Memorandum

BURNS & McDONNELL

Date: June 26, 2017

To: Eric Dulle

From: Gabriel Weger

Subject: CERT Groundwater Remediation Project – Noise Analysis

Burns & McDonnell Engineering Company, Inc. (Burns & McDonnell) has performed a noise analysis for the Cimarron Environmental Response Trust (CERT) Groundwater Remediation Project (Project). The Project consists of installation and continuous operation of groundwater recovery, treatment, and discharge systems designed to remediate groundwater at the existing site near Cimarron City, Oklahoma (Facility).

The U.S. Nuclear Regulatory Commission (NRC), is in the process of reviewing the *Cimarron Facility Decommissioning Plan* (Decommissioning Plan), submitted by Environmental Properties Management LLC (EPM) in December 2015. The NRC will review the Decommissioning Plan and prepare an Environmental Report (ER) which will include information on the environmental effects of the proposed Project.

The NRC NUREG-1748, Sections 6.3.7 and 6.4.7, provide that the ER should include information about potential impacts from noise during remediation system operation. This noise analysis has been completed in response to comments received from the NRC on the Decommissioning Plan, and will be included as a supplement to the revised Decommissioning Plan.

Applicable Regulations and Guidelines

The State of Oklahoma does not have applicable state-wide noise regulations and has delegated the authority to the individual counties and cities. The Facility is located in an unincorporated area of Logan County near Cimarron City and the City of Guthrie. Logan County does not have any noise regulations applicable to the Facility, and the cities' noise ordinances would not be applicable to the Facility, as it is located outside each cities' limits. Neither the City of Guthrie nor Cimarron City establish numerical noise limits in their city ordinances.

The Noise Control Act of 1972 (the Act)[1] mandated a national policy "to promote an environment for all Americans free from noise that jeopardizes their health or welfare, to establish a means for effective coordination of federal research activities in noise control, to authorize the establishment of federal noise emission standards for products distributed in commerce, and to provide information to the public respecting the noise emission and noise reduction characteristics of such products." As required by the Act, the Environmental Protection Agency (EPA) published *Information on Levels of Environmental Noise Requisite to Protect*

[1] United States Code (U.S.C.): 42 U.S.C. 4901 to 4918

Public Health and Welfare with an Adequate Margin of Safety[2] in 1974. These levels are shown in Table 1.

Table 1: EPA Noise Levels Identified to Protect Public Health and Welfare

Effect	Noise Level	Area
Hearing Loss	$L_{eq(24)} \leq 70$ dBA	All areas.
Outdoor activity interference	$L_{dn} \leq 55$ dBA	Outdoor residential and farm areas, and other outdoor areas where people spend widely varying amounts of time and other places in which quiet is a basis for use
	$L_{eq(24)} \leq 55$ dBA	Outdoor areas where people spend limited amounts of time, such as school yards, playgrounds, etc.
Indoor activity interference and annoyance	$L_{dn} \leq 45$	Indoor residential areas.
	$L_{eq(24)} \leq 45$ dBA	Other indoor areas with human activities, such as schools, etc.

The levels contained in Table 1 were established as required by the Act, but do not constitute enforceable federal regulations or standards. However, these noise levels represent valid criteria for evaluating the effect of project-generated noise on public health and welfare. Many noise studies performed for new projects compare residential noise levels to these EPA-established guidelines.

The recommended EPA guideline for outdoor activity in residential areas is a day-night average sound level (L_{dn}) of 55 dBA or less. An L_{dn} of 55 dBA can be equated to a steady-state energy equivalent sound level (L_{eq}) of 48.6 dBA for a 24-hour period, incorporating the 10-dB penalty that is applied to the nighttime hours.

Due to the absence of local noise regulations, the overriding design goal for surrounding noise-sensitive receivers will be an hourly L_{eq} of 48.6 dBA, per the EPA guidance.

[2] The United States Environmental Protection Agency, Office of Noise Abatement and Control

Ambient Measurements

Burns & McDonnell noise specialists conducted a noise survey on April 18 and 19, 2017, near the Facility. Burns & McDonnell personnel obtained ambient sound level measurements to establish baseline sound levels at various locations near the Facility. Measurements were taken using an American National Standards Institute (ANSI) S1.4 type 1 sound level meter (Larson Davis Model 831). The sound level meter was field calibrated before and after each set of measurements. None of the calibration level changes exceeded ± 0.5 dB, which is within the acceptable variance per ANSI guidance. A windscreen was used at all times on the microphone to avoid the influence of wind-induced sound increases.

Ambient measurements were taken during four time periods over a 24-hour span. All measurements were taken during times when meteorological conditions were favorable for conducting sound measurements. Meteorological conditions were obtained using a Kestrel 5000 anemometer and are presented in Table 2.

Table 2: Average Meteorological Conditions during Sound Measurements

Date	Time Period	Temperature (°F)	Relative Humidity (%)	Wind Speed (mph)	Sky Cover
4-18-2017	12:00 P.M.	74	57	5-10	Clear
4-18-2017	6:00 P.M.	80	49	3-8	Clear
4-19-2017	12:00 A.M.	71	71	calm	Clear
4-19-2017	6:00 A.M.	66	77	2-4	Clear

Ambient, sound level measurements were made at six locations, labeled Measurement Point (MP) 1 through MP6, as shown in Figure 1-1 of Attachment 1. The measurement locations were selected because they were accessible and representative of noise-sensitive receivers. The sound level measurement periods were 5 minutes long, and measured values were logged by the sound meter at each measurement location. The sound levels varied at each measurement point due to the extraneous sounds that occurred during each measurement.

Extraneous sounds during the measurement periods included sound associated with vehicular traffic from nearby roads and highways (including large trucks and motorcycles), insects, birds, and airplanes flying overhead. Various sound metrics can be used to qualify measured sound levels. The exceedance sound metric L_{90} – the sound level exceeded 90 percent of the time – is typically considered the background sound level for an area without short-duration, extraneous sound influences

The measured, A-weighted L_{eq} and L_{90} sound levels are presented in Attachment 1 Table 1 along with ambient sound sources noted throughout the measurements. Ambient A-weighted L_{eq} sound levels varied from a low of 34.8 dBA at MP1 during the midnight measurements to a high of 67.8 dBA at MP5 during the morning measurements. Ambient A-weighted L_{90} sound levels for areas near the Facility varied from a low of 32.6 dBA at MP1 during the midnight measurements to a high of 57.7 dBA at MP3 during the morning measurements. Due to constant traffic, ambient sound levels at some of the measurement locations exceed the design goal. Compliance measurements would need to account for ambient sound levels with environmental corrections to determine the Project's contribution to overall sound.

Predictive Modeling

Burns & McDonnell performed predictive sound modeling for the Project using the Computer Aided Design for Noise Abatement (CadnaA), Version 2017, published by DataKustik, Ltd., Munich, Germany. Air absorption, ground absorption, and reflections and shielding for each piece of sound-emitting equipment were considered per International Organization for Standardization (ISO) 9613-2, Acoustics – Sound Attenuation during Propagation Outdoors.

The ISO standard considers sound propagation and directivity. The sound-modeling software uses omnidirectional, downwind sound propagation and worst-case directivity factors. In other words, the model assumes that each piece of equipment propagates its maximum sound level in all directions at all times. Empirical studies accepted within the industry have demonstrated that modeling may over-predict sound levels in certain directions, and as a result, modeling results are generally considered a conservative prediction of the Project's actual sound level.

The modeled atmospheric conditions were assumed to be calm, and the temperature and relative humidity were left at the program's default values. Reflections and shielding were considered for sound waves encountering physical structures. The area surrounding the Facility has a significant amount of elevation change, which scatters and absorbs the sound waves. Thus, terrain was included to account for surface effects such as ground absorption and surface reflections. Ground absorption was set at a value of 0.5 for all areas surrounding the Facility, meaning only half the available ground absorption was considered. Ground elevation, based on United States Geological Survey 3D Elevation Program data, was included in the model. The Project basis of design layout is provided in Figure 2-1 of Attachment 2.

MPs from the sound survey, and the nearest off-site residential receivers (RES), were included in the model. The modeled receiver locations are provided in Figure 2-2 of Attachment 2.

Each piece of equipment associated with the proposed Project was modeled with expected sound power levels applied to them. The sound emitting equipment associated with the Project includes: various equipment and pump skids, air compressors, air handling units, and building exhaust fans. All sound emitting equipment was adjusted to meet a sound pressure level of 85 dBA at 3 feet horizontally from the emitting equipment. This is a conservative assumption, as some of the equipment may emit much lower sound levels. However, at this point in the design process, specific equipment sound levels are unknown. The following assumptions and equipment counts were used to develop the noise model and estimate sound levels at the nearest sensitive receptors.

- Treatment building with insulated metal panel walls and roof (STC=42)
    - Treatment building includes four (4) pumps (85 dBA at 3 feet, each)
- (1) Treatment building air handling unit (85 dBA at 3 feet)
- (2) Treatment building exhaust vent fans (85 dBA at 3 feet, each)
- (2) Bioreactor pump skids (85 dBA at 3 feet, each)
- (2) Blower skids (85 dBA at 3 feet, each)
- (2) Backwash pump skids (85 dBA at 3 feet, each)
- (2) Feed pump skids (85 dBA at 3 feet, each)
- (2) Sludge holding pumps (85 dBA at 3 feet, each)

The Project's estimated sound levels are based on the equipment data defined above. The majority of Project noise received by neighboring properties would be emitted from the pump skids located outside of the treatment building. The predicted overall sound levels experienced by neighboring properties would be the combination of the future Project sound and existing ambient sound. To determine the worst-case (loudest) increase to ambient sound, estimated Project sound levels were added to the lowest measured ambient sound levels to determine a maximum increase to ambient sound.

The amplitude of sound is measured as the logarithmic ratio of a sound pressure to a reference sound pressure (20 micropascals). The reference sound pressure corresponds to the typical threshold of human hearing. Because sound is measured on a logarithmic scale, sound levels cannot be added or subtracted directly and are somewhat cumbersome to handle mathematically. Some simple rules are useful in dealing with sound levels. First, if a sound's intensity is doubled, the sound level increases by 3 dB, regardless of the initial sound level. Thus, for example: 60 dB + 60 dB = 63 dB, not 120 dB. To the average listener, a 3-dB change in a continuous broadband sound is generally considered "just barely perceptible"; a 5-dB change is generally considered "clearly noticeable"; and a 10-dB change is generally considered a doubling (or halving, if the sound is decreasing) of the apparent loudness. The sound modeling results are provided below in Table 3.

Table 3: Predicted Sound Pressure Levels

Location	Receiver Type	Lowest L_{90} Ambient Sound Levels (dBA)	Predicted Project Sound Levels (dBA)	Predicted Overall Sound Levels[c] (dBA)	Increase to Ambient Sound Levels (dBA)
MP1	Monitoring Point	32.6	18.1	32.8	0.2
MP2	Monitoring Point	41.7	24.6	41.8	0.1
MP3	Monitoring Point	34.4	26.7	35.1	0.7
MP4	Monitoring Point	39.2	31.2	39.8	0.6
MP5	Monitoring Point	41.3	24.2	41.4	0.1
MP6	Monitoring Point	35.3	25.5	35.7	0.4
RES1	Residence[a]	35.3	24.9	35.7	0.4
RES2	Residence[b]	32.6	24.3	33.2	0.6
RES3	Residence[b]	32.6	27.0	33.7	1.1

(a) Ambient sound levels from MP6 were assumed for Residence 1
(b) Ambient sound levels from MP1 were assumed for Residences 2 and 3
(c) Predicted overall sound levels are the logarithmic addition of the ambient and Project sound levels.

The predicted sound pressure levels of the Project are shown as 5-dB contours in Figure 2-3 of Attachment 2. The contours are the expected sound pressure levels of the new equipment only, and do not include any contributions from ambient sound sources.

In addition to the operating remediation equipment, there will be two treatment system discharge outfalls located at the Cimarron River. These outfalls would have no operating equipment at their locations, only running water. Noise associated with these outfalls is not expected to be significant and would likely blend into the existing sound of running water from the Cimarron River.

As shown in Table 3, there are no significant increases to ambient sound levels expected at the offsite receiver locations. Generally, a 3-dB change in overall sound is considered noticeable and a 5-dB change is considered significant. The largest increases over the quietest measured background ambient sound levels are expected to be around one decibel. This does not suggest that the equipment will never be audible offsite, but rather that the sound generated from the new equipment will not increase overall ambient sound levels by a noticeable amount. The Project equipment as modeled will remain below the design goal of an hourly L_{eq} of 48.6 dBA at the surrounding noise-sensitive receivers, per the EPA guidance. Therefore, no additional noise mitigation is suggested at this time.

Gabriel Weger,
Burns & McDonnell

Attachments:

Attachment 1 – Ambient Measurements
Attachment 2 – Noise Modeling

ATTACHMENT 1

Path: G:\Air-Noise Dept\Project Files\Cimarron\Noise\GIS\Figure 1-1 Noise Monitoring Locations.mxd gweger 5/17/2017

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Figure 1-1

Noise Monitoring Locations

Source: Burns & McDonnell Engineering, Inc.

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Attachment 1 - Table 1

CERT Ambient Measurements

Point Number	*File Name*	*LAeq*	*LA90*	*Notes*
Ambient Measurements: 4/18/2017 12:00:00 PM				**Calibration before: 113.80**
74° F, 57% Humidity, 58° F dew point, 5-10 mph winds				**Calibration after: 114.07**
MP1	001	41.0 dBA	34.5 dBA	Birds, light wind, insects, rooster, airplane
MP2	002	56.4 dBA	48.3 dBA	Traffic, birds, insects, light wind
MP3	003	67.0 dBA	55.5 dBA	Traffic, airplane, birds, insects, light wind
MP4	004	61.3 dBA	48.9 dBA	Traffic, birds, insects
MP5	005	62.7 dBA	44.5 dBA	Traffic, birds, insects
MP6	006	44.7 dBA	35.5 dBA	Birds, insects, light wind
Ambient Measurements: 4/18/2017 6:00:00 PM				**Calibration before: 114.01**
80° F, 49% Humidity, 60° F dew point, 3-8 mph winds				**Calibration after: 114.06**
MP1	007	40.9 dBA	34.3 dBA	Birds, light wind, insects, dog
MP2	008	60.5 dBA	49.5 dBA	Traffic, birds, light wind
MP3	009	65.9 dBA	55.2 dBA	Traffic, insects, light wind
MP4	010	64.2 dBA	47.8 dBA	Traffic, birds, insects, light wind, airplane
MP5	011	64.9 dBA	48.3 dBA	Traffic, birds, insects, light wind
MP6	012	41.5 dBA	37.7 dBA	Traffic, birds, insects, light wind, airplane
Ambient Measurements: 4/19/2017 12:00:00 AM				**Calibration before: 113.96**
71° F, 71% Humidity, 60° F dew point, calm winds				**Calibration after: 114.03**
MP1	013	34.8 dBA	32.6 dBA	Traffic, insects, dog
MP2	014	55.7 dBA	41.7 dBA	Traffic, birds, insects, dog
MP3	015	57.5 dBA	34.4 dBA	Traffic, insects, cow, coyote
MP4	016	51.5 dBA	39.2 dBA	Traffic, insects, cow
MP5	017	66.1 dBA	41.3 dBA	Traffic, insects, frogs
MP6	018	43.7 dBA	35.3 dBA	Traffic, dog, insects, frogs
Ambient Measurements: 4/19/2017 6:00:00 AM				**Calibration before: 113.98**
66° F, 77% Humidity, 63° F dew point, 2-4 mph winds				**Calibration after: 113.96**
MP1	019	44.8 dBA	41.7 dBA	Traffic, birds, turkey
MP2	020	61.7 dBA	53.6 dBA	Traffic, birds, frogs, insects
MP3	021	67.1 dBA	57.7 dBA	Traffic, birds, insects
MP4	022	61.8 dBA	52.4 dBA	Traffic, birds, insects, car door, horn
MP5	023	67.8 dBA	55.5 dBA	Traffic, birds, insects, wind
MP6	024	42.5 dBA	40.1 dBA	Traffic, birds, turkey, insects, light wind

ATTACHMENT 2

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environmental properties management LLC

Figure 2-1

Project Layout

Legend

- MONITORING WELL IN TRANSITION ZONE
- MONITORING WELL IN ALLUVIUM
- MONITORING WELL IN SANDSTONE A
- MONITORING WELL IN SANDSTONE B
- MONITORING WELL IN SANDSTONE C
- PROPOSED EXTRACTION TRENCH SUMP
- PROPOSED INJECTION WELL
- PROPOSED EXTRACTION WELL
- PROPOSED GROUNDWATER EXTRACTION TRENCH
- PROPOSED TREATED WATER INJECTION TRENCH
- 1010 TOPOGRAPHIC CONTOUR AND ELEVATION

GE-WAA-01 = EXTRACTION WELL
GETR-WAA-01 = EXTRACTION TRENCH
GWI-WU-01 = INJECTION WELL OR TRENCH

Notes:
1. Extraction Well GE-WAA-01 is an existing well and has been incorporated into the remedial Design.
2. All upland remediation components will be installed in Sandstone A unless otherwise noted.
3. Nitrate remediaiton goal for is 52 mg/L in the Process Building Area and 22.9 mg/L for the remander of the Site.

0 150 300 600 Feet N

Source: ESRI and Burns & McDonnell Engineering.
COORDINATES: (NAD 83) STATE PLANE OKLAHOMA NORTH FEET
DATE: AERIAL PHOTO - 2010 / MAP PRODUCED - 1/17/2017

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Path: G:\Air-Noise Dept\Project Files\Cimarron\Noise\GIS\Figure 2-2 Model Receiver Locations.mxd gweger 5/17/2017

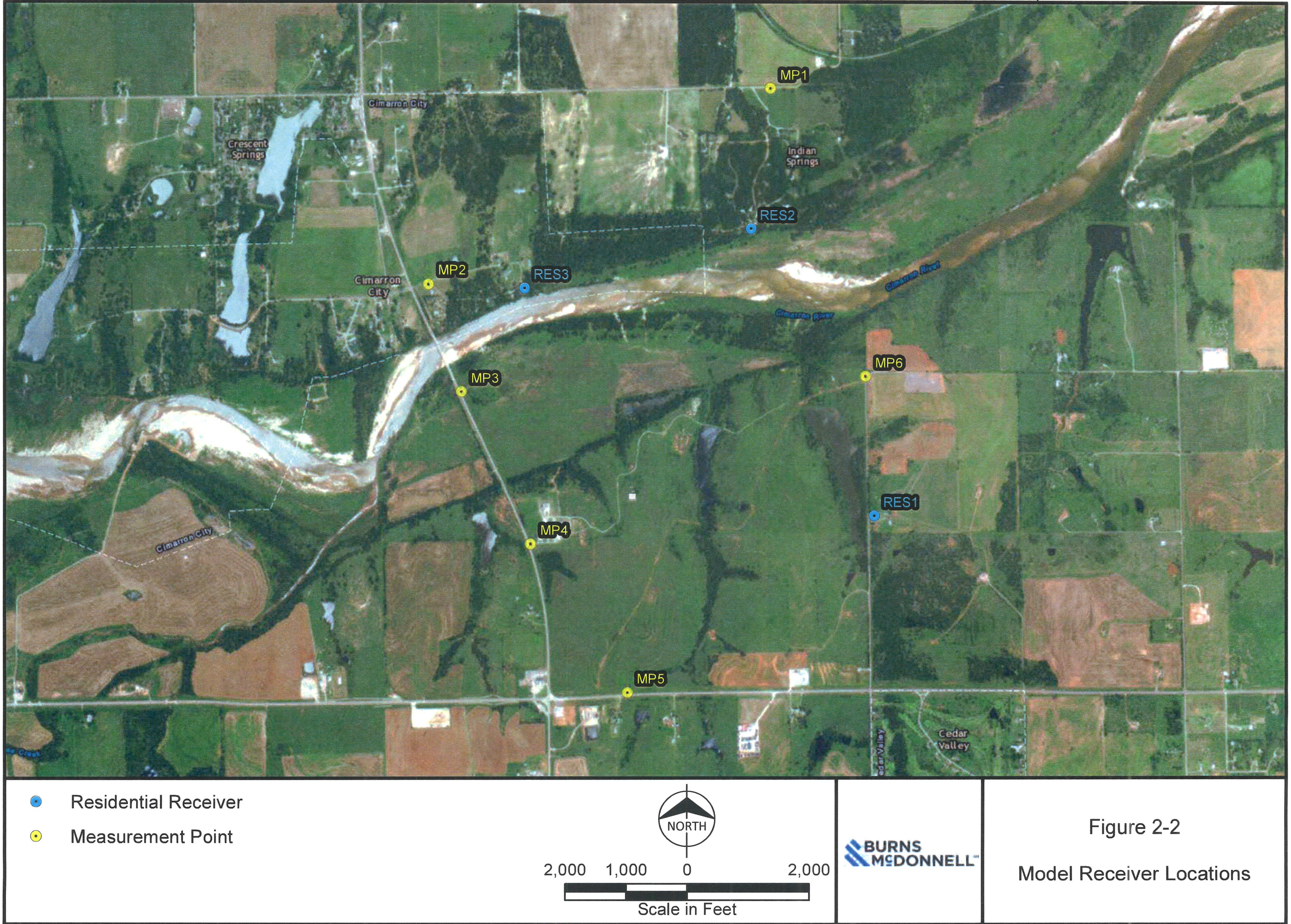

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Figure 2-2

Model Receiver Locations

Source: Burns & McDonnell Engineering, Inc.

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Path: G:\Air-Noise Dept\Project Files\Cimarron\Noise\GIS\Figure 2-3 Sound Level Contours.mxd gweger 5/17/2017

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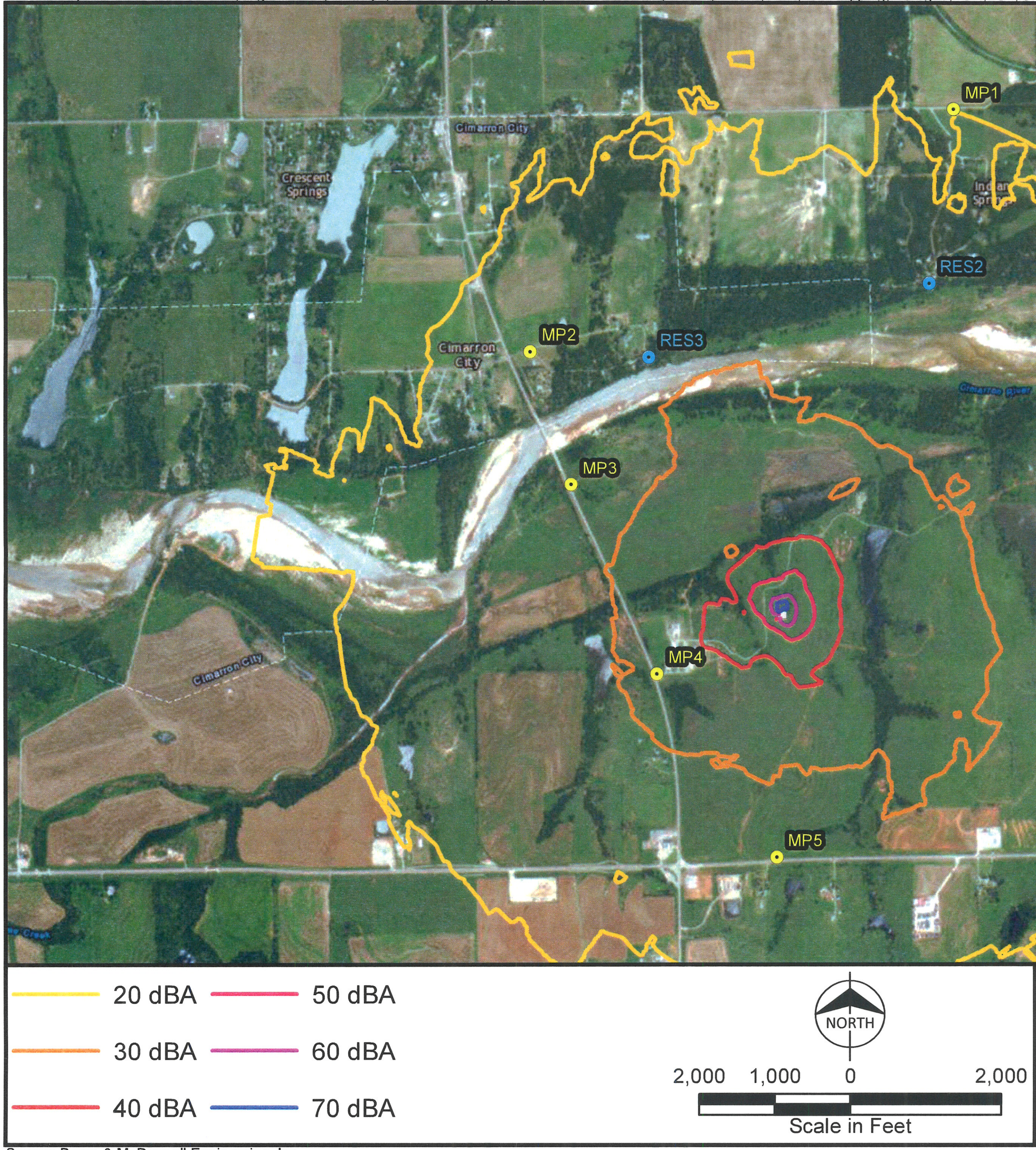

Figure 2-3

Sound Level Contours

Source: Burns & McDonnell Engineering, Inc.

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