution, therefore, provides a measure of elevation at an average 5cm increment across the study area.

In addition to the image and Lidar base-line data, UDOGM is in the process of collecting ground-based Lidar using a RIEGL terrestrial 3D LiDAR scanner to characterize the terrain immediately post grading and pocking. Ground-based Lidar collection will occur from multiple points surrounding the study site and the geometry of these multiple collection points will be managed with ground control points marked with t-posts and backsight reflectors. These scans will be repeated during the summer of 2019.

A portion of this study will include the evaluation of different Lidar collection techniques - airborne vs ground-based, as well as a comparison between a Lidar vs photogrammeterically derived topographic point cloud. We will evaluate how these tools replicate and/or complement each other.

At the end of the first growing season, as well as the start and end of the second growing season, we will fly the study area with two UAS platforms; the DJI S1000 octocopter outfitted with a high resolution visible light camera (Sony alpha-7) and a thermal camera (FLIR A65sc), and a smaller DJI Phantom-4 quad-rotor system. These overflights will collect airborne imagery to match the baseline imagery already collected as well as generate photogrammetric topographic point-clouds that can be compared with the baseline Lidar derived point-cloud. Differences in elevation estimation between the various techniques as well as collections across time will be normalized with established benchmarks with known elevations. While relative elevation postings using these techniques is extremely accurate (+/- 1cm or better), absolute elevation (from sea level) can have a larger variance between overflights. Therefore, established benchmarks will be necessary to normalize the different data collection methods and replicates through time.

Field instrumentation installed by UDOGM to help evaluate pocking effectiveness will include the aforementioned elevational benchmarks, as well as tipping bucket rain gauges and sediment staff gauges installed in the bottom of individual pocks.

The objective of flying both the S1000 and Phantom-4 systems is to compare the point-cloud and image quality of each. Currently a UAS of the S1000 caliber is relatively difficult to build (it comes as a kit), costs approximately $10,000 and is a bit more difficult to fly. In comparison, the Phantom-4, or similar, UAS currently costs just over $1,000, is significantly more portable, and is very easy to fly. The primary difference between these two platforms as far as data collection is concerned, is the quality and diversity of imaging systems with the S1000 capable of carrying multiple, high quality sensors. Therefore, we will be evaluating the cost/benefit of each platform to provide the data needed to evaluate rill and gully erosion as well as vegetation growth.

Anticipated Impact (estimated time frame for when this impact will be realized)

According to UDOGM, there are no references in the literature that describe the use of pocking as it's described here. Therefore, this seems to be the first attempt to quantify the effectiveness of this technique to reduce erosion and promote vegetation regrowth on reclaimed land. Quantitatively assessing the effectiveness of pocking and presenting these data to land managers will provide an additional tool to mitigate disturbed area sediment erosion, with the added benefit of encouraging the reestablishment of vegetation. Anecdotal evidence from past applications in Utah shows that pocking serves as an effective soil stabilization tool in the short term with little maintenance over the long-term. We anticipate that two years of data will provide sufficient information to show the beginnings of a trend. While we will only be able to assess sedimentation of pocks at four points in time (late spring and early fall of 2018 as well as late spring and early fall of 2019), the data we collect will be specific to individual pocks with sediment gauges. Therefore, we potentially have over 100 observations for each of those data collection periods. These observations at the Cottonwood/Wilberg mine coupled with overflights at the older Willow and Des Bee Dove mines should provide enough evidence for an initial assessment of pocking effectiveness. The UDOGM will continue monitoring efforts past the end of this grant period.

How project outcomes will enhance public lands management and/or policy.

Our research will quantify the effectiveness of pocking and aid land reclamation efforts in the development of standard designs and protocols for pocking reclaimed lands as well as protocols

for monitoring post reclamation using UASs. Results of this study will be compiled into a General Technical Report (GTR) and openly shared via the UDOGM web site to land managers. In addition to a GTR, we anticipate one Master Thesis as well as peer-reviewed professional journal publications. We will also present our research through professional conferences at local and national levels.

References

Cruzan, M. B., Weinstein, B. G., Grasty, M. R., Kohrn, B. F., Hendrickson, E. C., Arredondo, T. M., & Thompson, P. G. (2016). Small unmanned aerial vehicles (micro-UAVs, drones) in plant ecology. *Applications in Plant Sciences*, *4*(9), apps.1600041. http://doi.org/10.3732/apps.1600041

Fernández, C., J. A. Vega. 2016. Are erosion barriers and straw mulching effective for controlling soil erosion after a high severity wildfire in NW Spain? Ecological Engineering, V. 87, PP.132-138. https://doi.org/10.1016/j.ecoleng.2015.11.047.

Gholami, L., S.H. Sadeghi, and M. Homaee. 2013. Straw mulching effect on splash erosion, runoff, and sediment yield from eroded plots. Soil Sci. Soc. Am. J., 77, pp. 268-278. https://doi.org/10.2136/sssaj2012.0271.

Kunwar K. Singh & Amy E. Frazier (2018) A meta-analysis and review of unmanned aircraft system (UAS) imagery for terrestrial applications, International Journal of Remote Sensing, DOI: 10.1080/01431161.2017.1420941

Mandlburger, Gottfried & Glira, Philipp & Pfeifer, Norbert. 2015. UAS-borne Lidar for Mapping Complex Terrain and Vegetation Structure. GIM International. 29.

Utah Division of Oil, Gas, and Mines. 2000. The Practical Guide to Reclamation in Utah. https://fs.ogm.utah.gov/PUB/MINES/Coal_Related/RecMan/Reclamation_Manual.pdf