COLORADO OIL AND GAS CONSERVATION COMMISSION (COGCC)

2017 ANNUAL REPORT

to the

WATER QUALITY CONTROL COMMISSION (WQCC)
and
WATER QUALITY CONTROL DIVISION (WQCD)
of
THE COLORADO DEPARTMENT OF
PUBLIC HEALTH AND ENVIRONMENT
(CDPHE)

COLORADO
Oil & Gas Conservation Commission

IN ACCORDANCE
with
THE AUGUST 28, 1990 MEMORANDUM OF AGREEMENT
and
THE IMPLEMENTING PROVISIONS OF SENATE BILL 89-181

December 30, 2017

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1.0 INTRODUCTION

The Colorado Oil and Gas Conservation Commission (COGCC) is an implementing agency for water quality standards and classifications adopted by the Water Quality Control Commission (WQCC) for ground water protection. This authority was provided by Senate Bill (SB) 89-181, and is restated and clarified by a Memorandum of Agreement (MOA) that was adopted by the agencies on August 8, 1990.

Section 5.1 of the MOA specifies that the COGCC must report annually to the WQCC and the Water Quality Control Division (WQCD) about how its programs assure compliance with WQCC water quality standards and classifications for the activities that are subject to the jurisdiction of the COGCC.

This 26th annual report provides an overview of COGCC functions and a summary of calendar year 2017 activities, with a focus on groundwater protection programs. Major issues concerning the implementation of water quality standards and classifications are also reported.

2.0 WQCC/WQCD AND COGCC COORDINATION AND PUBLIC OUTREACH

2.1 Inter-agency Coordination

In 2017 the COGCC, WQCC, and WQCD coordinated implementing the provisions of SB 89-181 and the MOA. COGCC and the CDPHE Office of Emergency Preparedness and Response staff communicated frequently through email and telephone calls regarding spills at or near oil and gas facilities when there was some question as to whether or not a spill was exploration and production (E&P) waste. COGCC took the lead for all E&P waste spills.

The COGCC staff met with WQCD/WQCC on March 15 and October 37, 2017 to discuss program issues. Agenda items included follow up on various active investigations, enforcement projects, and E&P waste management practices within the oil and gas industry. COGCC and WQCD staff discussed revisions and updates to the February 15, 2000 MOA between the agencies concerning response to and reporting of spills and releases to surface water. COGCC and WQCD also coordinated on enforcement actions in incidents where surface water was impacted.

2.2 Public Outreach

The COGCC employed the following strategies for effective communication with the public and the regulated industry:

Commission Hearings:

- In 2017, the COGCC held three of its regular eight hearings outside of Denver: one in Loveland, Larimer County (March), one in Meeker, Rio Blanco County (June), and one in Durango, La Plata County (September).
- Staff reports were prepared prior to all eight hearings for the COGCC Commissioners. Ongoing staff activities such as compliance and enforcement actions, environmental and landowner issues, and other topics relevant to the mission of the COGCC were

summarized in these reports. The 2017 reports were distributed widely to interested parties and they are posted on the COGCC website www.cogcc.state.co.us.

COGCC staff participates in regularly scheduled meetings with the regulated community and other interested stakeholders in parts of the State with active oil and gas operations. The Gas and Oil Regulatory Team (GORT), established by COGCC Order, met in Durango three times in 2017, focusing on oil and gas operations in the San Juan basin in southwestern Colorado. GORT provides a forum for meaningful dialogue between operators, citizens, county and local governments, the Southern Ute Indian Tribe (SUIT), the Bureau of Land Management (BLM), the U.S. Forest Service (USFS), and the COGCC. The Northwest Colorado Oil and Gas Forum (NWCOGF) usually meets in Rifle or Grand Junction, also three times yearly, and focuses on the Piceance basin and other operations in the northwestern part of the state. The NWCOGF is co-chaired by Garfield County and the COGCC Director; other State, Federal, and local government agencies, the oil and gas industry, and concerned landowners and citizens regularly participate. COGCC staff regularly attend GORT and NWCOGF meetings and give presentations on emerging issues, hot topics, as well as routine updates on operations statewide and in the respective geographic areas.

COGCC has developed a web-based interface for citizens to file complaints about oil and gas operations. This tool allows a complainant to track COGCC's progress toward resolving the complaint and increases the transparency and accountability of COGCC's complaint response process. In 2017 (through October), the COGCC responded to 997 complaints regarding issues such as noise, dust, odors, and reclamation, among others. A substantial number of the complaints received in 2017 addressed a pair of locations near a residential community in Erie. Also included in the 997 complaints were 24 water well concerns (approximate 2.5 percent of the total), which the COGCC investigated.

COGCC continues to solicit participation in the regulation of oil and gas exploration and production. Stakeholders, including the oil and gas industry, local governments, citizens, other regulatory agencies, agriculture interests, and the environmental community provide input into permitting, policy development, rulemaking, and other processes. During 2017, COGCC staff participated in approximately 90 meetings at the request of municipal, county, and other local governments, EPA, BLM, trade organizations, and special interest groups.

The Local Government Designee (LGD) process was created by the COGCC in 1992 to provide a conduit of information between local governments and the COGCC. COGCC hired Local Government Liaison (LGL) Staff in 2012 to facilitate participation in the LGD program through training, answering questions, and providing information, data, and presentations about specific aspects of oil and gas operations, COGCC rules, and the COGCCs regulatory program. In total, 161 entities (55 counties, 101 municipalities, and 5 special districts) currently participate in the LGD program. In all, LGL staff participated in 2017 provided 16 LGD trainings, facilitated 6 public meeting, and attended over 40 other events, seminars, trainings, or public meetings.

The COGCC continues to use its website, http://cogcc.state.co.us, to make announcements and distribute information and data. COGCC information and data systems are described further in Section 3.3.

2.3 Significant Events in 2017

Firestone Home Explosion Investigation and Regulatory Oversight
Beginning on April 18, 2017, COGCC was involved in the investigation of the home explosion in Firestone, Colorado that occurred on April 17. Initially, COGCC field inspection unit and pipeline integrity inspectors were onsite and helped the Frederick-Firestone Fire Protection District (FFFPD) identify a cut gas flowline attached to an oil and gas well in the vicinity that, while no longer in use, had not been disconnected from the wellhead and properly abandoned according to COGCC rules. The flowline was identified by FFFPD as the "origin and cause of the explosion and subsequent fire." Immediately after the home explosion, the operator isolated this line and shut in the well to prevent an ongoing source of natural gas flowing through the line. COGCC witnessed the excavation and testing of the cut flowline and other oil and gas facilities in the days following the incident. COGCC further supported initial phases of the FFFPD investigation by screening and sampling soil gas at the incident site (Martinez residence at 6312 Twilight Avenue) and neighboring residences.

On April 26, COGCC's contractor performed a ground methane driving survey of the Oak Meadows neighborhood to determine if there were any other sources of natural gas that could pose a threat to public safety in the neighborhood. The survey identified two anomalies with low levels of methane and other hydrocarbon gases detected. The first anomaly, in the vicinity of the active production facilities in the southwest portion of the neighborhood, was consistent with the contractor's expectations for readings collected near production facilities. The second anomaly, east of the production facilities along Oak Meadows Boulevard required follow up investigation, described later.

On April 27, COGCC and its consultant began a soil gas survey on and around the Martinez property to determine if residual natural gas remained in the subsurface. The initial phase of the survey included approximately 30 samples collected from a modified 75-foot grid established based on residential lot size. Following utility locates, slide hammer holes were advanced to depths of 30 inches below ground surface. Soil gas samples were screened using hand-held monitoring equipment at each sample location. The soil gas survey data demonstrated methane was present in soil at and adjacent to 6312 and 6310 Twilight Avenue.

Following up on the driving survey, on May 5, COGCC continued soil gas surveying in the vicinity of the methane anomaly near Oak Meadows Boulevard. COGCC had determined that the same 1-inch diameter flowline that led to the Martinez residence also had a branch that led to the west where it terminated under Oak Meadows Boulevard. Initial testing conducted on May 5 indicated elevated concentrations of methane in the soil above the apparent flowline terminus at Oak Meadows Boulevard. Additional delineation was performed on the same day to determine whether residual natural gas in soil extended north toward the residences along the south side of Twilight Avenue. The additional testing demonstrated that soil gas concentrations were at or near background levels in close proximity to the homes on the south side of Twilight Avenue.

COGCC's preliminary investigation indicated that there was not a general or ongoing threat to public safety in the Oak Meadows neighborhood. COGCC continued its soil gas survey, laying out a grid of monitoring points to delineate the lateral extent of subsurface natural gas impacts. COGCC also mobilized a GeoProbe™ rig to advance deeper soil borings and install PVC

monitoring points to facilitate routine and repeated monitoring of the natural gas in the subsurface. These points were established as "sentry points" between the two source areas and the nearest residences. Daily monitoring of these points further verified that subsurface natural gas was not migrating toward occupied homes.

Once the results of the FFFPD investigation were made public on May 2, 2017, COGCC directed the operator of the well and flowline, Anadarko, to fully investigate the extent of impacts associated with the release of natural gas from their well. Anadarko mobilized crews on May 5, using several contractors and methods of investigation throughout the project area. Anadarko began with a walking survey using hand-held equipment to monitor the soil-air interface for the presence of methane and other hydrocarbon gases. Anadarko also utilized a Membrane Interface Probe (MIP) to advance soil borings to evaluate the vertical and lateral extent of natural gas in the subsurface. Anadarko ultimately installed 54 additional PVC monitoring points at depths of up to 30 feet, many of which would later be utilized in one of two Soil Vapor Extraction (SVE) systems which successfully removed the natural gas from the subsurface. As part of the investigation, Anadarko collected groundwater samples from monitoring points installed near the source of the release behind 6312 Twilight Avenue. These samples verified that there was no impact to groundwater related to the release. Anadarko worked under COGCC's oversight and in close cooperation with the agency. Details of the investigation and remediation efforts are documented in COGCC Remediation Project #10182.

The two SVE systems removed a total mass of over 2,000 pounds of methane and other hydrocarbons from the two affected areas between May 17 and June 7; the systems were shut down on June 7 due to removal rates dropping to asymptotically low levels. Subsequent monitoring of established monitoring points indicated no rebound in methane concentrations following system shut down. Anadarko also collected gas samples from the 63 PVC monitoring points and vent wells for laboratory analysis and the analytical results were non-detect for hydrocarbons, indicating successful removal of natural gas from the affected subsurface areas.

Anadarko continued to screen and sample a limited subset of monitoring points in July, August and September. No hydrocarbons were detected in any of the monitoring points during that three month period, indicating no rebound in methane concentrations since the remediation systems were shut down. Anadarko submitted a final remediation report with supporting documentation on October 18, 2017, which COGCC subsequently approved for closure on October 20th. COGCC Environmental Unit staff spent over 1,000 hours primarily in April, May, and June conducting direct environmental investigation and providing regulatory oversight to the operator as a result of this significant incident.

3.0 COGCC ORGANIZATION

3.1 COGCC Commissioners

The Colorado Oil and Gas Conservation Act specifies the composition of the Commission. The Act requires nine Commissioners, seven of whom are appointed by the Governor with the consent of the Senate, and two ex officio voting members who are the Executive Directors of the Department of Natural Resources (DNR) and the CDPHE. At least two members are appointed from west of the continental divide and the other members are appointed taking into account the

need for geographical representation of other areas of the state with high levels of oil and gas activity or employment. Of the seven, three members are to have substantial experience in the oil and gas industry and at least two of these must have college degrees in petroleum geology or petroleum engineering; one member must be a local government official; one member must have formal training or substantial experience in environmental or wildlife protection; one member must have formal training or substantial experience in soil conservation or reclamation; and one member must be actively engaged in agricultural production and also be a royalty owner.

The Commission welcomed two members, elected a new Chair, and two Vice-Chairs in 2017. A chart showing the makeup of the COGCC Commission is included in Appendix 1; biographies of the Commissioners are posted on our website http://cogcc.state.co.us/about.html#/commissioners.

3.2 COGCC Staff

The COGCC has 109 authorized full time employee (FTE) positions located in the Denver office and throughout the State in field offices. COGCC is currently holding six vacant positions open due to a decline in projected agency funding. The Staff include engineers, environmental protection specialists (EPSs), field inspectors, permitting technicians, hearings specialists, and a variety of administrative professionals. Table 3-1 summarizes each group and their primary functions. The current organizational chart and a series of maps showing regional areas of responsibility are included as Appendix 2.

Table 3-1

Group	Number of FTE	Primary Functions
Executive	1	Director
Environmental	21	Spills, Remediation projects, Pit closures, Complaint response, Environmental projects, Oil and Gas Location Assessments & Pit permitting, Environmental database
Engineering	16	Permitting downhole wellbore plans, UIC permitting, Oil/Gas facility oversight, Plugging orphaned wells, Flowline integrity
Field Inspection	31	Inspection of Oil/Gas wells, facilities, and locations; Complaint response; Interim and final reclamation
Permitting & Technical Services	24	Permitting oil and gas wells, Bonding, Production reporting, Database management/support, GIS, Website development/support, eForm development/support
Hearings	12	Hearings, Rulemaking, Enforcement, Local Government Liaisons
Financial	4	Budget management, Procurement, Purchasing

Staff functions that directly relate to water resource protection and compliance with groundwater and surface water standards include the following:

Permitting – Applications for Permit to Drill (APDs) are reviewed to ensure compliance with all rules related to aquifer protection. Oil and gas wells must be designed and installed to prevent

the migration of fluids or gas between formations or into aquifers. Permit technicians and engineering staff review drilling permit applications for surface casing and cementing requirements, among other requirements designed to protect aquifers. As reported in the December 11, 2017 COGCC Staff Report, COGCC issued 3,578 well permits in 2017 through December 1.

Location Assessments – Under the Form 2A process, Operators are required to provide site-specific environmental information about surface locations. Consultation by the CDPHE and Colorado Division of Parks and Wildlife (CPW) with the COGCC, the surface owner, and the operator is required in some circumstances. Oil and Gas Location Assessment (OGLA) specialists in the environmental group review and evaluate Form 2A applications, as well as publicly available information, to determine whether the proposed oil and gas operations have the potential to negatively impact water resources; public health, safety and welfare; the environment; or wildlife resources. Site-specific conditions of approval (COAs) may be placed on permits to prevent or mitigate potential impacts. Through December 1, 2017, COGCC approved 459 Form 2A Oil and Gas Location Assessments this year.

Underground Injection Control (UIC) Permitting – The U.S. Environmental Protection Agency (USEPA) has delegated authority to COGCC to review, approve and monitor the injection of E&P waste into Class II UIC wells. COGCC staff works with WQCD and USEPA staff to ensure that operators of Class II injection wells in Colorado are in compliance with groundwater standards and classifications. COGCC's staff geologic experts review UIC permits for site specific matters, such as the occurrence of faults and potential seismic issues. Injection operations in the Raton Basin and in Weld County are actively managed by the COGCC in conjunction with the U.S. Geological Survey Earthquake Notification Service, through the installation and continuous monitoring of several local seismometers to evaluate if injection of produced water has some relationship to local seismicity. COGCC has instituted a "traffic light" monitoring system, which dictates specific mitigation measures, up to requiring injection to be halted if seismic activity reaches specific levels. Through November, COGCC Staff approved 22 Class II UIC well permits in 2017.

Pit Permitting – Operators may construct pits at oil and gas locations for a variety of purposes; most commonly to contain drill cuttings, produced water and flow back, and for the reuse and recycling of produced water. COGCC is responsible for permitting pits (Form 15), inspecting their operation, and overseeing their closure. The OGLA and EPS staff review pit permits for construction and operational details, and evaluate the environmental setting to ensure that the pit can be used without causing adverse environmental impacts. The Director may apply conditions of approval with additional provisions to protect waters of the state, public health or the environment. In 2017, 61 new pits were permitted. Applications for new pits are down significantly over previous years reflecting both a decrease in new O&G activity in areas that traditionally have used pits for produced water disposal and widespread industry use of "pit-less" drilling and completion activities.

Centralized E&P Waste Management Facility Permitting – COGCC environmental staff permit non-commercial centralized E&P waste management facilities under Rule 908. Generally these facilities are larger than a typical tank battery or pit that might handle wastes from only one or a few wells. These larger facilities handle wastes from many wells and often from more than

one field or lease operated by a single oil and gas operator. These facilities may include lined pits, land treatment facilities, land application areas, drill cuttings solidification facilities, or tank batteries. A permit is required for these facilities and, as part of the approval process, staff evaluates the proposed site, operation, financial assurance, environmental impacts and preliminary closure plans. These facilities are currently required to have financial assurance in an amount equal to the estimated cost for proper closure, abandonment, and reclamation. During 2017, the COGCC permitted five new centralized E&P waste management facilities. There are 42 active permitted centralized E&P waste management facilities in the state.

Oversight of Produced Water Disposal – Approximately 50 percent of the water co-produced with oil and gas is disposed or used for enhanced recovery by underground injection. Most produced water that is not injected is disposed in evaporation and percolation pits or discharged under a Colorado Discharge Permit System (CDPS) permit. Disposal facilities may be commercial and subject to oversight by CDPHE or they may be private and subject to oversight by COGCC. A small amount of produced water is used for dust suppression on oil and gas lease roads, subject to applicable rules. To minimize waste and the use of fresh water, many operators are reusing and recycling produced water and other fluids for drilling and well completion activities including hydraulic fracturing (frac) treatment operations. COGCC staff review UIC permits, pit permits, centralized E&P waste management permits, and other proposals, including water reuse and recycling plans, to ensure that produced water is handled appropriately.

Complaint Response – COGCC responds diligently to complaints received from individuals and other agencies. Complaints are tracked in the COGCC's database and can be accessed via the COGCC website. In 2017, COGCC received 27 complaints related to groundwater or surface water issues. The environmental staff follows up, where appropriate, and collects samples for laboratory analysis. A letter report is provided to the complainant explaining the analytical results, regardless of whether an oil and gas impact is indicated. The COGCC staff frequently observes relatively poor overall water quality in many private domestic wells, often related to nuisance bacteria, natural water conditions, or influence from shallow groundwater which may be affected by surface activities. When oil and gas impacts are identified, COGCC requires operators to perform additional investigation, remediation, and mitigation, as needed, to bring sites into compliance with soil and groundwater standards.

Three water wells were identified as having oil and gas issues in the 27 complaints investigated this year. All of the three are related to an earlier well impact that is currently under investigation and enforcement action by the commission.

Spill/Release Response and Remediation Oversight – Spill response by the environmental staff includes onsite inspections, sample collection, remediation oversight, and review of reports, remediation plans, analytical data, and operating practices, to ensure protection of surface and groundwater, in accordance with COGCC rules and WQCC standards and classifications. Spills are tracked in COGCC's Master Records Database (MRDB) and can be accessed via the COGCC website. COGCC's oversight of spills, releases, remediation projects, and environmental investigations is discussed in more detail in Section 6 of this report.

Plugging Orphan Wells – COGCC engineering, environmental, and reclamation staff used appropriated funds and claimed financial assurance to perform plugging and abandonment,

remediation, and reclamation work at orphaned oil and gas sites in 18 counties: Adams, Boulder, Garfield, Jackson, Jefferson, La Plata, Larimer, Logan, Mesa, Moffat, Montezuma, Montrose, Ouray, Rio Blanco, Routt, San Miguel, Washington, and Weld. COGCC plugged 11 wells and remediated or reclaimed 7 locations during Fiscal Year 2017. Ongoing reclamation maintenance of stormwater BMPs, weed control, and maintenance seeding was also performed at other locations that were reclaimed in prior fiscal years. In Fiscal Year 2018, bond claim and PROW appropriation work is planned for plugging and abandoning up to 15 orphaned wells, remediation or initial reclamation of up to 13 orphaned locations, and other related work, including reclamation maintenance of previously-reclaimed locations in 12 counties including Adams, Boulder, Fremont, Jackson, Jefferson, La Plata, Larimer, Lincoln, Logan, Mesa, Moffat, Montezuma, Montrose, Routt, Washington, and Weld.

Enforcement – As of December 1, 2017, the Commission has issued 38 enforcement orders, including 30 Administrative Orders by Consent, 5 Orders Finding Violation, and 3 orders foreclosing a financial assurance instrument this year. These orders resolved 84 Notices of Alleged Violations and imposed $7,166,851 in gross penalties, of which $370,366 was conditionally suspended. The total penalties assessed amount is an all-time record high for a calendar year.

3.3 COGCC Information/Data Systems

Each year COGCC works to improve its data management systems and geographic information systems (GIS) as time and resources allow. Primary data systems that were improved or developed in 2017 include:

- eForms – additional forms developed and some existing forms revised
- Geographic Information Systems
- Environmental Database – Database improvements
- Data Downloads – new data sets were made available
- Online Environmental Reports
- Daily Activity Dashboard on website updated

Brief descriptions of the changes for each system are provided in the following sections.

3.3.1 eForms

COGCC uses an electronic form filing system built on a Microsoft Silverlight™ platform called "eForms." The eForm application allows operators to submit applications and notices electronically, and the system also provides for automatic email notices to appropriate parties, including the applicant or operator, COGCC staff, and local governments or other regulatory entities. Because Microsoft will no longer support Silverlight™ past 2020, COGCC has begun the transition to a new electronic form system. This process commenced with the pilot development of the Form 8 – Oil and Gas Conservation Levy and will continue over the next two years. eForms currently in use or pending completion (*****) are:

Form 2 – Application for Permit to Drill
Form 2A – Oil and Gas Location Assessment

Form 4 – Sundry Notice
Form 5 – Drilling Completion Report
Form 5A – Completed Interval Report
Form 6 – Well Abandonment Report
Form 7 – Monthly Operations Report
Form 8 – Oil and Gas Conservation Levy*
Form 10 – Certificate of Clearance/Change of Operator
Form 14 – Monthly Report of Non-Produced Water Injected**
Form 14A – Authorization of Source of Class II Waste for Disposal**
Form 15 – Earthen Pit Report/Permit
Form 17 – Bradenhead Test Report
Form 19 – Spill/Release Report
Form 21 – Mechanical Integrity Test (MIT) Report
Form 22 – Accident Report
Form 23 – Well Control Report
Form 26 – Source of Produced Water for Disposal
Form 27 - Site Investigation and Remediation Workplan (release date January 1, 2017)
Form 31 – Underground Injection Formation Permit Application
Form 33 – Injection Well (UIC) Permit Application
Form 41 – Trade Secret Claim of Entitlement
Form 42 – Field Operations Notice
Form 43 – Sample Analytical and Data Form*
FIR – Field Inspection Report
FIRR – Field Inspection Report Resolution Form
NOAV – Notice of Alleged Violation
Warning Letter

With eForms, operators are able to submit forms and attachments electronically online. COGCC staff review and approve the forms electronically, and data from the forms are uploaded to the MRDB instantaneously upon approval. For forms that require review by multiple staff members (i.e., permitting, engineering, etc.), each staff member involved in the process passes their task within the eForm system.

3.3.2 GIS – Geographic Information Systems

The GIS Online map is an important tool used by staff, industry, and other agencies to submit and process permits, create reports, and view information related to exploration and development. The COGCC interactive map is also a go-to resource for the general public and interested stakeholders regarding environmental concerns and siting issues related to current and planned drilling and production activity.

The GIS Online map contains over 170 spatial datasets including oil and gas well locations, permits, spacing orders, field boundaries, and useful reference information such as cities, rivers, roads, sections, land ownership, etc. Aerial photos, topographic quads, and geologic maps are also included as valuable information resources. The newest version of our online mapping system allows users to zoom to a specific street address or parcel for much of Colorado, has improved printing functionality, and includes a live connection to our environmental sampling

database. To aid operators and other interested parties with their own GIS work, the COGCC website provides GIS shapefiles for download, including files that have daily updated well information, permit and pending permit data, and wellbore traces for directional and horizontal wells across Colorado. Recently added are downloads of KMZ files for well locations that can be used in Google Earth on smartphones and tablets. The COGCC's online mapping tool is regularly recognized as one of the best state-level oil and gas resources in the nation.

3.3.3 Environmental Database

The Groundwater Protection Council (GWPC) in conjunction with the COGCC has developed a publicly available, searchable database of groundwater, surface water, and soil sample analytical results from throughout the state. This database is referred to as the COENV database. The COENV database has been active since September 2012. The database has sampling data dating back as far as 1941. The environmental database currently contains over 15,700 sample locations and 43,420 individual samples (as of December 1, 2017).

In 2017, 2,102 samples from 784 separate locations were added to the database. In addition to the 2017 samples, 474 samples from 2016 were received in 2017. Since the statewide rules for groundwater sampling went into effect on May 1, 2013, COGCC has received a total of 8,161 water samples from 3,472 separate locations from operators in compliance with the rules.

The data can be accessed through the GIS Online map. Sample locations with available water and natural gas data appear as green triangles when the "Sites with Lab Data" layer is turned on. The user can double click on a sample site and gain access to the analytical data for that site. An example analytical report is included as Appendix 3.

The COENV database allows for electronic data deliverables to be used for input. New samples from COGCC staff sampling efforts, current COGCC baseline sampling rules 317B, 318A.f, 608, and 609, and older samples from the COGA Voluntary Baseline Sampling Program are accessible. In April 2014, the COENV database was made available for download in an Access database format for those who wish to query large datasets.

COGCC is currently working with OIT on an enhanced set of tools for interfacing with the COENV database. The Form 43 Project includes tools that have been requested by both the COGCC and operators. Tools that the COGCC staff requested include an integrated GIS search tool, automatic generation of commonly used diagrams, and enhanced data export tools. Tools for the operator include a streamlined data upload process with built in data quality checks and a printable document (Form 43) that will serve as a receipt for information submitted to the COGCC. The tools are expected to be ready for testing in early 2018.

3.3.4 Data Downloads

Historically, the COGCC has provided production data, spacing order data, and GIS shapefiles for download from the website. GIS data available include well surface locations and directional data (updated daily), pits, oil and gas fields, sensitive wildlife habitat, certain significant geologic information, and approximate buffers associated with COGCC Rule 317B.

In addition to GIS data listed above, and in an effort to increase transparency, the COGCC aggregates datasets directly from our MRDB and provides them for public use. The MRDB, managed and maintained by COGCC with assistance from the Governor's Office of Information Technology, is a comprehensive repository of Colorado's oil and gas data. Although all the data is available through interactive search tools on the website, these downloads allow the industry, public, non-governmental organizations, or other interested parties to access large amounts of data in searchable formats so that they may run their own analyses. These datasets are updated periodically.

The data downloads now available are:

Complaints Data
NOAV Data
Flowline Notice to Operators (NTO) Inventory
MIT Data
Spill and Release Data
Analytical Sample Data
Field Inspection Reports
Production Data
Spacing Orders

The COGCC is developing additional data downloads for future release, including Remediation Projects.

3.3.5 Online Environmental Reports

Written reports for COGCC-managed baseline sampling projects and other special environmental studies, such as status reports for monitoring Project Rulison in Garfield County and the Methane Seep studies in Las Animas/Huerfano counties are posted on the website under the "Library" tab where they are primarily organized by basin and available for download as portable document format (PDF) files.

In 2013, COGCC staff developed a fact sheet, *Methane in Colorado Groundwater*, to explain the differences between thermogenic and biogenic methane and briefly discuss how the COGCC determines if the source of methane in a water well is biogenic or thermogenic. This topic is addressed in detail in Section 6.2 of this report and the fact sheet is provided in the appendices.

Although not new, the brochure, *How Well Do You Know Your Water Well* continues to be very popular. The brochure was updated and revised in 2011 to include information about mitigating methane in water wells, current contact information for various agencies, and water well maintenance and recordkeeping. COGCC provides this useful brochure to water well owners when water samples are collected from their wells by COGCC, operators, or third party contractors.

3.3.6 Daily Activity Dashboard

In late 2016, the COGCC launched the Daily Activity Dashboard, a new web based tool designed to give local governments, the public, and other stakeholders a more efficient way to access, sort, and display the most commonly used data related to oil and gas operations. The Dashboard is a visual interactive tool that allows a user to generate custom statistical charts, graphs, tables, and simple maps based on data that are updated every day.

The Dashboard does not offer any new types of oil and gas data to the public, or replace existing ways of searching for online oil and gas data in the Colorado Oil and Gas Information System, but instead provides a convenient way to access information on pending permits, well status, production, well inspections, NOAVs, active notifications, and spills. This tool can be accessed by clicking "Dashboard" in the main menu of the COGCC homepage.

In 2017, the Daily Activity Dashboard was updated to allow for exporting of data from within individual dashboard reports, thereby allowing the user to obtain and manipulate the information with programs such as MS Excel™.

3.4 COGCC Environmental Program and Project Funding

The General Assembly annually appropriates a line item within COGCC's budget for the environmental staff to respond to, investigate, prevent, monitor, or mitigate conditions that threaten or actually cause adverse impacts to air, water, soil, or to public health, safety, and welfare or to wildlife resources. This work includes, but is not limited to, the collection of water and soil samples, laboratory analyses of the samples, and the review and analysis of laboratory results and other environmental data. In fiscal year 2017-2018, the appropriation for this line item was $312,033.

In addition, the General Assembly annually appropriates a line item to fund special environmental protection and mitigation studies including, but not limited to, gas seepage mitigation studies, outcrop monitoring studies, soil gas surveys in the vicinity of plugged orphaned wells, and baseline water quality and subsequent follow-up studies. The intent was to provide readily available funds for special projects as the need arises. The COGCC reports all expenditures made from this line item in the previous year to the General Assembly in its annual budget request. The appropriation for this line item in FY 2017-18 is $325,000. The FY 2016-17 special environmental projects are described in Section 8.

In addition to the foregoing, COGCC receives an annual appropriation to respond to emergencies related to oil and gas operations that threaten or cause significant adverse impacts to public health, safety, welfare, or the environment. For FY 2017-18, this appropriation is $750,000. The COGCC also receives an annual appropriation for plugging, abandoning, and reclaiming orphaned wells. For the past several years, this appropriation has been $445,000.

4.0 NEW COGCC REGULATIONS AND POLICIES

4.1 Notice to Operators Statewide Flowlines or Pipelines

In response to the Firestone home explosion, COGCC issued an NTO on May 2, 2017. The NTO required all operators to systematically inspect their inventory of existing flowlines to verify that any existing flowline not in active use, regardless of when it was installed or taken out of service, is abandoned pursuant to Rule 1103, including being cut off below grade and properly sealed. In addition, operators were required to document the location of all existing, active flowlines located within 1,000 feet of a Building Unit and ensure and document that these lines have integrity.

Phase I of the NTO had to be completed by May 30, 2017, and required operators to inspect any existing flowlines and pipelines located within 1,000 feet of a Building Unit. As part of Phase I, operators were required to clearly mark unused risers using fluorescent paint, remove all operating valves, and cap the risers until the flowlines could be abandoned pursuant to Rule 1103.

Phase II of the NTO had to be completed by June 30, 2017, and required operators to ensure and document that all flowlines within 1,000 feet of a Building Unit had integrity. Phase II also required operators to abandon any flowline or pipeline not actively operated, regardless of distance to a Building Unit.

Although the NTO was developed in response to the Firestone home explosion and public safety concerns, the results of the NTO accomplish several things, including improving flowline integrity statewide. Flowline integrity failures result in a significant number of reportable releases each year, some of which impact groundwater. The improved integrity will result in fewer releases and fewer groundwater impacts.

4.2 Flowline Rulemaking

On August 22, 2017, Governor Hickenlooper announced his seven policy initiatives developed during the State's review of oil and gas operations. The changes contemplated by two initiatives—strengthening COGCC's flowline regulations and enhancing the 8-1-1 "one-call" program—will be proposed through a COGCC rulemaking process. COGCC staff have begun working with stakeholders and drafting amended rules for consideration by the Commission. Amendments to the current rules may include added or changed definitions and changing the word "pipeline" to "flowline" throughout the rules in accordance with Commission Order 1R-103.

Proposed changes to the 1100 Series Flowline Rules regarding the following topics are also being considered:

- Adding applicable installation or design standards for flowlines
- Including integrity monitoring standards and testing regimes
- Addressing integrity management for flowlines that operate at atmospheric pressure

- Removing the low pressure exemption from pressure testing and requiring integrity management
- Improving flowline integrity management recordkeeping and reporting requirements in the event of an integrity failure
- Improving regulatory oversight of flowlines that are designed to transport fluids from a wellsite to a remote production facility location
- Incorporating requirements from the COGCC's May 2, 2017 NTO
- Improving requirements for operators' membership in the Utility Notification Center of Colorado (UNCC or 8-1-1)
- Improving flowline abandonment requirements

The flowline rulemaking is ongoing with periodic stakeholder meetings although the formal Commission hearings to adopt amended Rules has been continued from December 2017 to January 2018.

5.0 OIL AND GAS EXPLORATION AND PRODUCTION ACTIVITY

Data used in the following discussion are current as of December 1, 2017 as reported in the December 2017 COGCC Staff Report.

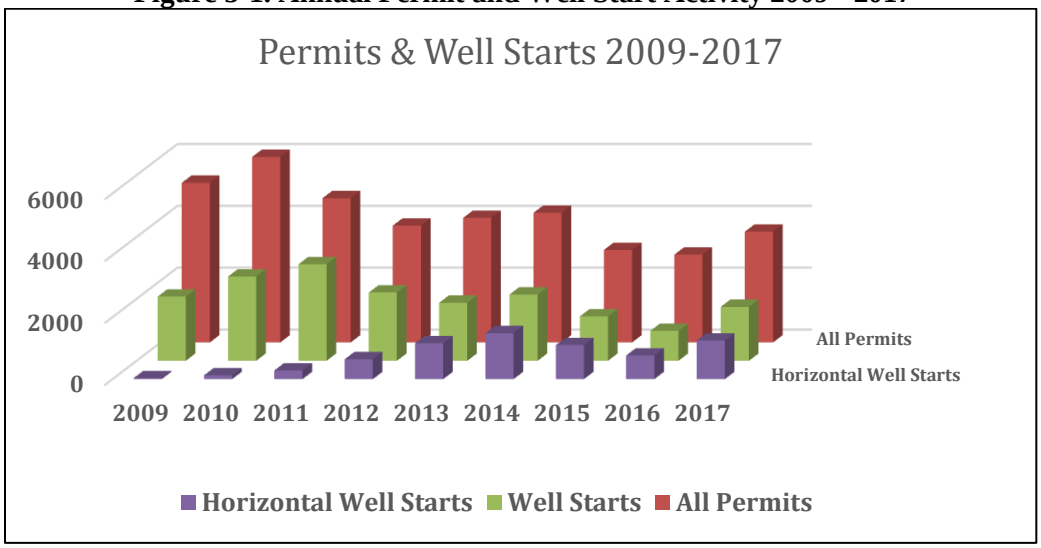
One metric used to measure exploration and development activity levels is the number of approved permits. A total of approximately 3,578 permits to drill were issued in 2017, compared to 2,835 in 2016. Most of the permits, approximately 62 percent, were issued in Weld County (2,219 permits) in the active shale play of the Niobrara and Codell formations. Of the 2,219 Weld County permits, 2,188 were for horizontal wells (approximately 98 percent). The second most active County for permits was Garfield County with 572 permits; however, only 11 were for horizontal wells. Historical details of permit activity by County since 2000 are provided in Appendix 4.

Another metric to gauge activity level is the number of wells drilled; COGCC tracks well starts and, specifically, horizontal well starts. As of December 1, 2017, there were 1,741 well starts statewide, compared to 964 well starts in 2016, 1,434 in 2015, and 2,139 in 2014. In 2017, 1,245 wells starts were for horizontal wells, or approximately 72 percent of the total. As in recent years, horizontal drilling associated with the Niobrara and Codell Formations in the Denver-Julesburg (DJ) Basin dominated the drilling activity in 2017; 1,169 (94 percent) of the horizontal wells were spud (started) in Weld County. Over time, wells drilled in Colorado have shifted from a dominance of vertical wells to horizontal wells as shown in the Table 5-1 and Figure 5-1, below.

Table 5-1. Annual Permit and Well Start Activity 2009 - 2017

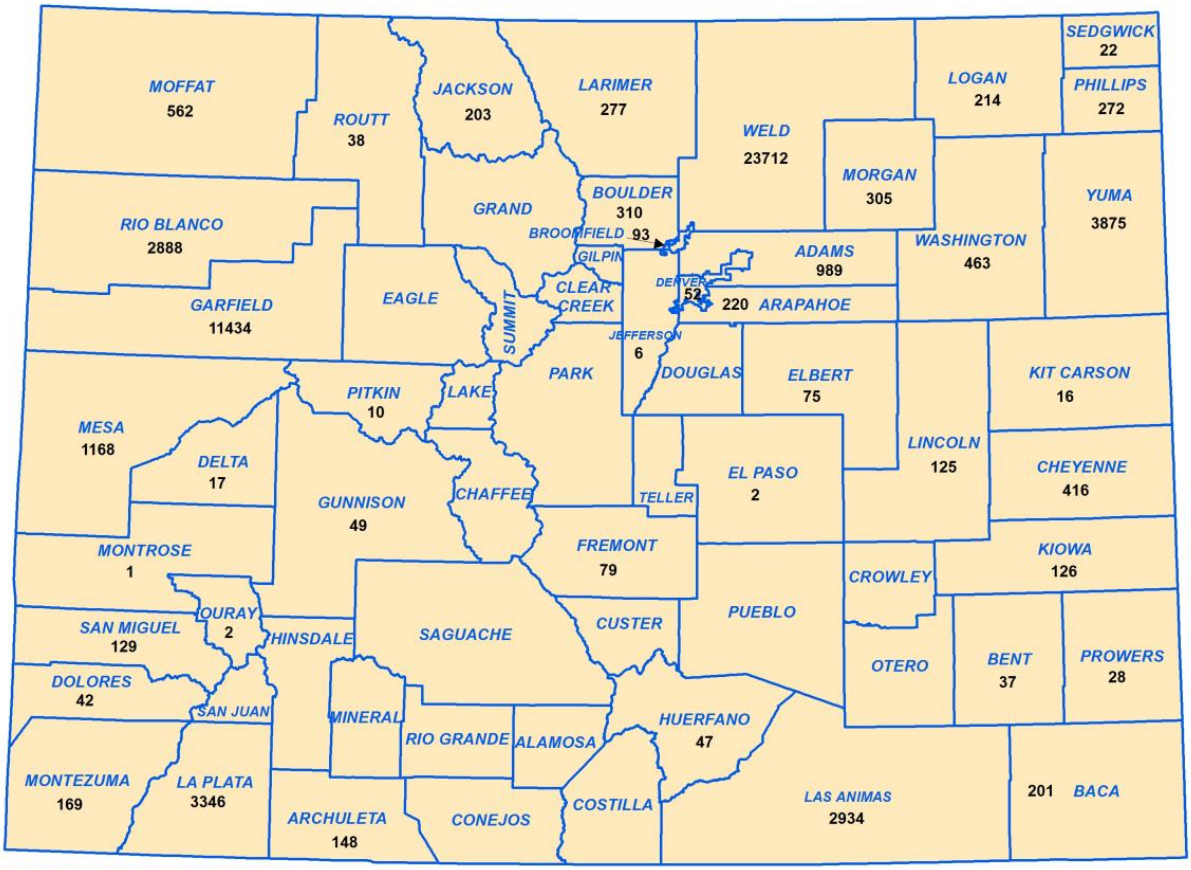
Year	2009	2010	2011	2012	2013	2014	2015	2016	2017
Permits	5159	5996	4659	3773	4025	4190	2987	2835	3578
Well Starts	2071	2719	3114	2202	1872	2139	1434	964	1741
Horizontal Well Starts	31	123	280	641	1160	1484	1096	764	1245
Percent Horizontal	1%	5%	9%	29%	62%	69%	76%	79%	72%

Figure 5-1. Annual Permit and Well Start Activity 2009 - 2017



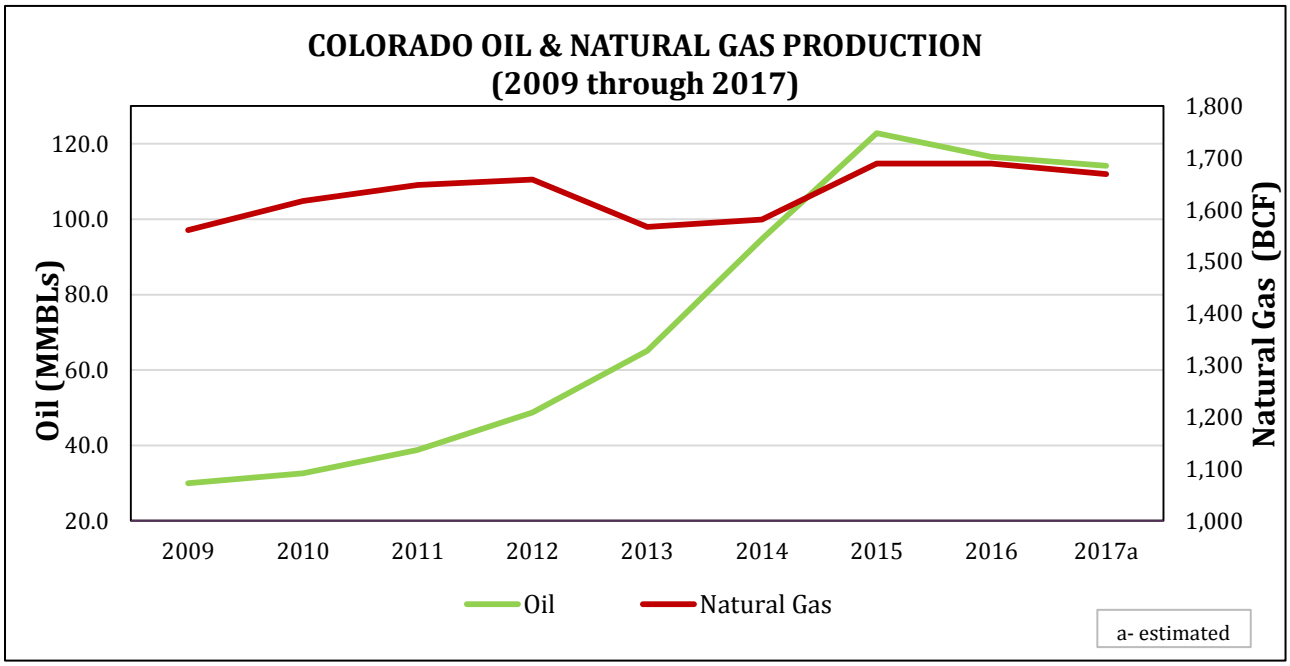
As of December 8, 2017, there were 55,062 active wells in the State. Figure 5-2 shows the approximate number of active wells by County. Weld and Garfield counties have the most active wells, with 23,708 and 11,423 wells, respectively.

Figure 5-2. Number of Active Wells by County (2017)



Oil and gas production reports for 2017 are not yet complete and, therefore, final production figures for 2017 are not available. COGCC expects production reporting to be finalized by April 15, 2018. With that caveat, COGCC estimates that statewide oil production for 2017 will be approximately 114.2 million barrels (BBLs) of oil produced after final accounting. This would be the third highest annual oil production on record, behind 2015 (122.8 million BBLs) and 2016 (116.5 million BBLs). Further, COGCC estimates that approximately 1.68 trillion cubic feet (TCF) of natural gas will be produced in Colorado during 2017, basically the same volume of natural gas production reported for both 2016 and 2015. Since 2009, Colorado's oil production has dramatically increased from 30.0 million BBLs to the current levels, while natural gas production has remained fairly flat (Figure 5-3)

Figure 5-3. Colorado Oil and Gas Production 2009-2017



The COGCC estimates the total dollar value for oil and natural gas produced in Colorado in 2017 to be approximately $10.6 billion. For comparison the combined value from 2016 was $9.2 billion and $10.8 billion in 2015.

6.0 SPILLS/RELEASES, REMEDIATIONS, AND ENVIRONMENTAL INVESTIGATIONS

6.1 Statewide Spills/Releases and Remediation Projects

Operators are required to report E&P waste spills and releases that occur as a result of oil and gas operations in accordance with COGCC Rule 906, as revised in 2013, using a Form 19 – Spill/Release Report. Oil, condensate, and produced water are the substances most commonly spilled or released. These substances fall under the E&P waste exemption to regulation as hazardous wastes under Subtitle C of the Resource Conservation and Recovery Act (RCRA); therefore, they are subject to COGCC jurisdiction. COGCC defines spills as "any unauthorized

sudden discharge of E&P waste to the environment" and releases as "any unauthorized discharge of E&P waste to the environment over time." Through December 1, 2017, 566 spills or releases were reported to the COGCC in 2017.

Although only spills and releases that meet certain thresholds require reporting, operators are required to remediate environmental impacts associated with any spill or release of E&P waste of any size. The COGCC environmental staff review and approve remediation plans, evaluate analytical data, monitor the progress of the remediation, and ensure cleanup standards and other remediation requirements are met through verification sampling, data review, site inspections, and other measures.

Where groundwater has been impacted, operators are required to eliminate any continued release; investigate the extent of contamination; remove the source of contamination (such as the impacted soils in contact with groundwater or free hydrocarbon product); remediate; establish points of compliance; and monitor contaminant levels. In accordance with the MOA for Response to Spills/Releases to Surface Water, the COGCC notifies the WQCD of spills or releases impacting surface waters; in 2017, eight such spills or releases to surface waters were reported to WQCD staff.

Remediation projects are tracked in the COGCC's database and can be accessed on the COGCC website. Through December 1, 2017, the COGCC received approximately 486 new remediation plans, and closed approximately 301 remediation projects. It should be noted that not all reported spills and releases are required to be closed under an approved remediation plan, but certain facilities, like production pits and partially buried produced water vessels are required by COGCC rule to be closed in accordance with an approved plan.

6.2 Investigations into Thermogenic Stray Gas Impacts to Domestic Water Wells

Although the presence of methane and other short chain hydrocarbon gases in groundwater are not regulated under WQCC Regulation 41, the Oil and Gas Conservation Act provides authority to COGCC to require that oil and gas operations be conducted in such a manner that the pollution of freshwater supplies by oil, gas, salt water or brackish water is prevented. COGCC Rule 209 specifically addresses this issue and in part requires that special precautions be taken in drilling and abandoning wells to guard against the "contamination of fresh water by objectionable water, oil, or gas." The means and mechanisms by which the Commission rules address isolation of groundwater resources from the intrusion of hydrocarbon gases, oil and produced water are principally by downhole use of steel casing string(s) held in place by cement layers. For example, Rules 317 and 317A specifically address the issue of isolation of groundwater resources from oil and gas bearing zones by use of engineered isolation barriers such as steel casing string(s) and placement of downhole cement barriers. The failure of wellbore isolation systems can provide pathways by which freshwater resources can be contaminated with objectionable water, oil, or gas from formations in which the objectionable water, oil, and gas are present, typically beneath the freshwater resources.

COGCC staff routinely investigate the possible presence of methane and other short chain hydrocarbon gases (C_1 to C_6) in groundwater in a manner similar the investigative methods used for complaints regarding possible impacts from Regulation 41 regulated compounds. The

forensic style investigations to determine if oil and gas related contamination is present in groundwater are complicated by the fact that methane (and ethane) occurs naturally in the groundwater in many sedimentary basins in Colorado. Methane is naturally produced by two distinct types of processes which are discussed below.

Thermogenic methane (and associated heavier hydrocarbons gases and liquids) forms in organic rich sediments from geologic processes involving burial and resulting elevated temperatures, increased pressures and also over relatively lengthy time frames such as millions of years. Commercial production of oil and natural gas in Colorado is largely of **thermogenic** hydrocarbons including methane and other heavier gaseous and liquid hydrocarbons.

Biogenic methane is generated by microbial processes that can produce methane by one of two mechanisms. One mechanisim that produces **biogenic** methane is the fermentation of organic matter in the absence of oxygen such as in wetlands or landfills. The second mechanism that produces **biogenic** methane is the microbially mediated reduction of carbon dioxide as found in many confined aquifers such as the Laramie-Fox Hills (LFH) aquifer in Colorado. Ethane of microbial origin may also be present in some aquifers. A fact sheet providing information on the presence of **biogenic** and **thermogenic** methane can be downloaded from the COGCC web page and a copy is provided in Appendix 5.

COGCC investigations into the source of gases present in groundwater may be initiated by any of the following:

1. Water well owner complaint alleging or concerned about the potential for oil and gas impacts to their water well;
2. Data received from groundwater sampling and analysis as required of oil and gas operators under COGCC Rules 318A, 608 and 609 or as required by specific Commission orders or conditions of approval of permits; or
3. Voluntarily collected data provided by homeowners, county health departments or oil and gas operators.

COGCC staff throughout the state utilize the general process outlined in this section for groundwater quality investigations related to possible presence of thermogenic gases in fresh water aquifers. It should be noted in advance that COGCC environmental staff coordinate with our engineering staff and rely on operators (sometimes through enforcement) to provide records and data for our review. COGCC often employs third party contractors to perform sampling services and utilizes commercial accredited environmental laboratories to perform requisite analyses. Additionally, COGCC may employ third party experts in carbon isotopic analysis and evaluation in support of complex groundwater investigations.

If COGCC determines that thermogenic gas is present in a domestic water well sample, a thorough investigation into the source of the gas is commenced and COGCC works with oil and gas operators to secure a reliable source of non-impacted water, typically through alternate supply or treatment systems. If COGCC finds no evidence of oil and gas impacts to the groundwater, a letter describing the water chemistry analyses and results is provided to the water well owner.

A first step in determining the presence or absence of undesirable thermogenic hydrocarbon gases in groundwater is the review of existing data available for the specific water well in question and nearby water wells (if such data exist). If no existing or no recent data are available, groundwater samples are collected and submitted to commercial labs for analysis. Groundwater samples are typically analyzed for general water quality parameters such as major cations and anions, volatile organic compounds (including aromatic organics such as benzene, toluene, ethylbenzene, xylene (BTEX) isomers and naphthalene), and composition and concentration of hydrocarbon gases; if dissolved hydrocarbon gases are present in sufficient concentrations, isotopic analyses are performed. Isotopic analyses include the laboratory determination of carbon and hydrogen isotope ratios of methane and of carbon isotopic ratios of straight chain and branched hydrocarbon gases from chain length of C_2 to C_5.

Review of gas composition and gas isotopic data by COGCC environmental staff is essential in determining if gas migration from oil and gas well bores to freshwater aquifers has occurred. For comparison to the analytical data discussed above, COGCC maintains a large set of publicly available data of gas compositions and isotopic ratios from various hydrocarbon producing formations throughout Colorado on the COENV database. In a general sense, the **thermogenic** gases in the producing basins are wetter than the **biogenic** gases in the aquifers, containing greater proportions of C_2 through C_6 gases than the drier gases produced by biogenic processes. For example, thermogenic production gas from the Niobrara Formation in the DJ Basin typically has a ratio of methane (C_1) to ethane plus propane (C_2+C_3) of 10-15. This thermogenic gas also would contain detectable quantities of all the hydrocarbon gases up to chain length of six. Whereas drier biogenic hydrocarbon gases present in many confined portions of the Laramie-Fox Hills aquifer are typically composed primarily of methane with only traces of ethane and have $C_1/(C_2+C_3)$ ratios of 100 or greater.

An equally important means of categorizing the mechanism of origin of gases is evaluation of isotopic ratios of carbon and hydrogen in methane and isotopic ratios of carbon in C_2 to C_5 hydrocarbon gases. In this process, carbon isotope ratios are compared to an international reference standard known as the Vienna Pee Dee Belemnite (VPDB). Carbon isotopic ratios for **biogenic** methane are typically more negative with respect to VPDB than are carbon isotopic ratios of **thermogenic** methane, and the comparison is reported as Delta ^{13}Carbon ($\delta^{13}C$) per mil (‰) VPDB

Using the DJ Basin as an example, biogenic methane present in the Laramie-Fox Hills aquifer typically has ^{13}C ratios in the range of -70 $\delta^{13}C$ ‰ VPDB. By comparison, thermogenic gases in the basin typically have less negative isotopic ^{13}C ratios in the range of -40 to -50 $\delta^{13}C$ ‰ VPDB. Likewise, biogenic ethane present in the Laramie-Fox Hills aquifer also has more negative ^{13}C ratio than ethane produced by thermogenic processes in deeper formations. The differences in the carbon isotope ratios are directly attributable to the materials from which and the processes by which the gases are generated.

Many times, aquifer samples contain mixtures of biogenic and thermogenic hydrocarbon gases with mixed isotopic and gas composition ratios. The presence of more than trace amounts of propane and heavier hydrocarbon gases can be diagnostic of intrusion of stray gas into the aquifer from formations containing thermogenic gases. The carbon isotopic ratios of propane as

well as the carbon isotopic ratios of butane isomers and pentane isomers are also useful diagnostics of the presence of thermogenic gases in an aquifer.

When COGCC determines that thermogenic hydrocarbon gases are present in a groundwater aquifer, COGCC engineering staff aid in the investigation. Initially, engineering staff review records for oil and gas wells within one-half to one mile of the groundwater sample location looking for possible oil and gas wellbore integrity problems such as casing leaks, short surface casing of old wells, high Bradenhead[1] pressures, or history of remedial cementing or previous casing repairs. COGCC staff contact operators with wells in the investigation area requesting systematic evaluation of their records for the same potential indicators. In addition to the paperwork and records review, operators are frequently requested to perform Bradenhead tests at some or all wells in the area, which COGCC field inspection staff may witness. Operators may also be required to collect and analyze samples of production and Bradenhead gases on wells of particular concern to COGCC staff.

Engineering review of nearby wells may indicate that plugged and abandoned oil and gas wells may be possible sources of stray gas found in an aquifer. Unfortunately, this means gas samples cannot be collected for analysis and subsequent comparison and evaluation. In order to aid potential future investigations, when operators file notice of intent to plug and abandon wells in areas such as the DJ Basin where numerous groundwater investigations take place, COGCC engineering staff currently require as a condition of approval Bradenhead testing prior to plugging. When Bradenhead pressures exceed a specified threshold, the operator is required to collect samples of the gases or liquids emerging from the Bradenhead and analyze them for composition and/or isotopic ratios. Collection and analysis of production gases from the wells may also be required as part of the conditions of approval of the plugging procedure.

COGCC engineering and environmental staff integrate the gas analytical data with any possible well bore integrity issues identified among nearby oil and gas wells in an effort to identify active or plugged wells that could be the source of the thermogenic gas impacts. COGCC will meet with the operators to discuss the investigation progress, results, and preliminary conclusions. If one or more active wells are identified as potential sources of thermogenic gas, COGCC will require the operator(s) to submit a Site Investigation and Remediation Workplan (Form 27) for approval. The Form 27 documents steps the operator will take that will aid in definition of a source and remedial steps that will be taken such as cement squeezes or casing patches at problem oil and gas wells. As part of these site investigations, operators may have offered to or been required to provide alternate water source to the water well owner(s). Follow-up sampling of the impacted well and surrounding water wells to determine extent of impacts as well as possible increases or decreases in level of impacts is a required component of the site investigation plans. COGCC staff may also undertake enforcement actions with respect to stray gas incidents depending on the totality of the investigation.

Currently, there are 22 such investigations ongoing in the DJ Basin of northeastern Colorado. Two enforcement actions with respect to four water wells impacted by thermogenic gas are in

[1] COGCC defines Bradenhead as "the annular space between the surface casing and the next smaller diameter casing string that extends up to the wellhead."

process. Appendix 6 has summaries of three groundwater investigation projects on which staff have been engaged in 2017.

6.3 *tert*-Butyl Alcohol in Raton Basin Groundwater

Since the conclusion of the Raton Basin *tert*-butyl alcohol (TBA) study in early 2015, the COGCC has continued to investigate the presence of TBA in groundwater in Las Animas County in response to citizen complaints. The COGCC has conducted five water sampling events in response to TBA related complaints. Samples were obtained from coal bed methane (CBM) wells and produced water pits not previously sampled for TBA and compared to recently obtained samples from the complainants' domestic groundwater wells known to contain TBA. To evaluate the CBM activities as a potential source of TBA, COGCC compared the overall geochemistry of domestic groundwater to CBM produced water and did not find any evidence that CBM produced water has influenced domestic groundwater aquifers in the areas investigated. None of the additional five samples of produced water collected since completion of the TBA study contained detectable concentrations of TBA. The levels of TBA found in all of the complainants' domestic water wells has remained relatively static with no changes observed in the overall geochemistry of their water throughout multiple COGCC sampling events.

In an additional effort to determine the origin of TBA in the domestic wells, the COGCC investigated the potential for disposal of household products containing TBA to septic systems as a possible source of TBA in groundwater. The presence of caffeine or optical brighteners in a domestic water well would indicate a link between local septic systems and the source aquifer of the domestic well. COGCC analyzed for caffeine and optical brighteners in one domestic well known to contain TBA, but no caffeine or optical brighteners were detected in the samples, indicating that the local septic system was not the source of TBA in the well.

None of the additional investigation conducted since the publication of the "Investigation of *tert*-Butyl Alcohol in Raton Basin Groundwater, Huerfano and Las Animas counties, Colorado" in January 2015, have led COGCC to alter the conclusions contained within that report. The investigation determined that the TBA in domestic water wells in the area is likely anthropogenic or may be naturally occurring due to bacterial degradation of isobutane, but its presence in groundwater is not demonstrably attributable to oil and gas activity.

7.0 SPECIAL ENVIRONMENTAL PROJECTS

This section describes projects which were completed or underway during calendar year 2017 for which funding came from the special environmental projects and mitigation studies budget line (the list below includes work completed in Fiscal Year (FY) 2016-17 and ongoing for FY 2017-18):

Upper Pierre Aquifer Water Quality Study, Weld, Morgan, and Logan Counties – The COGCC has published the report Water Quality and the Presence and Origin of Methane in the Upper Pierre Aquifer in Northeastern Weld County, Morgan County and Logan County, Colorado, COGCC Special Project 2141 available in the Library\Area Reports\Denver Basin section of the COGCC website. The COGCC undertook this study in response to a higher level of interest in the sands of the Upper Pierre Shale as a source of economic quantities of

groundwater. The water bearing sandstone intervals have collectively become known as the Upper Pierre Aquifer; and water well permit applications continue to be submitted in eastern Weld County for agricultural, commercial, and industrial uses, including applications for stock water and for oil and gas drilling and completion. The Division of Water Resources has published Water Resources Investigation WRI 2017-1a, *The Upper Pierre Aquifer of the Cheyenne Basin, Northeastern Colorado, Geologic Cross Sections*, available at http://water.state.co.us.

Results of the COGCC water quality study indicate the Upper Pierre Aquifer contains water suitable for industrial and stock uses, although high sodicity and high boron concentrations prevent use of the water for irrigation. Some water well owners are using the water for domestic or commercial supply with treatment. The average completion depth of water wells sampled was 848 feet, and the maximum completion depth was 1,302 feet. The water type ranges from sodium-bicarbonate to sodium-sulfate, depending on water well location, depth and construction. Total Dissolved Solids averages 1,430 milligrams per liter. Microbial methane was detected in the majority of the water wells sampled. Thermogenic methane and BTEX were not detected.

Naturally Occurring Radioactive Materials (NORM) Produced Water Project (COGCC Special Project 10243)

The COGCC Environmental Staff completed sampling of a total of 52 produced water samples and 5 production gas samples from 47 separate well sites statewide for Naturally Occurring Radioactive Materials (NORM) as part of this Special Project. The sampling targeted water production from geologic formations producing oil and gas throughout Colorado, including the Sussex, Codell, Niobrara, Muddy J, Dakota, Mesa Verde (Williams Fork), Mancos, Leadville, J and D Sand, Vermejo/Raton, Fruitland, Osage, Topeka, and Cherokee formations. Source water for hydraulic frac fluids along with frac "flowback" were also sampled. Twenty-two O&G operators participated.

NORM constituents analyzed include activities of radium isotopes and concentrations of uranium and thorium in addition to general water quality parameters. All water samples were analyzed for the stable isotopes of oxygen and hydrogen (diagnostic of water sources) and a subset of water samples were analyzed for carbon-14 and tritium (H_3) as indicators of age of waters sampled.

This study is a follow up to "Analysis of Naturally Occurring Radioactive Materials in Drill Cuttings, Greater Wattenberg Field, Weld County" completed in November 2014. It is also responsive to the October 2011 State Review of Oil and Natural Gas Environmental Regulations (STRONGER) review of COGCC regulations. The results of this study will help determine if NORM levels in produced fluids are acceptable in terms of applicable regulatory levels.

Analytical laboratory results are currently being received and Staff expects all sample results to be completed and sent to the COGCC by the end 2017. A final report will be completed in the first quarter of 2018.

3M4M Projects, La Plata and Archuleta Counties – Between 2001 and 2010, the COGCC installed 17 monitoring wells at 11 locations along the Fruitland Formation outcrop in La Plata

and Archuleta counties to monitor gas pressure changes in the Fruitland Coal. All monitoring wells are equipped with downhole pressure transducers that report data via a satellite telemetry system to a central data center. In 2008 and 2009, the COGCC and its contractor designed and installed methane seep mitigation systems at two locations in La Plata County. The system at the South Fork Texas Creek (SFTC) site collects methane from a shallow "French drain" type network of piping and converts the methane to electricity. A passive collection system is installed at the Pine River site.

The COGCC has continued the monitoring and mitigation systems to provide ongoing operations and maintenance (O&M) support to ensure the systems stay in working order and continue to relay data as designed. The COGCC and its contractors have conducted the following activities:

- Routine operations and maintenance activities of all systems;
- Reviewed gas quality measurements stored in all data loggers;
- Collected weather station data;
- Conducted a system-wide field inspection tour;
- Collected well pressure measurements from a central data center; and
- Analyzed data and prepared the annual report.

Since May 2009, the SFTC system has collected 21,665 million cubic feet (Mcf) of methane and generated 254,045 kilowatt-hours (kWh) of surplus electricity, which is transferred to the La Plata County Electric Association grid.

Project Rulison, Garfield County –The COGCC and its contractor have revised the Rulison Sampling and Analysis Plan (RSAP). In this revision of the RSAP, Tier I boundary is unchanged. It is set at 1 mile radius from the Project Rulison device emplacement well R-E. The Tier II boundary is redefined to take advantage of knowledge of the fracture orientation pattern and insights from subsurface modelling (Department of Energy [DOE] 2010) that have developed since the RSAP was initially published. The most significant modification to the plan is a realignment of the Tier II buffer zone from a circle to an ellipse with the major (long) axis aligned with the average hydro-geologic fracture orientation of $N75^0W$. The distance from the origin (emplacement well R-E) to the farthest point on the major axis of the ellipse is 2 miles. The minor (short) axis of the ellipse is perpendicular to the long axis and the distance from the origin to boundary is 1.5 miles. The draft version of this plan was distributed to various stakeholders including the CDPHE, DOE, Garfield County, and various operators for review and comment prior to finalizing the final revision.

Driving Methane Survey (Pilot Study) – In August 2017, in cooperation with the CDPHE – Air Pollution Control Division (APCD), the COGCC submitted a proposal to EPA Region 8 to utilize its Geospatial Measurement of Air Pollution (GMAP) system for a driving air monitoring survey, primarily in Weld County. The GMAP system is capable of quantitatively detecting methane, total volatile organic constituents, and benzene while the survey vehicle is in motion, allowing for surveys of large geographic areas. The COGCC proposed this pilot study for two basic purposes as follows:

1. To determine if there are uncontrolled releases of natural gas from oil and gas producing facilities in close proximity to residential areas that could result in public safety risks;

2. To identify and stop emissions from oil and gas production facilities to protect human health and the environment in accordance with applicable air quality regulations.

Field work for the GMAP surveying took place from November 1 through 15, 2017. The GMAP system was deployed in areas selected by COGCC for several reasons, but primarily for the large number of oil and gas facilities located in close proximity to both established and expanding residential areas within municipalities such as Dacono, Frederick, Firestone, Erie and several others. The field work consisted of a total of seven days of surveying covering approximately 100 miles of roads per day.

The real-time surveying results did not identify any public safety risks. Some locations had elevated readings of methane, total volatile organic constituents and benzene in close proximity to active oil and gas operations. EPA is expected to provide the final data to COGCC by May 2018. The COGCC will use the data to prepare a summary report of findings and evaluate the GMAP system, or a comparable technology, for additional surveys.

This study may provide valuable data for the development of an ambient methane monitoring pilot program consistent with one of the Governor's seven policy initiatives for oil and gas reform issued on August 22, 2017.

APPENDIX 1

COGCC Commissioners

Colorado Oil & Gas Conservation Commission Statutory Requirements

*Please note that information within parentheses is additional background information and not a statutory requirement

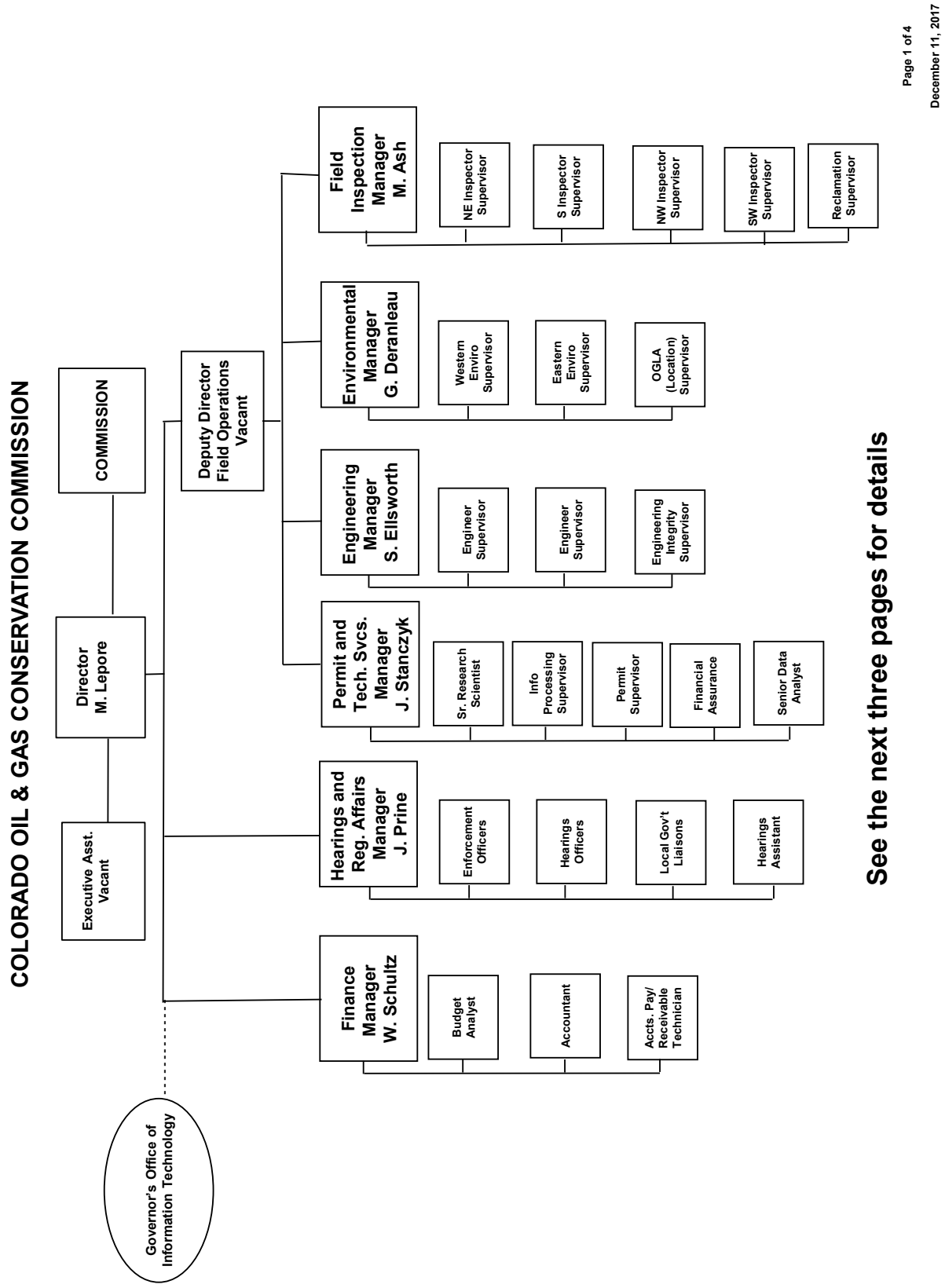
Commissioner (Officer)	**2 Executive Directors (ex-officio voting members)** (Current Employment)	**2 West of Continental Divide** (Resident County)	**3 with Substantial Oil & Gas Experience** (Employed by Oil & Gas Industry) (Current Employment)	**2 Out of 3 Must Have a College Degree in Petroleum Geology or Petroleum Engineering**	**1 Local Government Official** (Current Employment)	**1 with Substantial Environmental or Wildlife Protection Experience** (Current Employment)	**1 with Substantial Soil Conservation or Reclamation Experience** (Current Employment)	**1 engaged in Agricultural Production and a Royalty Owner** (Current Employment)	**Maximum of 4 from Same Political Party (excluding Executive Directors)**	**Current Term Expires**
Ashley L. Ager		**X** (La Plata)					**X** (Geologist)		D	7/1/2020
John H. Benton *Chair*		(Littleton)	**X**	**X**					R	7/1/2019
Howard Boignan *Vice Chair*		(Denver)	**X**						D	7/1/2020
James W. Hawkins *Vice Chair*		(Jefferson)	**X**	**X**					D	7/1/2019
Tommy Holton		(Weld)			**X** (Ft. Lupton Mayor)				R	7/1/2019
Kent Jolley		**X** (Garfield)						**X** (Rancher)	R	7/1/2020
Erin A. Overturf		(Denver)				**X** (Environmental Attorney)			D	7/1/2019
Robert W. Randall	**X** (Department of Natural Resources)	(Denver)								
Dr. Larry Wolk	**X** (Department of Public Health and Environment)	(Denver)								

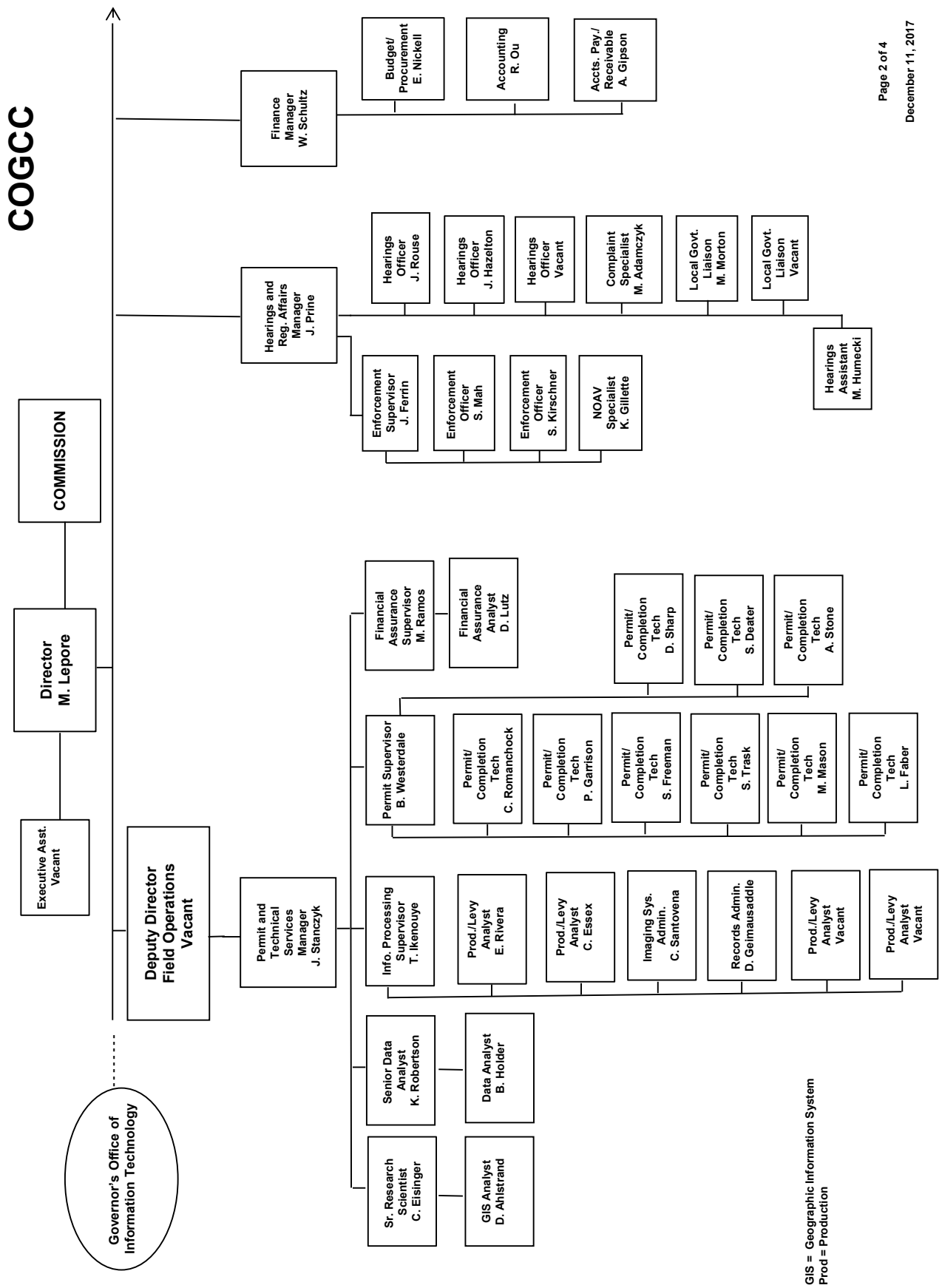
Commissioner requrements are set by statute in the Oil and Gas Conservation Act at §34-60-104 (2) (a)(1), C.R.S. (Current as of September 20, 2017)

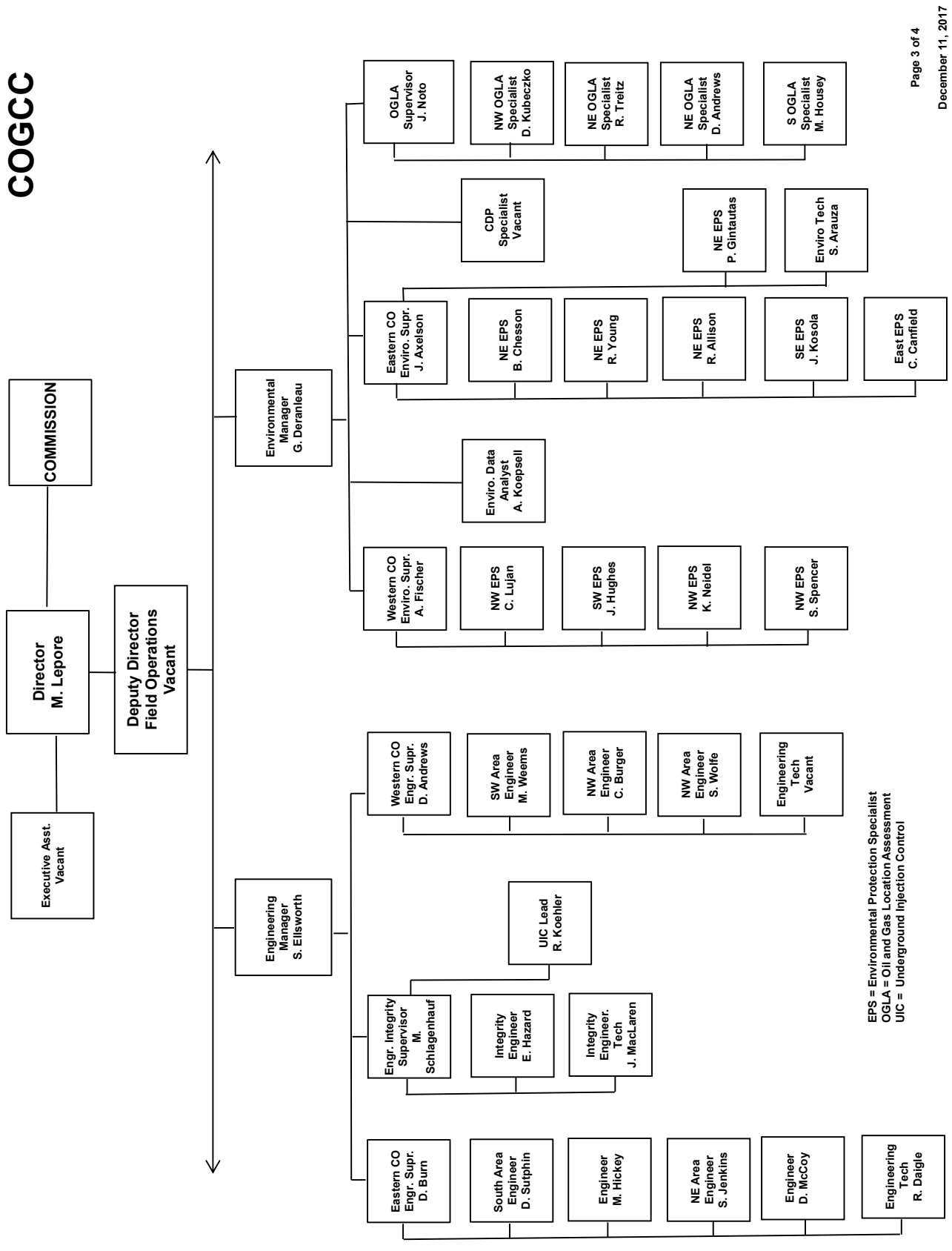
APPENDIX 2

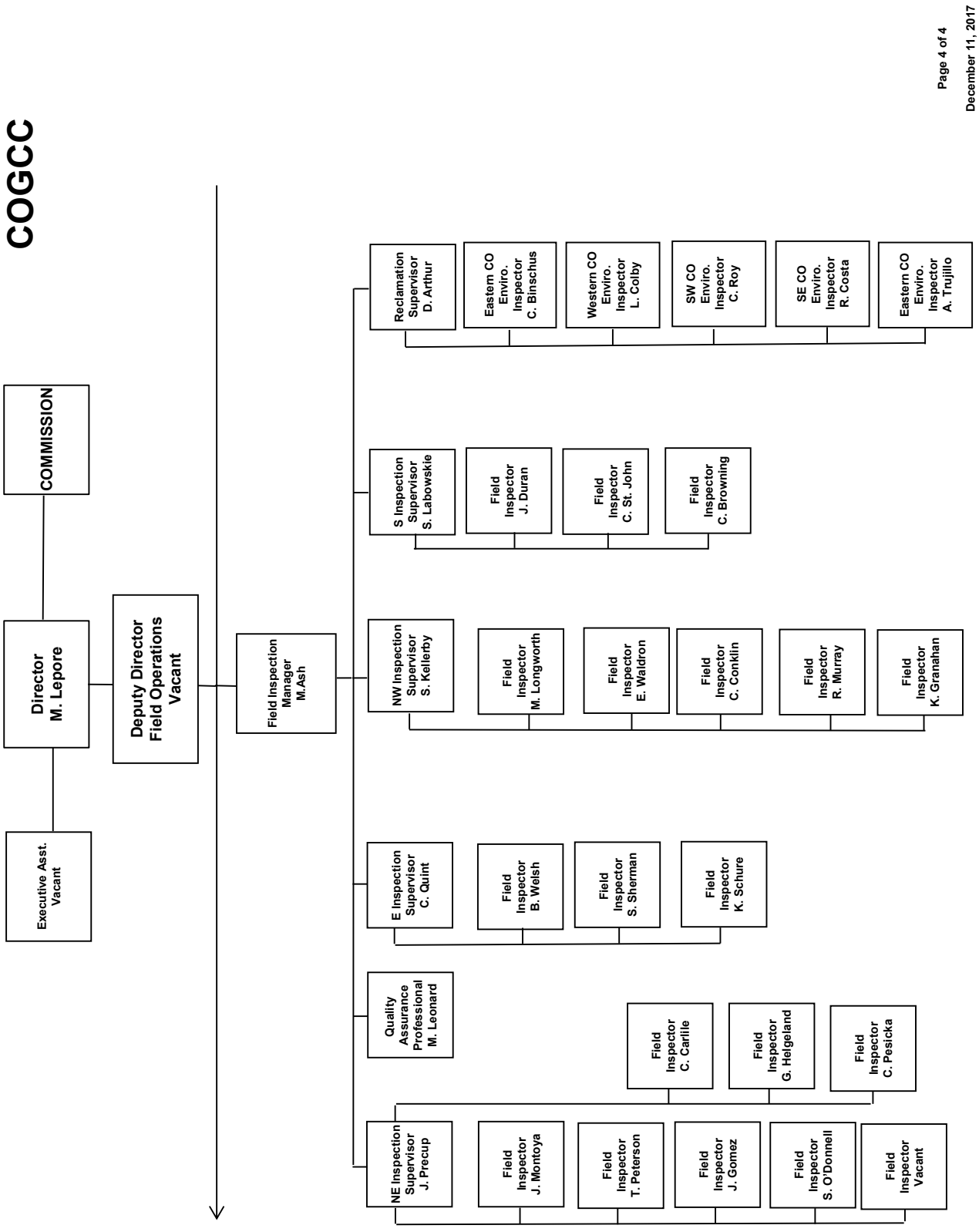
COGCC Organizational Chart

Organizational Charts and Statistics

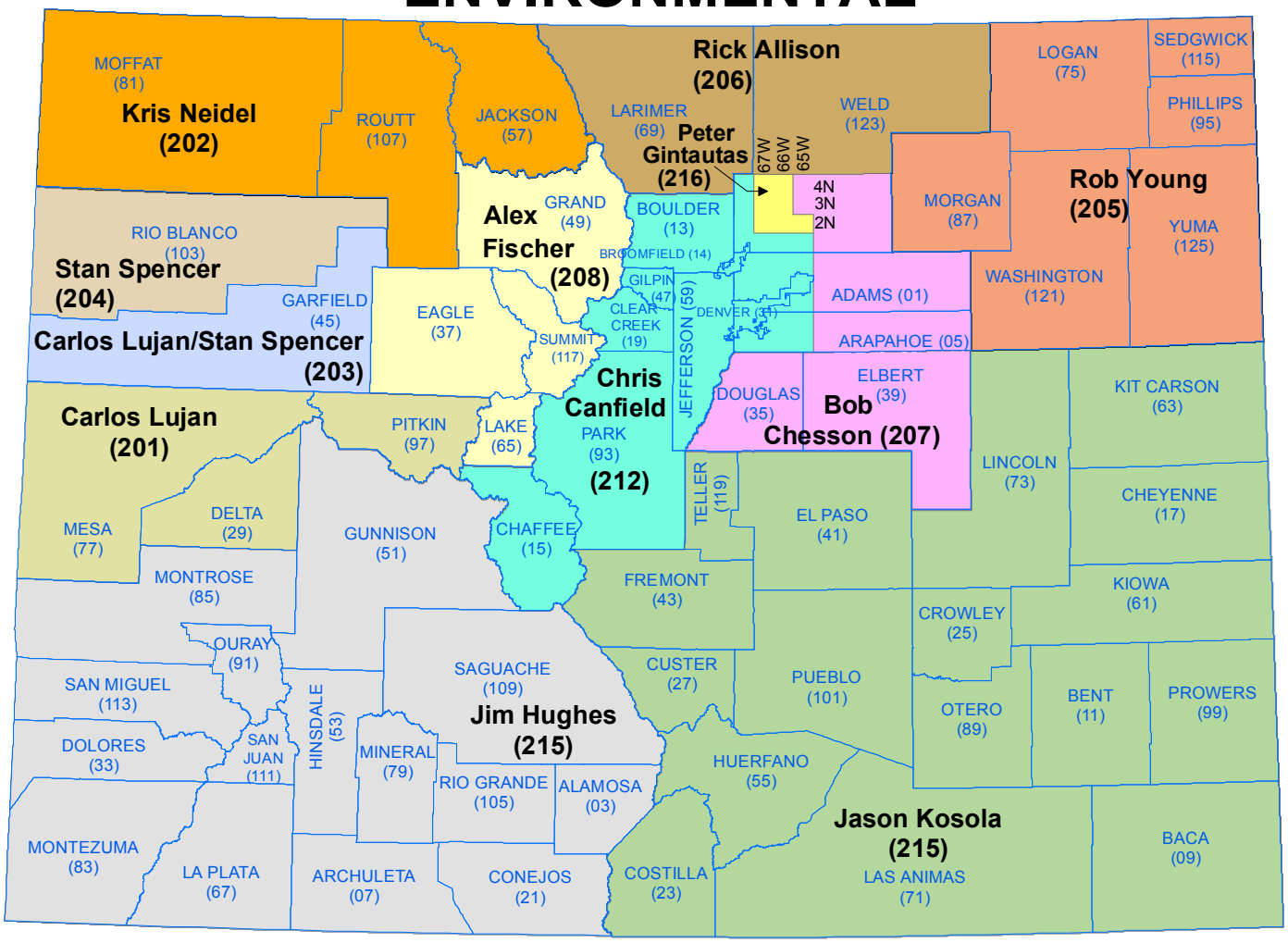



COGCC
COMMISSION
Director
M. Lepore
Executive Asst.
Vacant
Deputy Director
Field Operations
Vacant
Governor's Office of
Information Technology
Finance
Manager
W. Schultz
Budget/
Procurement
E. Nickell
Accounting
R. Ou
Accts. Pay./
Receivable
A. Gipson
Hearings and
Reg. Affairs
Manager
J. Prine
Hearings
Officer
J. Rouse
Hearings
Officer
J. Hazelton
Hearings
Officer
Vacant
Complaint
Specialist
M. Adamczyk
Local Govt.
Liaison
M. Morton
Local Govt.
Liaison
Vacant
Hearings
Assistant
M. Humecki
Enforcement
Supervisor
J. Fernin
Enforcement
Officer
S. Mah
Enforcement
Officer
S. Kirschner
NOAV
Specialist
K. Gillette
Permit and
Technical
Services
Manager
J. Stanczyk
Financial
Assurance
Supervisor
M. Ramos
Financial
Assurance
Analyst
D. Lutz
Permit/
Completion
Tech
D. Sharp
Permit/
Completion
Tech
S. Deater
Permit/
Completion
Tech
A. Stone
Permit Supervisor
B. Westerdale
Permit/
Completion
Tech
C. Romanchock
Permit/
Completion
Tech
P. Garrison
Permit/
Completion
Tech
S. Freeman
Permit/
Completion
Tech
S. Trask
Permit/
Completion
Tech
M. Mason
Permit/
Completion
Tech
L. Faber
Info. Processing
Supervisor
T. Ikenouye
Prod./Levy
Analyst
E. Rivera
Prod./Levy
Analyst
C. Essex
Imaging Sys.
Admin.
C. Santovena
Records Admin.
D. Geimausaddle
Prod./Levy
Analyst
Vacant
Prod./Levy
Analyst
Vacant
Senior Data
Analyst
K. Robertson
Data Analyst
B. Holder
Sr. Research
Scientist
C. Eisinger
GIS Analyst
D. Ahlstrand
GIS = Geographic Information System
Prod = Production

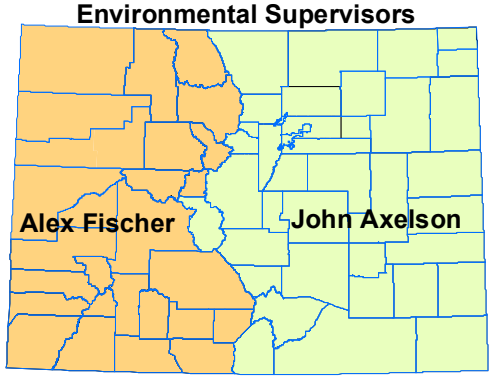

COGCC
COMMISSION
Director
M. Lepore
Executive Asst.
Vacant
Deputy Director
Field Operations
Vacant
Environmental
Manager
G. Deranleau
OGLA
Supervisor
J. Noto
NW OGLA
Specialist
D. Kubeczko
NE OGLA
Specialist
R. Treitz
NE OGLA
Specialist
D. Andrews
S OGLA
Specialist
M. Housey
CDP
Specialist
Vacant
NE EPS
P. Gintautas
Enviro Tech
S. Arauza
Eastern CO
Enviro. Supr.
J. Axelson
NE EPS
B. Chesson
NE EPS
R. Young
NE EPS
R. Allison
SE EPS
J. Kosola
East EPS
C. Canfield
Enviro. Data
Analyst
A. Koepsell
Western CO
Enviro. Supr.
A. Fischer
NW EPS
C. Lujan
SW EPS
J. Hughes
NW EPS
K. Neidel
NW EPS
S. Spencer
Engineering
Manager
S. Ellsworth
Western CO
Engr. Supr.
D. Andrews
SW Area
Engineer
M. Weems
NW Area
Engineer
C. Burger
NW Area
Engineer
S. Wolfe
Engineering
Tech
Vacant
UIC Lead
R. Koehler
Engr. Integrity
Supervisor
M.
Schlagenhauf
Integrity
Engineer
E. Hazard
Integrity
Engineer.
Tech
J. MacLaren
Eastern CO
Engr. Supr.
D. Burn
South Area
Engineer
D. Sutphin
Engineer
M. Hickey
NE Area
Engineer
S. Jenkins
Engineer
D. McCoy
Engineering
Tech
R. Daigle
EPS = Environmental Protection Specialist
OGLA = Oil and Gas Location Assessment
UIC = Underground Injection Control
Page 3 of 4
December 11, 2017


COGCC
Page 4 of 4
December 11, 2017
COMMISSION
Director
M. Lepore
Executive Asst.
Vacant
Deputy Director
Field Operations
Vacant
Field Inspection
Manager
M.Ash
Reclamation
Supervisor
D. Arthur
Eastern CO
Enviro.
Inspector
C. Binschus
Western CO
Enviro.
Inspector
L. Colby
SW CO
Enviro.
Inspector
C. Roy
SE CO
Enviro.
Inspector
R. Costa
Eastern CO
Enviro.
Inspector
A. Trujillo
S Inspection
Supervisor
S. Labowskie
Field
Inspector
J. Duran
Field
Inspector
C. St. John
Field
Inspector
C. Browning
NW Inspection
Supervisor
S. Kellerby
Field
Inspector
M. Longworth
Field
Inspector
E. Waldron
Field
Inspector
C. Conklin
Field
Inspector
R. Murray
Field
Inspector
K. Granahan
E Inspection
Supervisor
C. Quint
Field
Inspector
B. Welsh
Field
Inspector
S. Sherman
Field
Inspector
K. Schure
Quality
Assurance
Professional
M. Leonard
Field
Inspector
C. Carlile
Field
Inspector
G. Helgeland
Field
Inspector
C. Pesicka
NE Inspection
Supervisor
J. Precup
Field
Inspector
J. Montoya
Field
Inspector
T. Peterson
Field
Inspector
J. Gomez
Field
Inspector
S. O'Donnell
Field
Inspector
Vacant

ENVIRONMENTAL



Environmental Supervisors



Greg Deranleau
Environmental Manager
(O) 303-894-2100, Ext 5153

West Area

Alex Fischer
West Supervisor
(O) 303-894-2100, Ext. 5138

Carlos Lujan
(O) 970-625-2497, Ext 7
(C) 970-286-3292

Kris Neidel
(O) 970-871-1963
(C) 970-846-5097

Stan Spencer
(O) 970-625-2497, Ext 3
(C) 970-987-2891

Jim Hughes
(O) 970-884-0491
(C) 970-903-4072

East Area

John Axelson
East Supervisor
(O) 303-894-2100, Ext 5115
(C) 303-916-0527

Peter Gintautas
(C) 719-679-1326
(O) 303-651-0949

Robert Chesson
(O) 303-894-2100, Ext. 5112

Rick Allison
(O) 970-461-2970
(C) 970-623-0850

Chris Canfield
(O) 303-894-2100, Ext 5183
(C) 720-347-7484

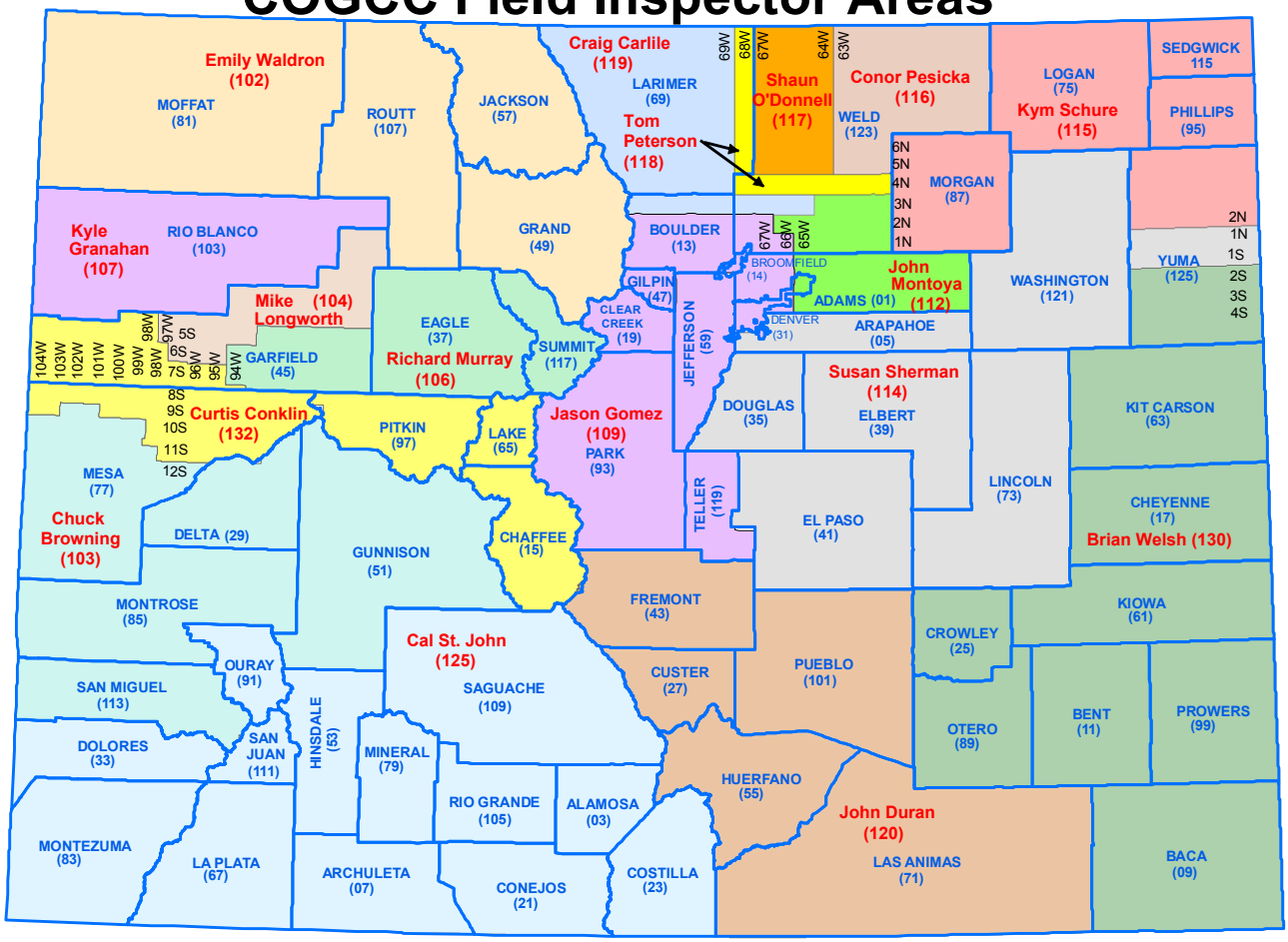
Rob Young
(O) 303-252-0126
(C) 720-471-1304

Jason Kosola
(O) (719) 574-8602
(C) 719-641-0291

COLORADO
Oil & Gas Conservation Commission
Department of Natural Resources

COGCC: November 1, 2017

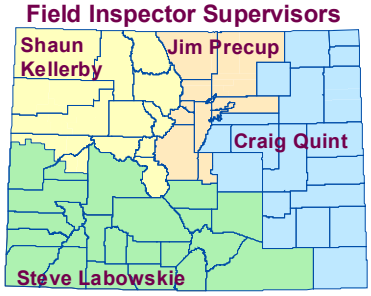
COGCC Field Inspector Areas



Margaret Ash, Field Inspection Unit Manager
(O) 303-894-2100, Ext. 5110
(C) 303 548-6298

Mike Leonard
Quality Assurance
(C) 719-343-0130

Field Inspector Supervisors



NW Area

Shaun Kellerby
NW Area Supervisor
(C) 970-712-1248

Mike Longworth
(C) 970-812-7644

Emily Waldron
(C) 970-819-9609

Curtis Conklin
(C) 970-986-7314

Kyle Granahan
(C) 970-989-4388

Richard Murray
(C) 970-623-9782

N Central

Jim Precup
N Central Area Supervisor
(C) 303-726-3822

John Montoya
(C) 970-397-4124

Jason Gomez
(C) 970-573-1277

Craig Carlile
(C) 970-629-8279

Tom Peterson
(C) 303-815-9641

Conor Pesicka
(C) 970-415-0789

Shaun O'Donnell
(C) 720-305-8280

East Area

Craig Quint
East Area Supervisor
(C) 719-342-5702

Kym Schure
(C) 970-520-3832

Susan Sherman
(C) 719-775-1111

Brian Welsh
(C) 719-325-6919

SW Area

Steve Labowskie
SW Area Supervisor
(C) 970-946-5073

John Duran
(C) 719-688-2626

Chuck Browning
(C) 970-433-4139

Cal St. John
(C) 970-556-1071

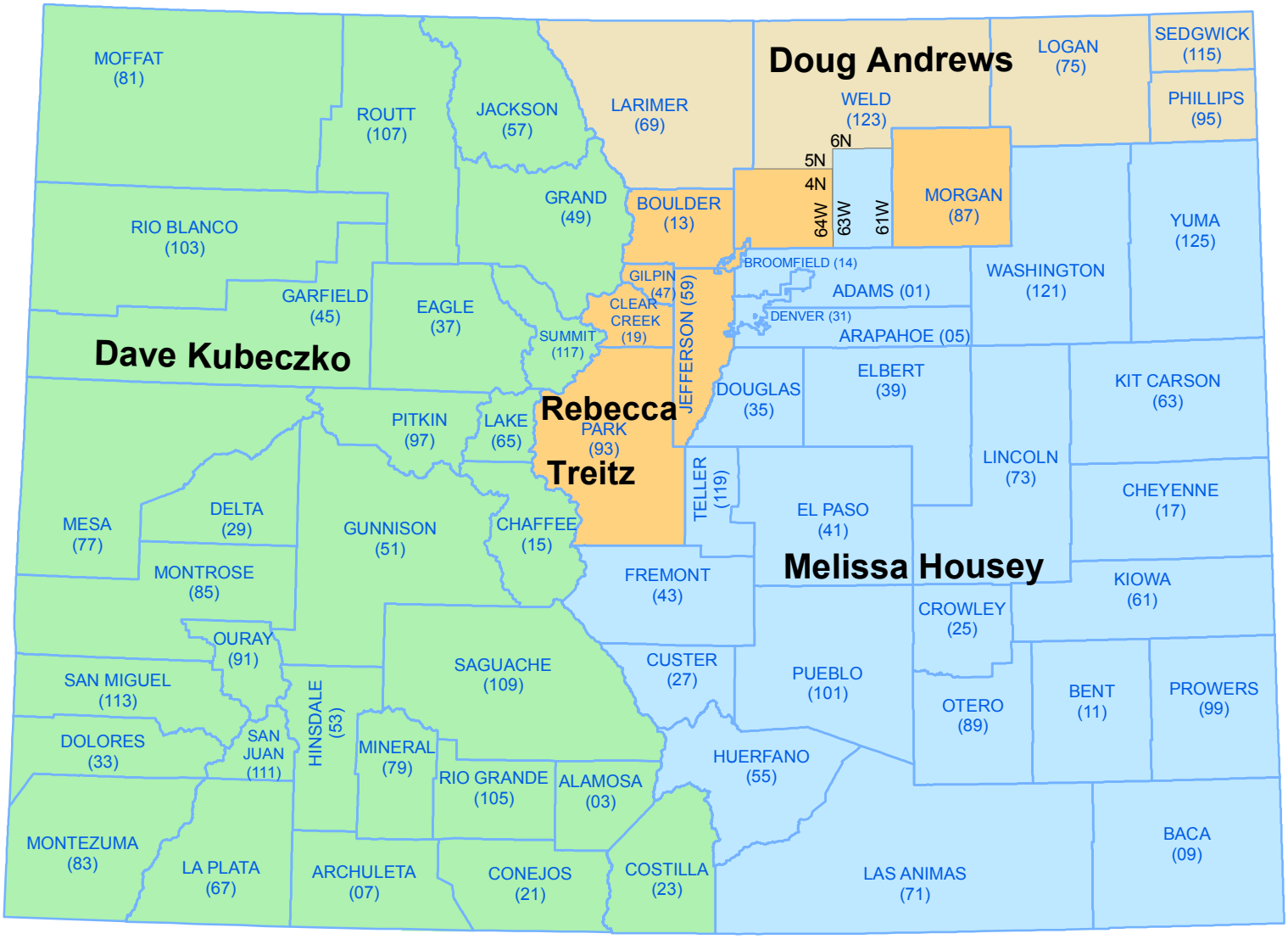
Unincorporated Adams County

Adam Kraich
IGA Inspector
(O) 720-523-6886

COLORADO
Oil & Gas Conservation Commission
Department of Natural Resources

September 26, 2017

OIL & GAS LOCATION ASSESSMENT



John Noto, OGLA Supervisor
303-894-2100, Ext. 5182

Dave Kubeczko 970-625-2497, Ext. 5

Doug Andrews 303-894-2100, Ext. 5180

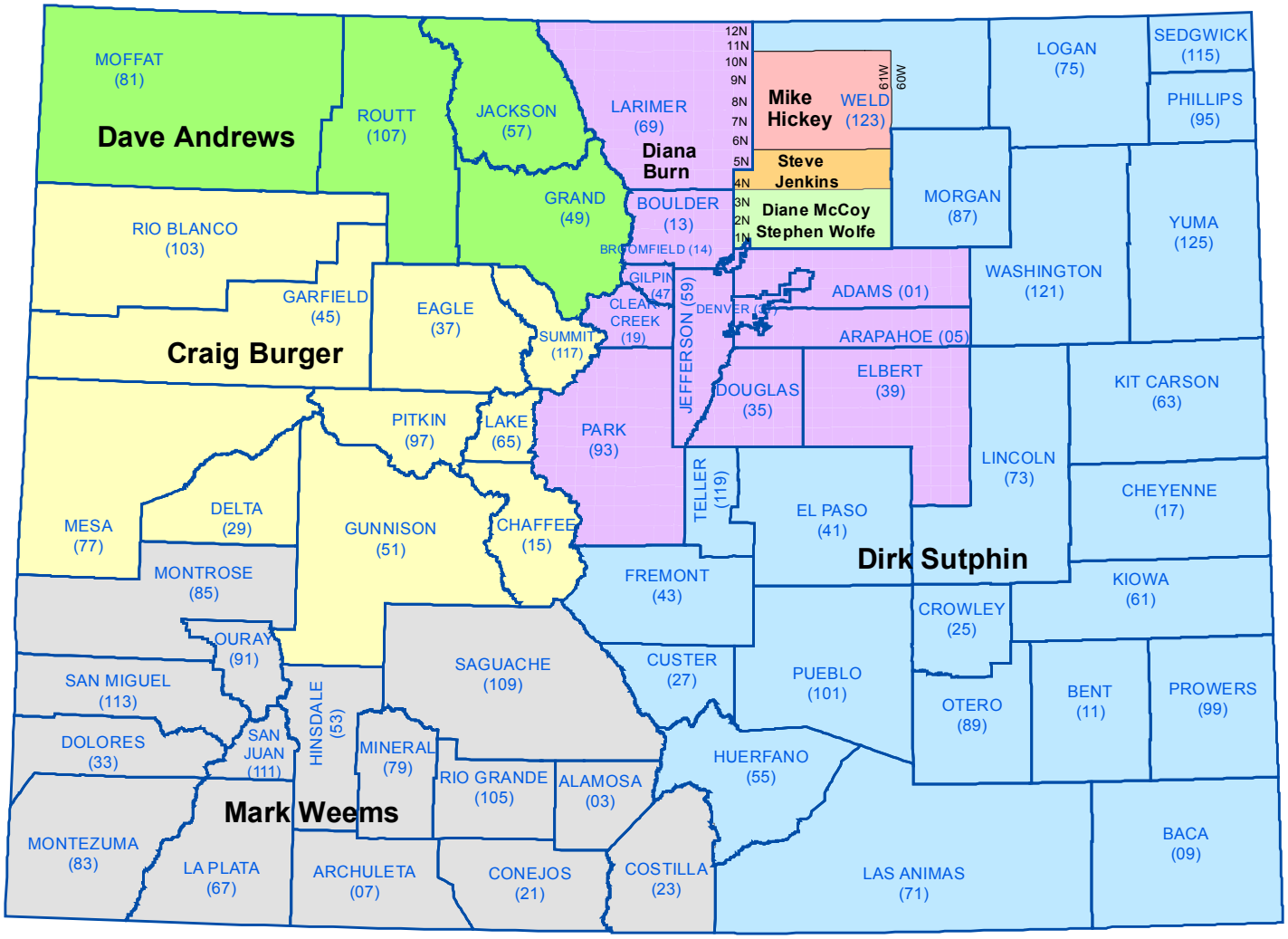
Melissa Housey 303-894-2100, Ext. 5194

Rebecca Treitz 303-894-2100, Ext. 5173

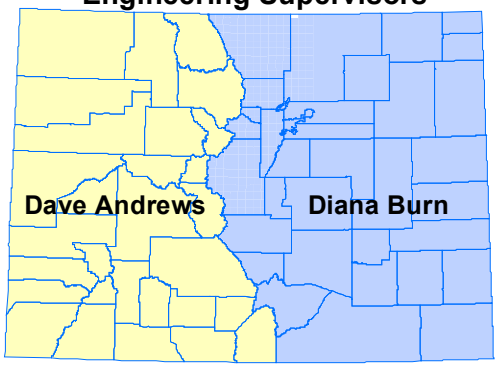
COLORADO
Oil & Gas Conservation Commission
Department of Natural Resources

COGCC, December 29, 2014

ENGINEERING



Engineering Supervisors



Stuart Ellsworth
Engineering Manager
(O) 303-894-2100, EXT. 5108
(C) 303-489-2977

Western Region

David Andrews
W. Colorado Engineering Supervisor
(O) 970-625-2497, Ext. 1
(C) 970-456-5262

Mark Weems
(O) 970-259-4587
(C) 970-749-0624

Craig Burger
(O) 970-625-2497, Ext 2
(C) 970-319-4194

Bob Koehler, UIC Lead, Statewide
(O) 303-894-2100, Ext. 5147

Eastern Region

Diana Burn
E. Colorado Engineering Supervisor
(O) 303-894-2100, Ext. 5106
(C) 303-918-6320

Dirk Sutphin
(O) 303-894-2100, Ext. 5107

Diane McCoy
(O) 303-894-2100. Ext. 5114

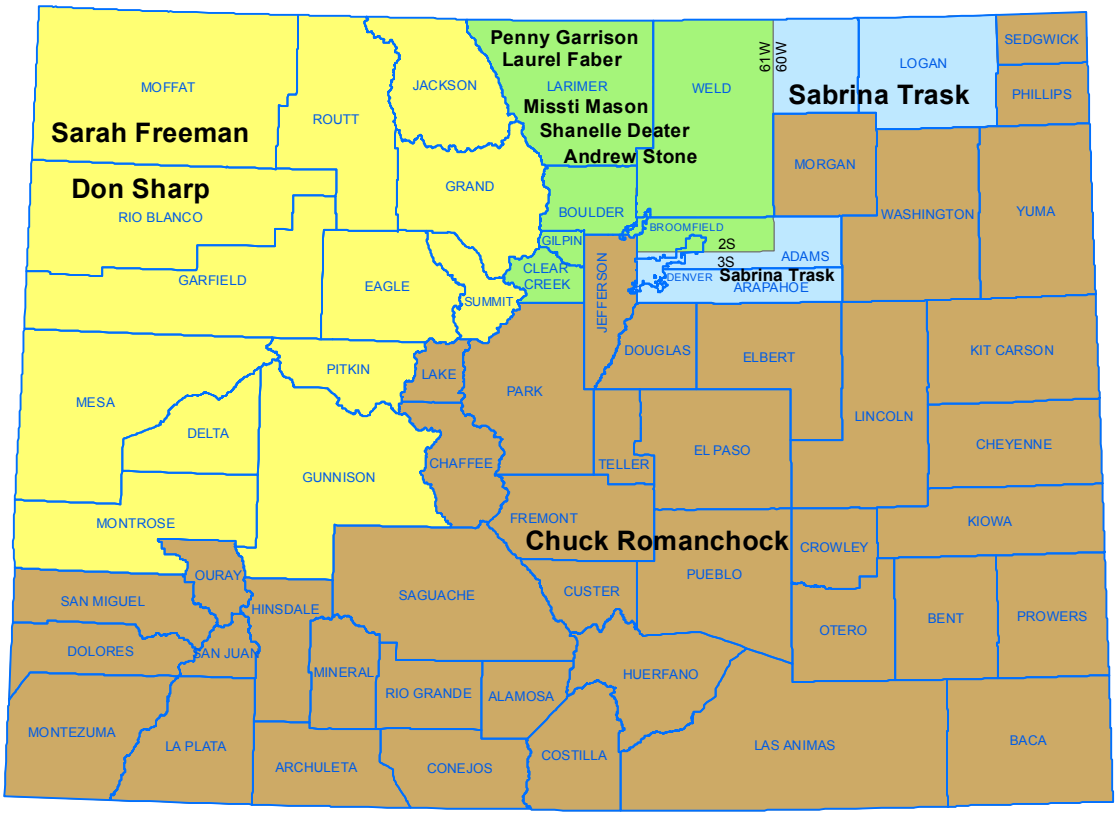
Steve Jenkins
(O) 303-894-2100. Ext. 5104

Mike Hickey
(O) 303-894-2100. Ext. 5105
(C) 970-302-1024

Stephen Wolfe
(O) 303-894-2100. Ext. 5187

COLORADO
Oil & Gas Conservation Commission
Department of Natural Resources

PERMITTING



Jane Stanczyk, Permitting Manager
303-894-2100, Ext 5119

Barbara Westerdale, Permitting Supervisor
303-894-2100, Ext 5159

NW Colorado

Sarah Freeman Forms 2, 2A & 4	303-894-2100, Ext 5135
Don Sharp Forms 5, 5A, 6 & 10	303-894-2100, Ext 5174

NE Colorado

Sabrina Trask All Forms	303-894-2100, Ext 5125

Greater Wattenberg

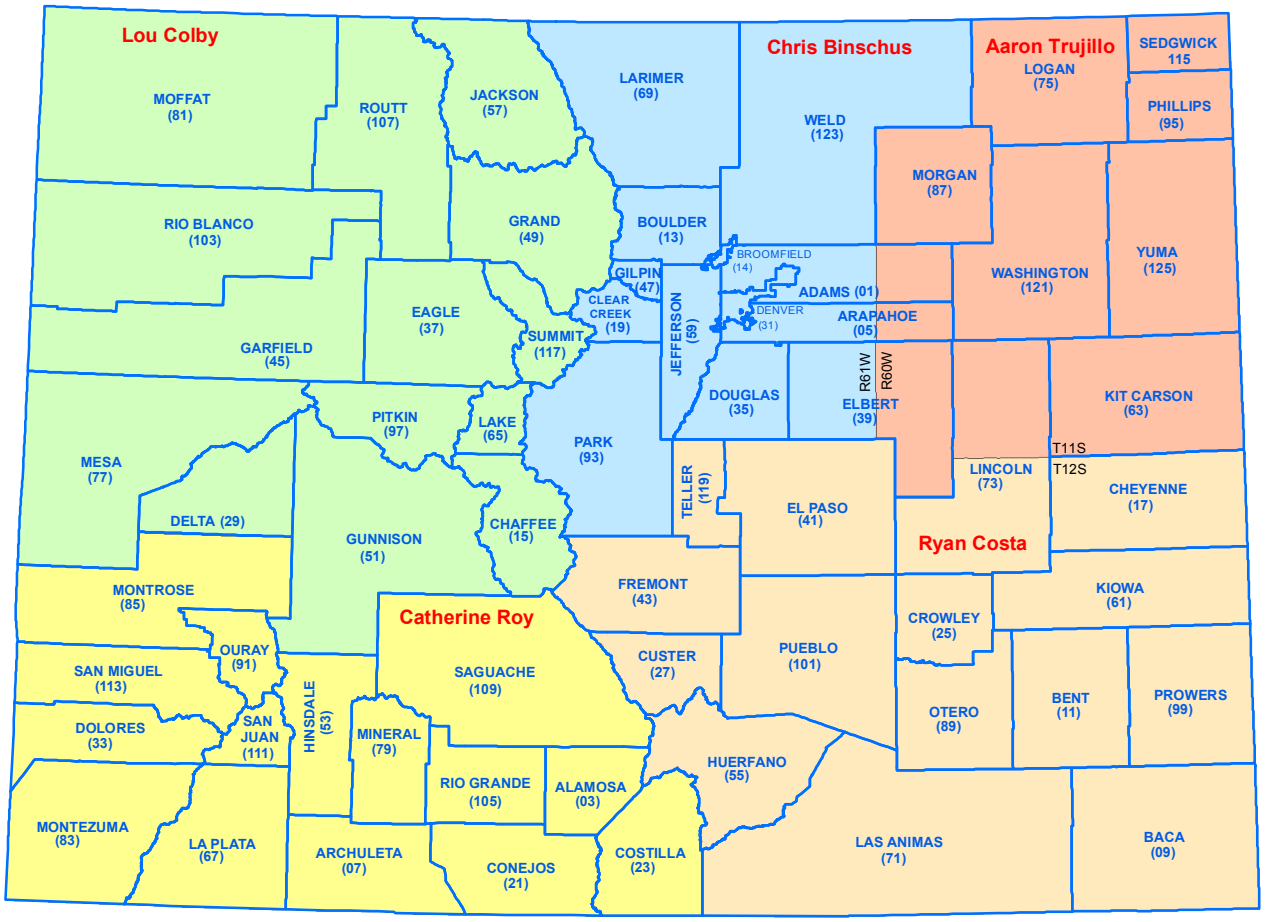
Penny Garrison Forms 2, 2A & 4	303-894-2100, Ext 5156
Laurel Faber Forms 5, 5A, 6 & 10	303-894-2100, Ext. 5101
Shanelle Deater Forms 5, 5A, 6 & 10	303-894-2100, Ext 5149
Missti Mason Forms 5, 5A, 6 & 10	303-894-2100, Ext 5118
Andrew Stone Forms 5, 5A, 6 & 10	303-894-2100, Ext. 5188

South & East Colorado

Chuck Romanchock All Forms	303-894-2100, Ext. 5154

COLORADO
Oil & Gas Conservation Commission
Department of Natural Resources

COGCC Reclamation Specialist Areas



Margaret Ash, Field Inspection Manager
(O) 303-894-2100, Ext. 5110
(C) 303 548-6298

Reclamation Specialists

Denise Arthur
Reclamation Supervisor
(O) 303-894-2100, x5195
(C) 720-630-6533

Cathrine Roy
Area 146 Reclamation Specialist
(O) 970-247-0253
(C) 970-946-9107

Ryan Costa
Area 147 Reclamation Specialist
(O) 719-868-2047
(C) 719-505-3245

Lou Colby
Area 142 Reclamation Specialist
(C) 970-989-4402

Aaron Trujillo
Area 147 Reclamation Specialist
(C) 970-441-1009

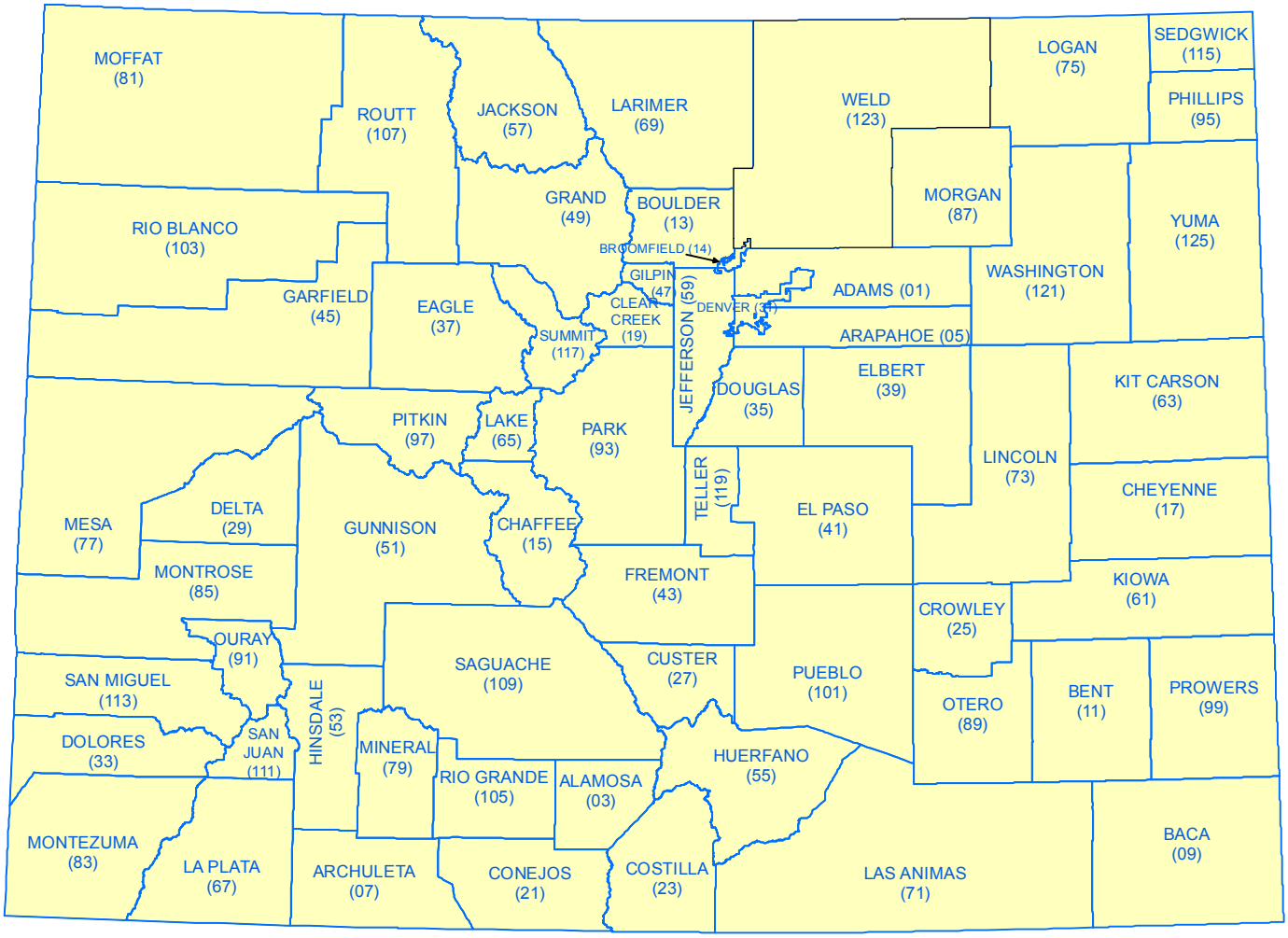
Chris Binschus
Area 144 Reclamation Specialist
(C) 970-702-3003

Mike Leonard
Quality Assurance
(O) 719-647-9716
(C) 719-343-0130

COLORADO
Oil & Gas Conservation Commission
Department of Natural Resources

COGCC, December 11, 2015

Local Government Liaison: Mark Morton



Julie Murphy, Hearings Manager
303-894-2100, Ext 5152

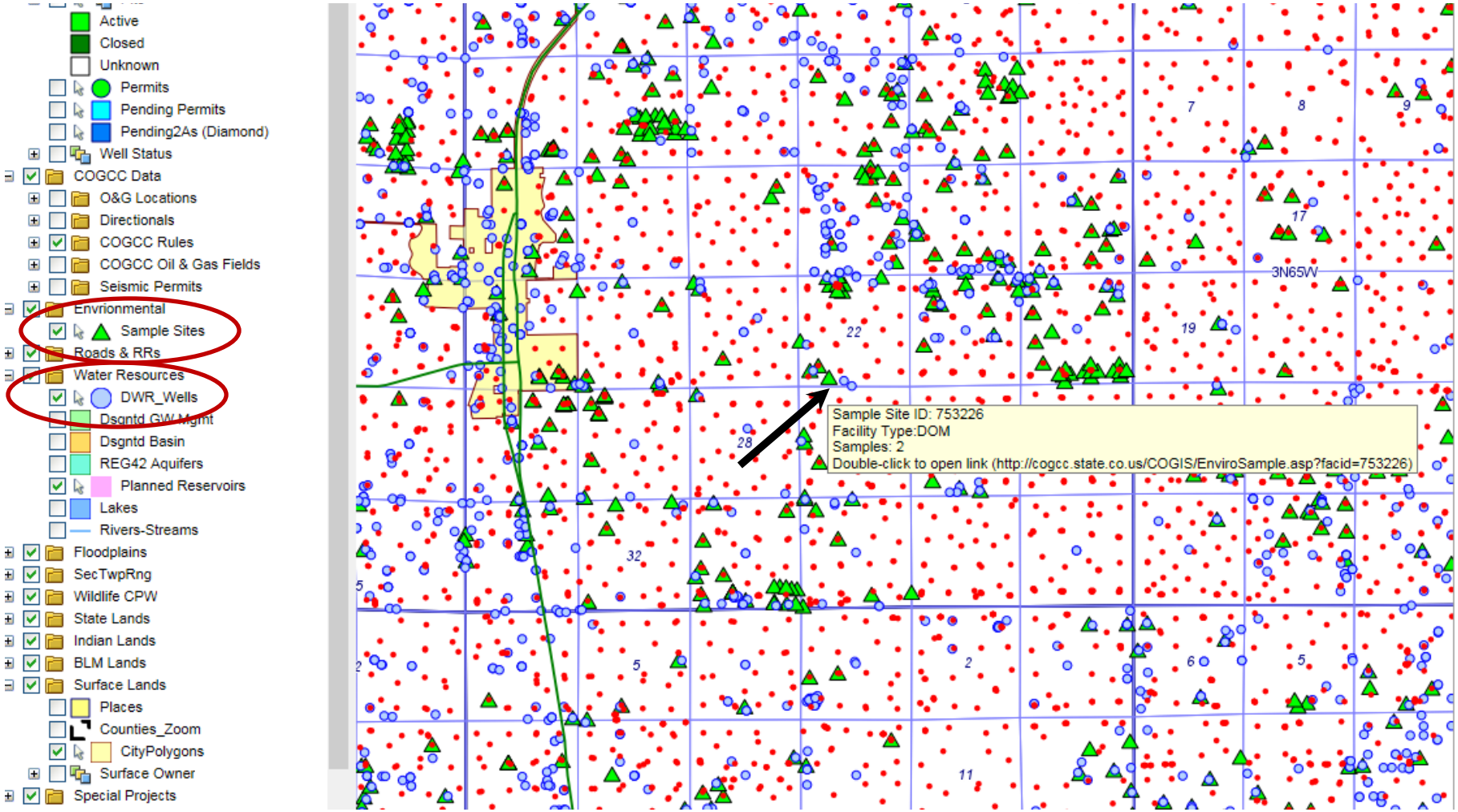
Marc Morton 303-894-2100, Ext 5132

COLORADO
Oil & Gas Conservation Commission
Department of Natural Resources

APPENDIX 3

Example Analytical Report

GIS Online Sampling Data



GIS Online Sampling Data

COGIS - Environmental Sample Site Information

Doc GIS

#753226 Information

Sample Site ID:	753226			
FacilityType:	DOM	ProjNumber:		
County:	WELD - #123	Location:	SESW 22 3N 66W	
Elevation:	5006	Lat/Long:	40.20446/-104.76767	
DWR Receipt #:	3616678	WellDepth:	300	

Related Facility/Well

NonFacility ID:	-99999	Facility Name:	No Facility	Location:
Status:	CL	Operator Name:	UNKNOWN # 1	

COGCC Water Quality Database Disclaimer:
The analytical data and other information in this database are a compilation of data collected by COGCC staff, data submitted to COGCC from a variety of third parties, and historical data. All analytical data collected by or submitted to the COGCC is public information and COGCC posts the data to this database as a public service. The data is provided for informational purposes only. COGCC does not conduct a detailed review of quality control/quality assurance protocols, chain of custody procedures, or field or laboratory methodologies on data received from third parties. The level of review performed on historical data is unknown. COGCC does not regularly perform formal data validation for any of the data posted to this database. **The COGCC makes no warranties or representations of any kind, express or implied, regarding the quality, accuracy, reliability, merchantability, or fitness for a particular purpose of the data provided herein.**

Sample(s) ☐ All Export to CSV

☐ Sample ID:	537748	Sample Date:	4/16/2014	Matrix:	WATER	Collection Point: Dom	Type: Dom	Lab:	ALS Lab Group (formerly Paragon)
☐ Sample ID:	537750	Sample Date:	4/16/2014	Matrix:	WATER	Collection Point: Dom	Type: Dom	Lab:	ALS Lab Group (formerly Paragon)

GIS Online Sampling Data

#753226 Information

Sample Site ID:	753226		
FacilityType:	DOM	ProjNumber:	
County:	WELD - #123	Location:	SESW 22 3N 66W
Elevation:	5006	Lat/Long:	40.20446/-104.76767
DWR Receipt #:	3616678	WellDepth:	300

Related Facility/Well

NonFacility ID:	-99999	Facility Name:	No Facility	Location:	
Status:	CL	Operator Name:	UNKNOWN # 1		

COGCC Water Quality Database Disclaimer:
The analytical data and other information in this database are a compilation of data collected by COGCC staff, data submitted to COGCC from a variety of third parties, and historical data. All analytical data collected by or submitted to the COGCC is public information and COGCC posts the data to this database as a public service. The data is provided for informational purposes only. COGCC does not conduct a detailed review of quality control/quality assurance protocols, chain of custody procedures, or field or laboratory methodologies on data received from third parties. The level of review performed on historical data is unknown. COGCC does not regularly perform formal data validation for any of the data posted to this database. **The COGCC makes no warranties or representations of any kind, express or implied, regarding the quality, accuracy, reliability, merchantability, or fitness for a particular purpose of the data provided herein.**

Sample(s) ☐ All Export to CSV

☐ Sample ID: 537748 Sample Date: **4/16/2014** Matrix: **WATER** Collection Point: **Dom** Type: **Dom** Lab: **ALS Lab Group (formerly Paragon)**

Sample Results for Sample # 537748 ALS Lab Group (formerly Paragon) ID: 1404281-1 - Minimize

Methodcode	ParamDescription	ResultValue	Units	DetectionLimit	Qualifier
BART	BACTERIA, IRON RELATED	ND	cfu/ml	1	U
BART	BACTERIA, SLIME FORMING	2500	cfu/ml	1	
BART	BACTERIA, SULFATE REDUCING	ND	cfu/ml	1	U
E200.8	BARIUM	9.1	ug/L	1	
E200.8	BORON	61	ug/L	50	
E200.8	CALCIUM	13000	ug/L	1000	
E200.8	IRON	ND	ug/L	100	U
E200.8	MAGNESIUM	3400	ug/L	100	
E200.8	MANGANESE	28	ug/L	2	
E200.8	POTASSIUM	2700	ug/L	1000	
E200.8	SELENIUM	ND	ug/L	1	U
E200.8	SODIUM	550000	ug/L	1000	
E200.8	STRONTIUM	470	ug/L	1	
E300.0	BROMIDE	1.2	mg/L	0.4	
E300.0	CHLORIDE	87	mg/L	5	
E300.0	FLUORIDE	0.21	mg/L	0.2	
E300.0	NITRATE AS N	ND	mg/L	0.4	U
E300.0	NITRATE/NITRITE AS N	ND	mg/L	0.1	U
E300.0	NITRITE AS N	ND	mg/L	0.2	U

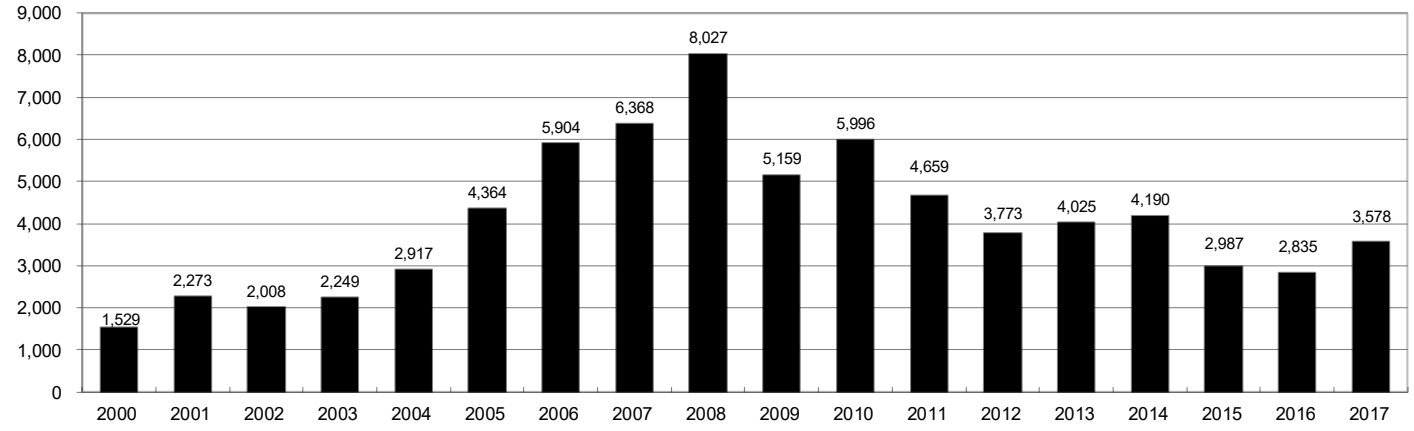
APPENDIX 4

Permit Statistics

Annual Drilling Permits by County as of December 1, 2017

County	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
ADAMS	38	28	9	26	39	34	37	89	51	35	21	8	40	40	51	96	74	121
ARAPAHOE		2	1	2	5	7	11	10	10	10	8	23	35	23	34	19	5	78
ARCHULETA	7	9	6	10	8	13	14	26	47	11	18	12	5	4	3	11	3	18
BACA	22	6	2	3	7	8	2	11	13	3	4	5	3	1	1			3
BENT	2				5	3	8	1	1		5		2	1				
BOULDER	1	5	6	7	17	13	21	37	32	35	24	30	22					
BROOMFIELD			2	7		1	1		2	33	28	11	36		31			
CHEYENNE	3	3	3	3	3	10	21	15	33	12	13	16	31	50	26	9		0
COSTILLA																		
CROWLEY															2			3
DELTA			7	4	5	10	9	2			4	3	6	1	2			
DENVER		3					19	25	24									
DOLORES				1	1	1	6	10	12	21	8	8	13	12	3		3	2
EAGLE														1				
ELBERT	2						4			1		1	2	2	4	3	3	1
EL PASO										2	3	3	18	1	2			
FREMONT					1	3	2	4	14	13	22	14	11	2	8	2	2	1
GARFIELD	213	353	362	567	796	1,509	1,845	2,550	2,888	1,981	2,037	1,323	1,046	870	1,066	532	724	571
GRAND																		
GUNNISON			5	10	1	9	19	7	10	12	4	3	11	9	20	28	19	30
HUERFANO	41	27	27		8	2			7		2	1	9	1	13	2		
JACKSON	34	18	21	9	14	6	8	5	27	19	9	18	5	12	17	3	57	25
JEFFERSON	1						1	3	2					1				
KIOWA	11	18	2	4	2	1	11	9	26	7	16	17	17	12	5	3		0
KIT CARSON				1	3	5	4	4	13	7	3	2	6	1	2		1	
LA PLATA	127	156	104	162	102	115	235	251	328	298	191	99	71	32	87	106	96	103
LARIMER	2		1			1		5	46	12	41	8	13	2	4	28	4	29
LAS ANIMAS	268	400	259	180	332	413	500	362	303	88	92	85	11	2	1			
LINCOLN	2	2	1	6	3	4	1	2	58	44	48	31	36	87	129	24	5	28
LOGAN	4	7	3	3	6	13	17	14	5	9	17	8	27	4	5		1	1
MESA	13	27	30	27	54	136	265	293	501	427	306	127	150	105	74	126	7	215
MOFFAT	35	52	62	63	63	60	120	68	57	51	53	93	88	44	54	12	17	4
MONTEZUMA	4		5	8	8	11	5	12	22	39	19	27	29	14	25	3	3	6
MONTROSE	1	3	2	4	2		1	3	3		1	1						
MORGAN	9	9	2	7	9	7	3	6	2	1	6	13	5	16	6	4	28	
OTERO																		
PARK										3	4	1						
PHILLIPS	1	2		7	13	17	12	69	82	45	64	112	56		11	2		
PITKIN					1			1								1		
PROWERS	2	5	4		7	5	7	5	8	1	3	1			1		1	
RIO BLANCO	89	187	105	179	154	161	360	321	477	348	441	109	117	167	121	107	71	110
RIO GRANDE	1	1		1					1	1			2		1			
ROUTT	20	13	1		4	6	9	8	4	2	3	10	4	12	4	9		
SAGUACHE	2		2					2	1	2								
SAN MIGUEL	11	13	27	18	42	45	35	23	20	13	10	2	1		2	3		
SEDGWICK				1	5	2	7	2	1	19	11	12	2		7	1		
WASHINGTON	23	17	27	34	128	50	69	45	11	1	6	12	6	19	12	9	7	9
WELD	509	702	760	757	832	901	1,418	1,527	2,340	1,448	2,152	2,262	1,826	2,468	2,303	1,841	1,704	2,219
YUMA	31	205	160	138	237	782	797	541	545	105	299	148	11	9	53	3		1
TOTAL	1,529	2,273	2,008	2,249	2,917	4,364	5,904	6,368	8,027	5,159	5,996	4,659	3,773	4,025	4,190	2,987	2,835	3,578

ALL COUNTIES

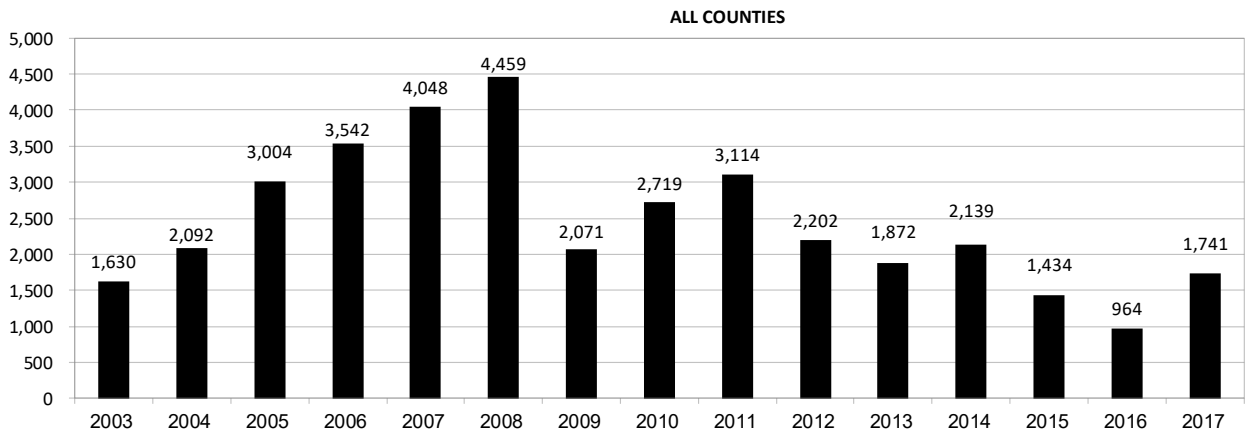


Horizontal Well Activity as of December 1, 2017

County	Prior Years			2009		2010		2011		2012		2013		2014		2015		2016		2017		Total	Completion			
	Drilled	DA	PA	Permit	Spud	Permit	Spud	Permit	Spud	Permit	Spud	Permit	Spud	Permit	Spud	Permit	Spud	Permit	Spud	Permit	Spud	Spud	AC	PR	DA	PA
ADAMS				6	5	2	3	1		17	2	26	1	42	18	92	3	72	2	121	22	56	3	23		1
ARAPAHOE	2							10	1	22	4	11	13	22	11	9		5	1	77	14	46	2	29		1
ARCHULETA	17			7	6	15	7	10	8	5	9	2		1		6	3	2	1	15	2	58		53		
BENT											1	1										1				
BOULDER								4														0				
CHEYENNE	5		4									7	2	1	1	1	1					9		3		5
DELTA							2			6	1	1		2								3		3		
DOLORES	9			18	2	6				9	3	5	4	3	1							18		12		5
EL PASO										10												0				1
ELBERT										1												0				
FREMONT	7	6		6		12	5	3	4	4	1	1	1			1						18		10	7	1
GARFIELD	10		2	1	1	16	2	18	6	43	6	18	4	20	11	12	7	4		11		42		40		2
GUNNISON	1					1				3	2	2		9		18	2	10	1	21	1	7		5		
HUERFANO										4	1			2								1		1		
JACKSON	8	1	1	8		3	4	9	1	4		8	5	15	4	3		52	24	24	8	52		20		3
KIOWA										1		4	2	1								2				1
KIT CARSON	1									1		1	1									2				4
LA PLATA	28	2		11	2	28	3	18	7	12	1	5	1	43	7	42	3	67	8	80	4	74		68	1	3
LARIMER	3	2						5	1	2	1		2			22	8	4	3	29	25	40		11	2	
LAS ANIMAS	16		2	4		1	1															16		16		
LINCOLN				2	1	2	1	1				6		4	2							4		1		3
LOGAN	2									1												2		2		
MESA	3	2		36		22	7	24	13	14		9	2	9	1	6	3					31		28	2	4
MOFFAT	7	1	1	6	3	4		9	4	44	6	18	13	15	1	5	2	3	1	3		35		23		10
MONTEZUMA	6		1	23	6	11	2	8	2	18	6	3	4	15	2							36		28		7
MORGAN								6	2	2	1	13	1	6		4	1	28				5		5		
PARK						1	1	1														1				
RIO BLANCO	7	2				1	1	11	2	15	2	4	5	3	2	3				4		16		12	3	
ROUTT	10	6	1							1		1				3						1		1	6	1
SAN MIGUEL	1			1																		1				1
WASHINGTON	1		1																			1				1
WELD	11	3		12	5	208	84	763	229	964	594	2,114	1,099	2,215	1,423	1,789	1,063	1,671	723	2,188	1,169	6,397		4,447	12	62
YUMA	1		1	6																		1		1		
TOTAL Horizontal	156	25	14	147	31	333	123	901	280	1,203	641	2,260	1,160	2,428	1,484	2,016	1,096	1,918	764	2,573	1,245	6,976	5	4,842	33	116
Percent of Total HZ		16%	9%																				0%	69%	0%	2%
Total All Permits				5,159		5,996		4,659		3,773		4,025		4,190		2,988		2,835		3,571						
HZ Percent of Total				2.8%		5.6%		19.3%		31.9%		56.1%		57.9%		67.5%		67.7%		72.1%						

Annual Well Starts by County as of December 8, 2017

County	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
ADAMS	19	22	24	13	41	14	14	21	1	13	4	23	3	2	23
ARAPAHOE		6	1	5	2	1	1	3	7	5	14	16		1	16
ARCHULETA	5	4	10	5	7	29	9	11	6	10		1	2	2	5
BACA	1	6	6	2	6	12		5	4	2	2		1		1
BENT		3	2	8	1	1			1	1					
BOULDER	2	5	11	9	14	25	16	13	7	14					
BROOMFIELD		1				10		21	11	5					
CHEYENNE	3		9	14	15	14	8	12	11	17	32	19	3		
COSTILLA															
CROWLEY												2			1
DELTA	5	4	6	5	2			3	2	1					
DENVER				7	5	4									
DOLORES		2		2	13	6	2		1	3	6	1			1
EAGLE											1				
EL PASO								2		4		1			
ELBERT				1									3		1
FREMONT		1	3	2	2	5	3	9	15	6	1	4		1	1
GARFIELD	417	585	799	1,005	1,304	1,689	765	898	869	493	388	357	172	161	277
GUNNISON		1	1	9	5	1	4	5	2	4	1	2	2	1	6
HUERFANO	3	6	2			2		1		1	1	2	1		
JACKSON	10	10		3	3	12	1	5	4		5	5		23	12
JEFFERSON					2										
KIOWA	4	2	1	7	7	2	5	15	13	10	9	3	2		
KIT CARSON	1	1	6	2	1	14	3	1	1	3	1	2			1
LA PLATA	110	103	104	108	179	199	131	58	32	3	8	20	23	20	29
LARIMER			1		4	8	1	28	2	10	4	1	8	3	25
LAS ANIMAS	221	296	384	413	326	222	14	7	78	1		1			
LINCOLN	5	2	2	1	2	18	11	13	21	22	38	39	12	2	11
LOGAN	3	2	11	12	12	3	7	3	9	13	4	6			
MESA	13	25	89	156	209	225	14	11	35	4	8	16	77	4	113
MOFFAT	28	19	40	60	42	26	18	15	27	18	20	3	6	3	
MONTEZUMA	5	1	7	2	4	22	10	1	2	10	7	8	1		2
MONTROSE	2	1			1	2		1							
MORGAN	7	5	5	3	1	1	2	3	0	3	1	3	1		
PARK								1							
PHILLIPS	6	10	11	4	35	18	2	42	130	48		9			
PROWERS		5	5	6	3	5	2	3	1				1		
RIO BLANCO	83	92	95	107	95	205	118	102	68	51	36	40	17		5
RIO GRANDE											1				
ROUTT		1	6	3	2		2	1	2	3	2	2			
SAN MIGUEL	19	28	13	20	17	5	1	2	2			1			
SEDGWICK	1	2	1	1	5			3	8	3			1		
WASHINGTON	29	65	34	23	14	11	2	2	4	1	9	7	2	6	8
WELD	522	632	718	931	1,222	1,312	878	1,185	1,632	1,404	1,256	1,506	1,096	735	1,203
YUMA	106	144	597	593	445	336	27	213	106	16	13	39			
TOTAL	1,630	2,092	3,004	3,542	4,048	4,459	2,071	2,719	3,114	2,202	1,872	2,139	1,434	964	1,741



Monthly Statistics as of December 1, 2017

YEAR and MONTH	Baker - Hughes Rig Count	Permits: Drilling Rcvd	Drilling Apvd	Recompletion Rcvd	Recompletion Apvd	Injection Rcvd	Injection Apvd	Pits Rcvd	Pits Apvd	Locations Rcvd	Locations Authz	Well Spud Notices	Active Drilling Permits	Active Wells	Public Visits: Data	Office	Internet
2011 TOTAL		**4,709**	**4,659**	**325**	**320**	**44**	**32**	**190**	**192**	**2,382**	**2,267**	**3,216**			**187**	**1,294**	**1,337,865**
2012 TOTAL		**3,982**	**3,773**	**154**	**168**	**63**	**44**	**114**	**84**	**1,373**	**1,293**	**2,297**			**159**	**1,305**	**1,324,443**
2013 JAN	53	538	331	6	0	3	5	6	8	176	124	141	5,060	50,265	9	108	47,406
FEB	56	260	455	10	5	2	3	4	11	91	141	139	5,250	50,372	7	102	40,649
MAR	57	344	241	5	9	3	8	15	6	129	84	173	5,093	50,540	9	133	43,019
APR	61	331	333	6	5	5	5	6	8	146	117	161	4,925	50,687	3	132	46,459
MAY	61	350	342	8	6	6	6	10	7	106	142	162	5,110	50,810	3	123	45,215
JUN	62	349	273	2	8	8	8	5	3	114	85	145	5,273	50,909	8	122	41,015
JUL	68	864	304	11	4	9	2	9	5	218	91	160	5,070	51,091	7	154	45,558
AUG	69	232	291	6	4	3	2	4	1	35	76	206	5,200	51,255	20	130	44,722
SEP	69	212	362	9	5	10	9	3	19	56	109	164	5,185	51,407	5	105	41,256
OCT	72	319	376	5	9	7	5	1	8	67	88	238	4,967	51,598	5	135	45,151
NOV	69	346	353	4	13	7	4	2	27	67	85	163	5,141	51,711	12	119	38,903
DEC	64	336	367	2	4	4	6	2	3	63	71	125	5,129	51,737	4	93	32,381
2013 TOTAL		**4,481**	**4,028**	**74**	**72**	**67**	**63**	**67**	**106**	**1,268**	**1,213**	**1,977**			**92**	**1,456**	**511,734**
2014 JAN	62	278	232	3	2	3	4	14	8	90	43	171	4,926	51,840	1	90	46,150
FEB	61	284	297	6	4	1	1	3	1	91	94	150	5,051	51,847	12	113	43,408
MAR	62	367	329	4	6	7	1	6	6	110	88	183	4,997	51,952	16	140	46,620
APR	63	276	317	2	3	2	5	8	3	89	99	172	4,897	52,060	11	188	45,558
MAY	65	458	383	2	2	3	1	6	7	83	94	180	4,923	52,202	18	131	42,365
JUN	67	429	377	3	0	6	7	5	2	134	92	223	4,924	52,337	10	156	42,518
JUL	69	272	446	2	5	3	11	8	5	97	126	181	4,955	52,431	7	166	45,481
AUG	73	376	259	4	3	4	4	3	4	111	87	218	5,060	52,582	8	145	42,431
SEP	76	412	304	2	3	3	1	20	1	116	81	214	5,006	52,694	14	175	43,577
OCT	76	459	371	3	2	9	2	4	6	93	109	191	4,827	52,785	19	138	46,030
NOV	73	326	479	5	2	5	4	4	0	54	103	167	5,171	52,947	8	96	39,583
DEC	69	286	397	1	2	2	7	1	2	45	99	191	5,236	53,054	6	144	37,964
2014 TOTAL		**4,223**	**4,191**	**37**	**34**	**48**	**48**	**82**	**45**	**1,113**	**1,115**	**2,241**			**130**	**1,682**	**521,685**
2015 JAN	64	349	316	3	1	2	9	3	1	60	43	196	5,060	53,195	17	114	41,502
FEB	49	324	161	3	2	5	6	9	0	73	28	115	4,750	53,309	4	117	38,245
MAR	38	246	294	1	6	1	5	7	5	44	70	166	4,983	53,414	6	146	42,513
APR	37	194	165	3	1	2	5	1	2	46	37	96	4,854	53,456	1	125	39,559
MAY	39	324	190	1	4	2	6	8	0	41	44	107	4,632	53,535	5	113	unavailable
JUN	38	327	281	4	1	0	5	2	1	52	49	142	4,726	53,608	5	138	unavailable
JUL	38	373	250	4	2	2	1	0	0	57	48	120	4,663	53,706	7	145	26,975
AUG	37	289	300	2	6	3	0	5	5	32	46	121	4,847	53,766	2	109	30,674
SEP	33	242	312	3	1	1	7	0	3	59	49	100	4,953	53,806	4	146	31,642
OCT	30	372	223	2	2	3	1	1	0	54	51	108	4,694	53,898	12	119	33,199
NOV	31	190	254	6	2	4	3	1	0	21	49	116	4,765	53,719	7	105	29,112
DEC	25	275	242	1	5	3	6	1	0	42	43	85	4,594	53,652	3	112	25,659
2015 TOTAL		**3,505**	**2,988**	**33**	**33**	**28**	**54**	**38**	**17**	**581**	**557**	**1,472**			**73**	**1,489**	**339,080**
2016 JAN	22	250	126	1	0	3	5	0	0	34	9	71	4,528	53,698	2	118	30,105
FEB	20	205	227	3	0	3	2	44	2	31	39	68	4,599	53,723	8	115	28,611
MAR	17	268	268	0	0	2	2	5	0	34	36	73	4,530	53,710	3	132	30,902
APR	17	185	224	0	1	3	4	0	0	24	39	62	4,511	53,774	4	113	27,914
MAY	16	353	217	0	2	3	1	1	1	33	24	85	4,464	53,749	4	106	26,778
JUN	16	315	233	0	0	2	3	2	1	38	30	68	4,456	53,651	2	80	27,284
JUL	20	268	249	5	0	4	4	6	6	31	30	88	4,344	53,724	5	91	24,151
AUG	21	141	150	1	3	5	3	2	0	33	23	95	4,436	53,740	1	106	29,192
SEP	19	366	270	0	2	4	2	0	6	29	24	70	4,522	53,817	4	154	25,698
OCT	19	334	297	6	1	6	3	1	0	42	29	95	4,601	53,903	1	135	25,893
NOV	20	368	304	3	3	3	3	0	1	40	45	131	4,566	53,993	2	97	25,140
DEC	26	342	267	1	4	7	5	1	2	48	25	102	4,477	54,036	5	92	23,449
2016 TOTAL		**3,395**	**2,832**	**20**	**16**	**45**	**37**	**62**	**19**	**417**	**353**	**1,008**			**41**	**1,339**	**325,117**
2017 JAN	28	442	211	8	2	2	2	0	0	42	25	133	4,492	54,111	6	79	28,702
FEB	26	701	263	2	4	4	3	0	0	62	38	136	4,543	54,194	1	97	27,715
MAR	28	510	423	2	2	7	4	3	24	71	48	177	4,714	54,322	1	152	31,952
APR	29	352	301	5	4	3	7	1	2	41	54	131	4,635	54,369	1	103	30,406
MAY	31	307	367	4	3	1	6	1	28	41	55	169	4,899	54,369	5	94	36,109
JUNE	36	493	331	3	2	6	1	1	1	58	40	162	4,947	54,605	5	109	30,644
JULY	37	508	234	2	4	2	2	1	1	45	31	182	4,999	54,699	2	80	27,025
AUG	37	572	349	9	0	8	3	1	2	53	49	160	5,000	54,814	1	143	30,715
SEP	35	528	450	2	6	5	4	1	1	56	41	148	4,976	54,925	2	114	27,402
OCT	34	550	311	0	2	2	3	0	1	58	40	139	5,022	54,989	2	174	31,995
NOV	37	438	331	12	1	13	10	1	1	47	38	156	5,016	55,062	1	124	28,802
2017 TOTAL		**5,401**	**3,571**	**49**	**30**	**53**	**45**	**10**	**61**	**574**	**459**	**1,693**			**27**	**1,269**	**331,467**

Abbreviation Key: Rcvd = Received, Apvd = Approved, Authz = Authorized

Monthly Statistics as of December 1, 2017

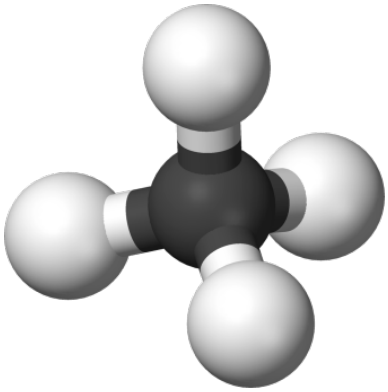
YEAR and MONTH	Well Oper Change	Operators		Bonds					Hearings		Enforcement					Remediation Projects		Inspections	
				Release			Claim												
		New	Inactive	Ind	Blnkt	Replace	Ind	Blnkt	Apps.	Orders	NOAVs	AOCs	OFVs	Cmplt	Spills	Rcvd	Comp	Wells	Locations
2011 TOTAL	**6,743**	**33**	**31**	**79**	**44**	**43**	**4**	**4**	**403**	**349**	**230**	**10**	**19**	**247**	**527**	**726**	**536**	**12,394**	**-**
2012 TOTAL	**7,546**	**47**	**37**	**70**	**46**	**33**	**3**	**0**	**482**	**396**	**157**	**9**	**2**	**244**	**402**	**690**	**641**	**19,071**	**12,670**
2013 JAN	653	3	5	12	2	0	0	0	48	75	15	4	-	21	40	31	45	1,622	789
FEB	289	4	2	6	3	2	0	0	41	35	11	2	-	15	30	42	90	1,044	615
MAR	354	1	3	2	2	1	0	0	54	67	16	2	-	11	25	65	29	1,968	1,149
APR	333	7	1	5	2	8	0	0	-	-	21	-	-	16	33	39	37	1,510	910
MAY	346	2	1	3	0	0	0	0	46	50	22	6	-	13	31	41	60	2,621	1,576
JUN	1,456	6	2	2	4	5	0	0	91	44	13	2	-	25	40	47	37	1,860	1,102
JUL	1,009	4	1	2	2	0	0	0	96	70	25	3	-	21	47	50	22	2,298	1,338
AUG	389	6	4	5	4	2	0	0	-	-	23	-	-	25	57	36	41	2,146	1,033
SEP	277	4	1	6	1	0	0	0	101	51	7	2	-	16	60	43	51	1,536	703
OCT	345	6	0	2	2	2	0	0	52	82	4	12	3	12	79	47	60	1,868	1,158
NOV	442	2	0	2	2	0	0	0	-	-	30	-	-	12	51	31	34	2,401	1,613
DEC	1,299	4	1	1	2	0	0	0	42	48	50	4	-	14	75	35	35	2,677	1,384
2013 TOTAL	**7,192**	**49**	**21**	**48**	**26**	**20**	**0**	**0**	**571**	**522**	**237**	**37**	**3**	**201**	**568**	**507**	**541**	**23,551**	**13,370**
2014 JAN	1,971	6	3	3	2	0	0	0	57	46	25	2	-	8	68	46	28	3,243	1,597
FEB	2,039	8	2	6	5	0	0	0	-	-	23	-	-	17	59	51	13	2,330	1,282
MAR	493	2	3	1	5	0	0	0	97	75	29	10	-	22	63	66	31	1,822	1,298
APR	312	5	3	6	4	1	0	0	74	64	17	8	1	20	57	47	59	2,651	1,715
MAY	508	6	2	3	3	5	0	0	-	-	12	-	-	13	63	50	42	2,437	1,571
JUN	1,008	5	3	7	4	1	0	1	95	90	14	6	1	16	74	44	50	3,209	1,717
JUL	338	2	1	5	3	1	0	0	96	96	11	6	-	12	60	60	59	3,071	1,536
AUG	452	6	2	2	3	0	0	0	-	-	8	-	-	31	56	32	58	2,788	1,682
SEP	378	4	2	1	2	0	0	0	73	63	13	7	1	18	65	39	50	2,587	1,616
OCT	886	8	2	0	2	0	1	0	80	75	12	3	1	13	74	78	36	3,886	1,914
NOV	498	2	4	8	4	5	0	0	-	-	6	-	-	15	72	27	59	3,156	1,458
DEC	1,414	1	1	0	2	0	0	0	126	89	9	1	-	58	75	56	17	3,028	1,596
2014 TOTAL	**10,297**	**55**	**28**	**42**	**39**	**13**	**1**	**1**	**698**	**598**	**179**	**43**	**4**	**243**	**786**	**596**	**502**	**34,208**	**18,982**
2015 JAN	727	2	3	2	3	0	0	0	76	64	15	2	1	36	64	38	58	2,491	1,246
FEB	556	5	2	2	3	1	0	0	-	-	10	-	-	22	44	34	64	2,667	1,382
MAR	183	5	3	5	2	4	2	0	72	72	33	1	1	42	76	59	94	3,469	1,738
APR	271	7	1	0	5	3	0	0	60	54	19	3	-	21	46	40	61	3,451	1,620
MAY	436	8	0	0	2	3	0	0	89	54	10	10	2	25	46	56	41	2,869	1,422
JUN	508	2	2	3	5	4	0	0	-	-	27	-	-	25	41	32	43	3,366	1,716
JUL	396	3	3	0	5	1	0	0	123	140	5	13	1	32	67	52	28	3,445	1,774
AUG	218	8	2	0	7	4	0	0	-	-	13	-	-	18	56	24	62	3,693	1,848
SEP	273	6	5	1	7	4	0	2	112	78	25	11	-	30	41	44	40	2,887	1,528
OCT	356	4	1	6	1	6	1	0	115	103	6	12	1	32	58	51	33	3,420	1,494
NOV	97	2	3	5	0	0	0	1	-	-	6	-	-	15	38	47	40	3,348	1,666
DEC	437	7	2	3	5	1	0	0	91	80	4	5	2	60	46	39	37	3,851	1,765
2015 TOTAL	**4,458**	**59**	**27**	**27**	**45**	**31**	**3**	**3**	**738**	**645**	**173**	**57**	**8**	**358**	**623**	**516**	**601**	**38,957**	**19,199**
2016 JAN	508	2	1	0	5	5	0	0	76	66	4	7	1	29	51	44	36	3,184	1,551
FEB	165	2	1	0	1	1	1	0	-	-	8	-	-	27	47	34	49	3,666	1,738
MAR	1,035	6	4	2	2	2	1	1	62	57	3	7	1	19	42	50	45	3,020	1,646
APR	244	3	3	2	7	4	0	0	34	32	6	4	2	20	40	48	90	4,046	2,117
MAY	374	2	3	6	3	3	1	0	-	-	0	-	-	20	37	41	29	3,491	2,193
JUN	272	6	3	3	4	1	1	1	67	65	3	6	2	20	36	40	77	4,099	2,330
JUL	2,234	3	2	0	2	0	0	0	-	-	10	-	-	20	41	29	56	3,483	2,068
AUG	137	3	3	3	2	1	1	1	71	43	20	4	-	20	51	39	38	4,065	2,288
SEP	321	3	1	9	3	3	0	1	-	-	8	-	-	20	37	44	22	3,527	1,788
OCT	426	1	3	7	5	1	0	0	96	74	23	7	1	21	40	34	36	3,325	1,811
NOV	550	3	0	4	0	0	3	0	-	-	19	-	-	22	40	27	50	3,855	1,912
DEC	249	4	4	1	7	2	1	1	67	60	3	8	-	23	66	31	72	3,374	1,684
2016 TOTAL	**6,515**	**38**	**28**	**37**	**41**	**23**	**9**	**5**	**473**	**397**	**107**	**43**	**7**	**261**	**528**	**461**	**600**	**43,135**	**23,126**
2017 JAN	4,174	3	3	3	3	1	0	0	80	72	1	11	1	46	48	23	11	3,007	1,447
FEB	353	1	5	2	4	2	0	3	0	0	13	0	0	74	57	34	17	3,180	1,372
MAR	1,087	6	4	2	2	2	1	1	86	65	18	3	0	44	55	49	18	3,812	1,851
APR	899	3	0	1	5	5	0	0	0	0	6	0	0	32	40	43	29	2,895	1,578
MAY	572	1	3	0	5	0	0	0	128	93	3	6	0	185	55	46	30	2,488	1,484
JUNE	320	6	1	1	2	0	0	0	107	102	2	4	1	131	63	57	26	2,532	1,680
JULY	357	5	2	2	2	0	0	1	108	104	5	3	0	66	38	29	23	2,168	1,299
AUG	477	4	2	27	13	32	0	0	0	0	3	0	0	207	55	63	51	2,885	1,705
SEP	549	1	2	9	6	6	0	1	133	74	20	1	0	212	54	64	38	2,796	1,559
OCT	143	1	0	0	2	2	0	0	131	79	3	5	4	237	51	37	24	2,757	1,580
NOV	251	2	0	0	0	0	0	0	0	19	1	0	0	81	50	51	34	2,555	1,157
2017 TOTAL	**9,182**	**33**	**22**	**47**	**44**	**50**	**1**	**6**	**773**	**608**	**75**	**33**	**6**	**1,315**	**516**	**445**	**267**	**28,520**	**15,555**

Abbreviation Key: Ind = Individual, Blnkt = Blanket, Apps = Application for Hearing, NOAV = Notice of Alleged Violation, AOC = Administrative Order of Consent, OFV = Order Finding Violation, Cmplt = Complaint, Comp = Completed

APPENDIX 5

Methane in Colorado Groundwater Fact Sheet

COGCC Fact Sheet - Methane in Colorado Groundwater



What is methane?

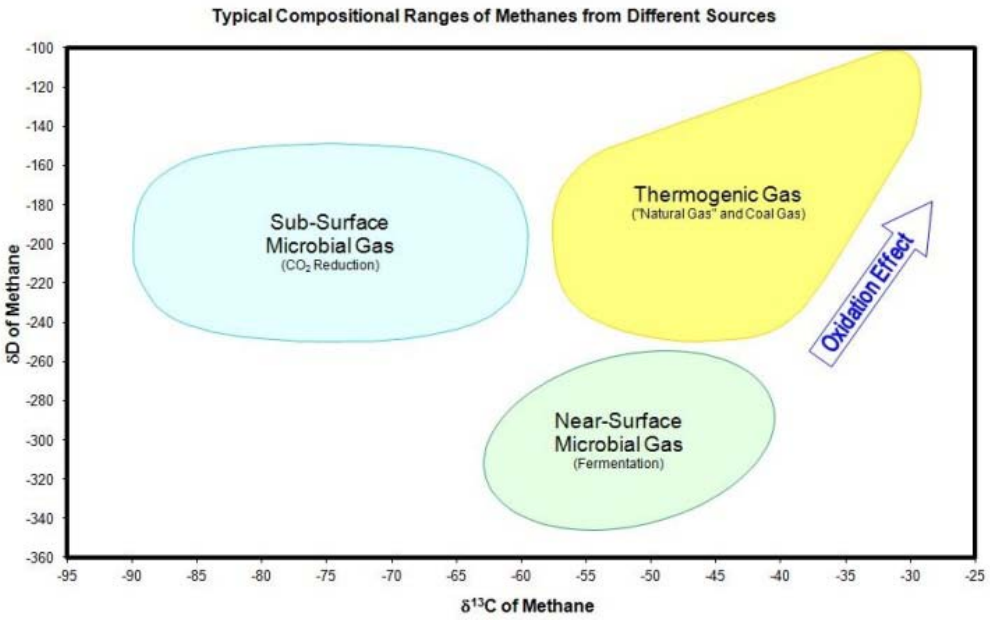
Methane (CH_4) is a simple hydrocarbon molecule of one carbon atom and four hydrogen atoms. Methane gas is colorless, tasteless, and odorless. Methane is a naturally occurring hydrocarbon gas that is flammable and explosive in certain concentrations.

Where does Methane come from?

Methane is produced either by bacteria, or by geologic processes involving heat and pressure. Methane gas can be **biogenic** or **thermogenic** depending on its origin. Biogenic methane is created by the decomposition of organic material through fermentation, as is commonly seen in wetlands, or by the chemical reduction of carbon dioxide. Biogenic methane is found in some shallow, organic rich water-bearing geologic formations, such as coal seams, into which water wells may be completed. Biogenic methane typically is not targeted for production in Colorado; however, the Niobrara gas field in Yuma County is an exception.

Thermogenic methane is created by the thermal decomposition of buried organic material. Thermogenic methane is typically found in rocks buried deeper within the earth than biogenic methane. In Colorado, thermogenic methane may be associated with oil and gas development. In certain regions of Colorado thermogenic methane may be naturally produced in water wells where formation rocks are at or close to the surface.

Different types of data analyses can be used in conjunction to help determine whether a methane gas is of biogenic or thermogenic origin, or a mixture of the two. The analytical methods used to differentiate between the two types of methane are well-known, scientifically accepted, and summarized in a well-known presentation by Dennis Coleman and papers by I.R. Kaplan and Dennis Coleman. These works, in turn, cite nearly 75 other references related to the topics of methane generation, "fingerprinting," forensic investigations, and stable isotope geochemistry.



Stable Isotopic data is used in the determination of whether a methane gas is biogenic or thermogenic. The figure to the left shows the typical isotopic ratios (δDeuterium/δCarbon^{13}) for methane produced by biogenic and thermogenic processes.

In addition to the isotopic data, compositional analysis

can be used to determine the origin of a methane gas. Naturally occurring methane gas typically contains small amounts of ethane and other hydrocarbons as well as methane. The proportion of methane to ethane in a gas can help determine its origin. Biogenic methane gas typically contains much greater percentage of methane than ethane or other hydrocarbons.

What is the Occurrence of Methane in Colorado groundwater?

Methane gas occurs naturally in groundwater in sedimentary basins in Colorado and around the world. Colorado water wells that contain methane are frequently drilled into sedimentary formations that contain coal. Wells are frequently completed in coals seams in the San Juan basin in Southwestern Colorado, the Raton Basin in Southeastern Colorado and the Laramie Fox Hills Formation in Northeastern Colorado. The included drillers log clearly shows that the screened portion of the well is placed across several coal seams, and two of those coal seams are the primary sources of groundwater in the domestic well.

The occurrence of methane in the coal bearing sedimentary formations used as water sources in Colorado has been well documented in numerous publications. For example, a 1976 publication by the Colorado Division of Water Resources states that the Laramie Fox Hills aquifer contains "troublesome amounts of . . . methane." The Raton Basin Baseline Study conducted by the COGCC from 2000 – 2003 states "methane is widely distributed in the shallow aquifers across the basin." In addition, the BLM North San Juan Basin White Paper, December 1999, discusses the historic occurrences of methane in water wells completed in the Fruitland and Menefee formations.

4. GROUND SURFACE ELEVATION _____ feet
DATE COMPLETED 4/9/2006 TOTAL DEPTH 740
DRILLING METHOD AIR ROTARY
feet DEPTH COMPLETED 740 feet

5. GEOLOGIC LOG:

Depth	Type	Grain Size	Color	Water Loc.
0-3	overburden	dirt	brn	
3-106	ss	med	gray	
106-153	sh	clay	gray	
153-192	ss	med	gray	
192-197	coal/sh	/clay	blk/gray	
197-239	sh	clay	gray	
239-293	sh/ss	clay/med	gray	
293-295	coal		blk	295
295-359	sh	clay	gray	
359-364	coal		blk	
364-412	sh	clay	gray	
412-422	ss	med	gray	
422-423	coal		blk	
423-531	sh	clay	gray	
531-533	coal		blk	
533-691	sh	clay	gray	
691-693	coal		blk	691
693-740	ss	med	gray	

Remarks: _____

6. HOLE DIAM (in.)

	From (ft)	To (ft)
83/4	0	39
61/8	39	740

7. PLAIN CASING:

OD (in)	Kind	Wall Size (in)	From (ft)	To (ft)
65/8	steel	188	+1	39
41/2	pvc	200	8	280
41/2	pvc	200	320	680

PERFORATED CASING: Screen Slot Size (in): 1/8th

41/2	pvc	200	280	320
41/2	pvc	200	680	740
37	interval	37-20's		

8. FILTER PACK: Material none; Size; Interval

9. PACKER PLACEMENT: Type none; Depth

10. GROUTING RECORD

Material	Amount	Density	Interval	Placement
cement	6bags	36gals	4-39	poured

Is methane in groundwater a health risk?

Studies have not linked ingestion of water containing methane to any short term (acute) or long term (chronic) health effects. When present at high concentrations, methane gas may act as an asphyxiant. Asphyxiants displace air and can cause breathing and other health problems.

At higher concentrations in the atmosphere methane gas can present an explosive hazard. Methane gas forms explosive mixtures in the atmosphere at concentrations between 5% and 15% by volume. If free methane gas or water with high concentrations of dissolved methane enter confined spaces, other factors such as water temperature, ventilation of the well, air movement inside the confined space, size of the confined space, and the percent composition

of combustible gas are factors that must be evaluated to determine if the methane gas or dissolved methane in water is capable of producing an explosive hazard.

My water well has methane in it, what should I do?

Further information regarding the treatment/mitigation of methane in groundwater can be found in "How Well Do You Know Your Water Well?" The information was prepared by Michael Matheson, P.G. with Plateau Environmental Services, Inc. and Joe Bowden, PhD, with CDS Environmental Services, LLC.

APPENDIX 6

Groundwater Well Investigation Summaries

Water Well Investigation Summary #1 (Complaint 200409931)

Thermogenic gas was identified in three water wells in close proximity through pre-drilling baseline sampling. The first sample containing thermogenic gas was collected in August of 2013 and two additional wells were found to have thermogenic gas in April 2014. The three water wells are within approximately 500 feet of each other and are located in Weld County in Township 3 North, Range 66 West; all three are completed in the Laramie Fox Hills aquifer.

In response to the identification of thermogenic gas, the water well owners were provided temporary sources of potable water, and the water wells were disconnected from the households. The COGCC initiated an investigation into the source of the gas in the water wells as described above, and conducted an engineering review of the wells with 0.75 mile of the affected water wells to determine if there was a well with documented integrity issues. Staff also reached out to operators to complete reviews of their wells to determine if there were undocumented repairs or other indicators of suspect well integrity.

COGCC requested operators with wells within 0.5 mile of the water wells to conduct Bradenhead pressure tests and collect gas samples for laboratory analysis from both the production gas and Bradenhead gas, if present. Production gas samples were collected from 25 wells and Bradenhead samples were collected from 24 wells. All gas samples were submitted to laboratories for gas composition and isotopic analysis.

Water well, production well, and Bradenhead gas sample analytical data through October 2015 were provided to COGCC's consultant for their review and opinion as to the source of the gas in the water wells. The report included a detailed analysis of the isotopic data collected from the production wells and water wells. Based on the analysis of the isotopic data the report identified five wells as candidates for further investigation.

As part of the investigation, COGCC staff created detailed structure maps of the Laramie Fox Hill formation in the area surrounding the water wells. Data for the maps came from the electric logs in COGCC records. Utilizing the third party report, a review of the Laramie Fox Hills structure maps, and additional well integrity data collected in the field, COGCC determined that a well that had been plugged and abandoned in 2015 was the most likely source of the thermogenic gas in the water wells.

The well identified as the likely source was spud in 1993 and produced from the J-sand, Niobrara, and Codell formations until it was plugged in July 2015. Bradenhead tests conducted on the identified well in 2013 and 2015 indicated high pressures and both Bradenhead and production gas samples were collected prior to the 2015 plugging of the well. The compositional and isotopic analysis of the samples indicated that the gas in the Bradenhead and the produced gas were from the same source. The isotopic data were also very similar to the isotopic data from dissolved gases in the three water wells.

The operator of the identified well has provided the owners of the affected water wells methane mitigation systems on their wells to eliminate methane from entering the households. The

operator collects quarterly samples from the three affected water wells and will continue to do so until the attenuation of the thermogenic gas is documented.

In summary, laboratory analytical results of the gas composition and isotopic analysis indicated that three wells completed in the Laramie Fox Hills aquifer were impacted by thermogenic gas. COGCC identified the source of the gas through the analytical data review, Bradenhead testing, and review of the geologic structure of the Fox Hills Formation. The suspected source well has been plugged and abandoned, eliminating the source of the thermogenic gas to the Laramie Fox Hills Aquife,r and the water wells have methane mitigation systems installed, protecting the residents from gas buildup. Quarterly sampling events will be conducted until the thermogenic gas in the aquifer has attenuated.

Water Well Investigation Summary #2 (Remediation Project 9425)

In October 2015, a water well owner notified an operator of a suspected problem with his domestic water well completed in the Fox Hills sand. The aquifer overlies the Dakota D sands in which East Cheyenne Gas Storage stores natural gas in Logan County in Northeastern Colorado. The operator sampled the domestic water well in November 2015, and compositional and isotopic laboratory analyses of gases in the water showed that the gas was thermogenic and consistent with gas injected into the gas storage field. Upon receipt of notification from the operator, COGCC requested the operator submit a Form 27 Site Investigation and Remediation Workplan for approval.

By the time the operator submitted the Form 27 on December 23, 2015, they had already installed an inline treatment system to remove methane from the water serving the residence. On January 29, 2016 the COGCC conditionally approved the Form 27, requiring a methane survey of the gas storage field, quarterly monitoring of the impacted water well, sampling of surrounding water wells subject to available access, collection of pre- and post-treatment system samples, and an evaluation of all gas storage wells within 0.75 mile of the affected water well. The COGCC Environmental Unit and the Engineering Unit have worked with the operator to investigate and begin to remediate the issue.

The operator installed a treatment shed and commercially available gas/water separation system which has been operational since April 2016. Pre- and post-treatment samples from the gas/water separation system document methane reduction from approximately 30 parts per million (ppm) to less than 5 ppm. The operator also installed lower explosive limit ("LEL") methane detectors in the water well owner's home and the water treatment system building. In March 2016, the operator performed an aerial methane detection survey of the gas field. The helicopter survey did not identify methane at the surface of the gas storage facility. Handheld methane detection work confirmed these findings.

Using historical well records and Bradenhead pressure records, the operator identified the wells deemed most likely to be the source of the gas. The operator's consultant developed a reservoir model of the Fox Hills and simulated the introduction of gas into the Fox Hills by each of the surrounding gas injection/withdrawal wells to determine which could be a potential source well.

Based on the records and modeling, five gas injection/withdrawal wells were identified as potential suspect source wells. The performed remedial work on the five wells by squeezing with cement and, in some cases, a specialized epoxy to provide an additional barrier to gas movement outside the casing. The modelling, coupled with operational knowledge of the field, showed that the amount of gas potentially lost to the Fox Hills aquifer was less than, but in the range of, 0.5 billion cubic feet (Bcf).

The operator has reduced the concentration of methane in the water servicing the residence to a safe level and has installed methane detectors in the home to ensure the residents' safety. The operator has identified and remediated five suspect wells. The operator is monitoring the single affected domestic water well and surrounding water wells and will continue to do so until attenuation of thermogenic methane in the aquifer is confirmed.

Water Well Investigation Summary #3 (Complaint 200443863)

On Saturday September 9, 2017 a water well owner noticed prolific water coming from around his water well and gas bubbles of unknown composition rising though the water filling the well pit. The water well owner contacted an oil and gas operator identified through an emergency number located on a natural gas gathering line adjacent to the property. The operator went to the property and tested the area around the water well for combustible gases. Combustible gases were detected near the water well casing and around four other water well casings in the surrounding area.

The local fire department was called to check some of the houses and informed homeowners it was safe to go inside the houses. The operator of the gathering line was concerned about the situation and shut down and tested their gas pipelines around the area, but the gas continued to be detected around the water well casing. The gathering line operator concluded that the source of the combustible gases was not their nearby gas pipelines. COGCC was contacted by the gathering line operator on September 11, 2017 and contacted the water well owner to begin an investigation. During initial conversations, the water well owner confirmed that the well was turned off and expressed concern for safety following the detections of combustible gases.

On September 11, 2017 COGCC staff inspected the area and collected water samples for laboratory analysis. During the inspection gas bubbles continued coming up around the water well and a large amount of water (approximately 500 gallons every 3 hours) was being produced by water flowing from the ground into the pit surrounding the water well. The water samples were submitted to Test America for analysis of inorganic and volatile organic compounds. Samples of water pumped from the well along with samples of water emerging from the base of the well pit were submitted to Dolan Integration Group for gas composition and isotopic analysis of gases in the water. Initial observations and descriptions from the water well owner indicated the potential for a significant down-well pressure source resulting in the upwelling of water in the well vault.

COGCC staff conducted a second inspection of the well on September 13, 2017. Levels of combustible gases were less than 10 percent of the lower explosive limit (LEL) in the well pit. Combustible gases were not detected from 0.5-1 liter bubbles as they burst after rising through

the water in the well pit. The absence of combustible gases in the bubbles indicated the bubbles were likely air entrained in water.

COGCC Staff conducted another site inspection on September 14, 2017 and additional samples were collected and submitted to ALS Laboratory Group for general inorganic and volatile organic analysis from two domestic water wells nearby. In addition, a sample was collected for compositional and isotopic analysis of the gases venting from the wellhead by sealing a trash bag around the well head.

On September 15, the power to the well pump was turned off at the breaker and the water that was present in the vault began dropping rapidly; the pump was then turned back on and the water level in the vault began to rise and bubbles were visible rising through the water in the vault. COGCC repeated this test on the same day with similar results. Further conversations with the water well owner indicated possible damage to the faucet riser, which was later confirmed to have been associated with a break in the piping between the pitless adapter and the house. Because of the leak, which diverted most of the water pumped to the ground, the water pressure sensor in the pressure tank at the house was triggering the submersible pump in the well to remain on continuously, and the pumped water was flowing into the well vault and bubbling as if containing gas.

COGCC staff collected samples from two neighboring wells on September 19, 2017. COGCC staff visited the complainant's property again on September 19 and at that time the ground around the well had been excavated and the homeowner indicated he had determined the a water leak from the pipe which ran between the water well and the house was the source of the bubbling water.

In conclusion, this investigation initially found that the source of the water emanating from the well vault was the Laramie-Fox Hills aquifer. Further investigation revealed that what little gas was in found in the water well samples was not thermogenic in origin, and ultimately, most of the visible gas bubbles were entrained air from the constantly running pump. Although samples in the vicinity did indicate the presence of biogenic gas, this turned out to be a case where no impacts from oil and gas were found and the complaint was closed with a letter report to the water well owner.