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**Introduction**

Underground injection is the placement of fluids, including but not limited to waste by-products, into the subsurface through a wellbore. Underground injection is not a new practice. The Chinese injected freshwater for salt extraction as early as A.D. 300. The first documented use of injection to dispose oilfield produced water (brine) was in Texas during the 1930s, over eighty years ago. Beginning in the 1930s, the oil and gas industry also began to inject produced water into pressure-depleted oil reservoirs in order to enhance recovery of crude oil resources. During the 1970s and 80s, oil refineries and chemical industries began to inject liquid wastes in deep disposal wells. Today, underground injection is used to remove more than 50 percent of the liquid hazardous waste, and more than 98 percent of salt water produced by onshore oil and gas operations from the surface environment.

Some waste is an unavoidable by-product of a myriad of resource development and manufacturing processes that create thousands of products that we use in our daily lives including: steel, plastics, pharmaceuticals, fuels, and natural gas. Underground injection is an important waste management practice internationally and in the United States. Some renewable energy sources, such as geothermal, also rely on underground injection. Municipalities need underground injection to replenish aquifers (aquifer storage and recovery), combat saline water encroachment in coastal areas, to dispose of residual waste streams generated by treatment and desalination of water for public use, and to dispose treated sewage. While industries continue to develop ways to reduce waste volumes and recycle, generated wastes must be disposed in a safe manner. Various types of injection wells have unique associated benefits and risks. To dispose fluids safely, injection wells must be properly constructed, located in an appropriate geologic setting, operated, maintained and monitored in accordance with standards that are protective of our groundwater resources.

Liquid wastes can be managed in a variety of ways other than underground injection including:

- treatment and release into surface waters, such as rivers, through a National Pollutant Discharge Elimination System (NPDES) permit issued pursuant to the federal Clean Water Act;
- biological treatment;
- incineration;
- storage in evaporation pits;
- discharge into percolation pits; and
- beneficial re-use (e.g., irrigation, livestock watering, ice or dust control)
Each of these practices has its limitations and associated environmental risks. For many waste streams, including produced water generated during oil and gas exploration practices, the volumes are too great to rely solely on these alternative waste management practices. Furthermore, injecting highly saline fluids back into deep subsurface reservoirs that contain equally saline water is a common-sense waste management practice that poses fewer environmental or public health risks than these alternatives.

Underground injection plays a crucial role in disposing residual wastes, especially those that would pose the greatest risks to society if managed by any other method, such as discharge to surface waters. In other words, if underground injection is restricted or eliminated, the result will be more, not less risk of environmental harm.

In 1974, Congress passed the Safe Drinking Water Act (SDWA), which required the U.S. Environmental Protection Agency (USEPA) to develop minimum federal requirements for injection practices. Regulations adopted pursuant to the SDWA are now administered by USEPA along with state and tribal partners that collectively constitute the UIC Program. The purpose of the UIC Program is to protect public health by preventing contamination of underground sources of drinking water (USDWs).

A USDW is defined as an “aquifer or its portion which supplies any public water system or contains a sufficient quantity of groundwater to supply a public water system, and either currently supplies a public water system, or contains less than 10,000 milligrams per liter of total dissolved solids and is not an exempted aquifer.” Most groundwater used for public drinking water today contains less than 500 milligrams per liter of Total Dissolved Solids (TDS), and most water that is treated for drinking water contains less than 3,000 milligrams per liter TDS. Therefore, the UIC Program ensures that water resources that could be treated and used as drinking water in the future are protected today.

After passage of the Safe Drinking Water Act (1974), USEPA worked with a twelve-member state workgroup to develop the UIC Program rules (1976-1977). From the onset of rule development, regulatory officials sought to apply lessons learned from decades of injection experience. Prior to enactment of the federal regulations, USEPA and state officials examined best practices and problems associated with injection well operations that pre-dated passage of the SDWA.

While developing the UIC Program regulatory framework, USEPA and state officials recognized six pathways through which injected fluids could potentially migrate into
USDWs. Officials sought to develop regulatory standards that mitigate and effectively address the following pathways:

- migration of fluids through a faulty injection well casing;
- migration of fluids through the annulus located between the casing and wellbore;
- migration of fluids from an injection zone through the confining strata;
- vertical migration of fluids through improperly abandoned and improperly completed wells that penetrate the injection zone;
- lateral migration of fluids from within an injection zone into a protected portion of that stratum; and
- direct injection of fluids into or above an USDW

The USEPA has defined six classes of injection wells that are permitted and regulated under the SDWA, which are summarized in the following table.

<table>
<thead>
<tr>
<th>U.S.EPA Classification</th>
<th>Injection Well Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLASS I</td>
<td>Wells used to inject waste beneath the lowermost USDW</td>
</tr>
<tr>
<td>CLASS II</td>
<td>Wells used to dispose of fluids associated with the production of oil and natural gas</td>
</tr>
<tr>
<td>CLASS III</td>
<td>Wells used to inject fluids for the extraction of minerals</td>
</tr>
<tr>
<td>CLASS IV</td>
<td>Wells used to dispose of hazardous or radioactive wastes into or above a USDW</td>
</tr>
<tr>
<td>CLASS V</td>
<td>Wells not included in the other classes generally used to inject non-hazardous waste</td>
</tr>
<tr>
<td>CLASS VI</td>
<td>Wells used to geologically sequester carbon dioxide to reduce greenhouse gas emissions</td>
</tr>
</tbody>
</table>

Table 1 Injection well classification chart Source: after USEPA

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The USEPA is charged with enforcement of the SDWA, and exercises that authority directly or through formal agreements with state and tribal partners, under their oversight. The USEPA has given primary enforcement authority (primacy) over underground injection wells to those state agencies or tribes that have shown they are able to implement a UIC Program that is effective in protecting groundwater resources. These requirements are in Sections 1422 and 1425 of the SDWA, and the Federal Register (40 Code of Federal Regulations Sections 144 through 147). The states that USEPA has determined have regulations, laws, and resources in place that meet the federal requirements and are authorized to run the UIC Program, are referred to as Primacy states. Primacy states manage their programs subject to periodic audits and program reviews conducted by USEPA. In states that have not received primary responsibility for the UIC Program, USEPA remains the responsible regulatory agency. These states are referred to as Direct Implementation (or DI) states, because USEPA directly implements the federal UIC regulations in these states. Some states share responsibility with the USEPA, with authority over some well classes residing at the state level, and other well classes being regulated by USEPA.

The Class II UIC Program

Class II injection wells are used primarily to inject fluids that are associated with oil and gas exploration and production (E&P) activities including drilling, stimulation (hydraulic fracturing), and production operations. Since the inception of oil and gas exploration and development (1860), the oil and gas industry has been generating and managing produced water. Produced water is the water extracted from the subsurface during oil and gas E&P activities. Produced water is generated during several oil and gas E&P activities including:

- drilling through saline water zones that naturally occur in the subsurface and overlie the target oil and gas reservoir(s);
- stimulation of oil or gas reservoirs by hydraulic fracturing during the flow back and swabbing process; and
- workover operations, and
- during day-to-day production operations

Long before hydraulic fracturing operations started in the 1940’s, the oil and gas industry generated large volumes of produced water that was capable of harming the environment if not properly managed.
Produced water characteristics and physical properties vary considerably depending on the geographic location of the field, the geological formation with which the produced water has been in contact for thousands of years, and the type of hydrocarbon product being produced. Produced water properties and volumes can even vary throughout the lifetime of an oil and gas well or reservoir. Produced waters can be highly saline, with salt concentrations exceeding 200,000 milligrams per liter of chloride (more than ten times as salty as sea water) or may be pure enough for agricultural or irrigation purposes. In addition, produced water commonly contains many organic and inorganic compounds that can lead to toxicity. Some of these are naturally occurring dissolved or emulsified hydrocarbons derived from associated crude oil while others are related to chemicals that have been added for well-control or reservoir stimulation purposes. These fluid wastes are specifically excluded from hazardous waste classification under the Resource Conservation and Recovery Act (RCRA).  

The 1980 amendments to the RCRA required USEPA to conduct a study of the environmental and potential human health impacts associated with E&P wastes and their associated waste management practices. USEPA completed its two-year study in 1987. Based on the findings in the Report to Congress, and on oral and written comments received during public hearings in the spring of 1988, on June 30, 1988, USEPA decided not to recommend federal regulation of E&P wastes as hazardous wastes under Subtitle C of RCRA (USEPA 1988). This determination is commonly referred to as the “RCRA exemption”. Although produced water is exempt from one section of RCRA, it is subject to requirements in RCRA Subtitle D and the Safe Drinking Water Act.

Approximately 20.5 billion barrels (bbl.) of produced water are generated by federal and state onshore operations in 2012. Generally, the volume of produced water from oil wells does not remain constant over time. The water-to-oil ratio can increase over the life of a conventional oil well. For such wells, water makes up a small percentage of produced fluids when the well is new. Over time, the percentage of water increases and the percentage of crude oil declines. On average, more than seven bbl. of water are produced for each barrel of oil. For crude oil wells nearing the end of their productive lives, water can comprise as much as 98% of the fluid brought to the surface.

Shale gas wells generate most of their produced water after hydraulic fracturing operations are completed and pumping pressure is relieved from well. During the flow

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back process, water-based fracturing fluid mixed with natural formation (connate) water begins to flow back to surface. The majority of produced water recovered from typical shale gas operations is recovered during the first several months. West Virginia’s shale formations flow back roughly 10% of injected fluids.

Produced water is separated from crude oil or natural gas at the surface facility associated with producing oil and gas wells. It is delivered to Class II injection well facilities by pipeline or truck. Once delivered to the storage facility at the injection well, any remaining crude oil is skimmed, the water may be filtered to remove solids such as sand or silt, and the water may undergo other types of treatment prior to injection.

Today there are approximately 168,000 Class II injection wells operating in 31 states. There are three types of Class II injection wells:

- Hydrocarbon storage wells;
- Enhanced oil recovery wells; and,
- Produced water disposal wells.

Hydrocarbon storage wells are used to pump crude oil and other hydrocarbons that are liquid at standard temperature and pressure underground for temporary storage, prior to recovery, processing and use. Enhanced oil recovery (EOR) wells are used to prolong the productive life of oil wells within a specific oil field. Secondary recovery is an EOR process commonly referred to as water-flooding. Salty water produced with oil is separated from the oil at surface and re-injected in the oil-producing formation to drive oil to proximal, pumping oil wells completed in the same reservoir. This saline waste-water by-product is referred to as “produced water” or “salt water” because salts (sodium, calcium, magnesium, potassium chlorides) are the predominant dissolved constituents in produced water. Produced water disposal wells are sometimes referred to as “salt water disposal wells” because they inject fluids into deep saline reservoirs for disposal purposes. Nationally, approximately 60 percent of all salt water produced with onshore oil production wells is re-injected at Class II EOR wells, while 40 percent is injected for disposal.

USEPA has awarded primacy for the Class II Program to 44 states and territories, and two tribes. The following map shows the distribution of Primacy states and Direct Implementation states.

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Class II injection well regulations establish standards that address the six potential pathways in the following manner:

- Prior to issuance of a permit, geologists evaluate the suitability of a proposed site for injection. As part of the permit review process, geologists determine the depth of the deepest USDW, evaluate the adequacy of the proposed injection zone, and examine the thickness and nature of confining strata on a site specific basis.
- Permit writers establish the depth of surface casing necessary to extend through and isolate all USDWs.
- In addition to cemented surface casing, Class II injection wells must be constructed with multiple layers of protection (cemented, steel casing strings) between USDWs and the injected waste stream. Most Class II injection wells have three-to-six layers of protection between the injected fluid and the protected groundwater. Therefore, injected fluids can only enter USDWs as a result of faulty casing when there are multiple, concurrent failures of cemented, steel casing strings.
- Regulators establish injection pressure limits designed to confine injected fluids in the authorized injection zone.
- The mechanical integrity of casing and injection tubing are tested prior to commencement of injection operations and monitored on a regular, scheduled basis thereafter. Mechanical integrity tests must be conducted at least every five years, and more frequent tests may be required by rule or permit condition.
- All known wellbores that penetrate the proposed injection zone are evaluated within an “Area of Review” surrounding the proposed injection well.
that pose potential avenues for fluid migration by virtue of their construction or plugging status must be mitigated before injection can be authorized.

- Injection owners must monitor their operations and submit reports regarding injection pressures and fluid volumes.

Produced water is injected into depleted oil and gas reservoirs or deep reservoirs that are naturally saline. These saline reservoirs contain water with similar in chemistry to the injected produced water. Typically, produced water is injected into porous and permeable sandstone or dolomite formations that are overlain by “confining strata”.

Confining units consist of rock types that typically have low permeability, such as shale, halite (salt), anhydrite, and some limestone formations. When confining units overlie oil and gas reservoirs, they are also referred to as “cap rocks” because the strata have effectively sealed oil, natural gas and even CO₂ in the underlying reservoir for millions of years with no, or minimal, leakage. The effectiveness of confining units has been further validated through extensive stratigraphic tests, and decades of successful experience at gas storage and injection operations.

Constructing a wellbore and maintaining mechanical integrity throughout injection operations is a key principal of injection well regulations. An injection well is said to have “mechanical integrity” if:

1) there are no significant leaks in the casing, including injection tubing (the string of steel pipe through which fluids are actually injected), and
2) there is no significant fluid movement behind casing (either behind cement or in un-cemented annular spaces) into a USDW

Class II regulations require operators to construct a well in a manner that mechanical integrity can be tested and monitored

Injection well operators are required to verify that each Class II well has mechanical integrity before commencement of injection is approved; at least every five years thereafter; and every time down hole equipment, such as injection tubing or packer, is removed for servicing or repair. These standards are enforced to protect USDWs and ensure that fluids are injected into the authorized injection zone.

The Peer Review Process

The Ground Water Protection Council (GWPC) conducts the Class II UIC Peer Review process under the joint GWPC and Interstate Oil and Gas Compact Commission (IOGCC) “StatesFirst” Initiative. The purpose of this process is to assess the effectiveness of Class
II UIC programs that have been delegated to states under Sections 1422 or 1425 of the Safe Drinking Water Act (SDWA).

The review team consists of the following persons:

- two volunteer state Class II UIC program persons from primacy programs of states that reside outside of the USEPA Region of the state being reviewed
- A GWPC staff member
- A facilitator hired by the GWPC
- An federal observer from the USEPA Region in which the state being reviewed resides

The review process and desired timing is as follows:

1) Initial contact with states to solicit volunteers for review (GWPC)
2) Coordination of timing for the review with the state program (GWPC)
3) Recruiting of review team members at least 60 days prior to the in-state interview (GWPC)
4) Distribution of the questionnaire to the state program to be reviewed at least 60 days prior to the in-state interview (GWPC)
5) Notification to state program of review team members at least 30 days prior to in-state review (GWPC)
6) Submission of the completed questionnaire to the GWPC at least 30 days prior to the in-state interview
7) Review of the completed questionnaire and development of follow-up questions no later than two weeks prior to the in-state interview (Review team)
8) In-state interview of up to 1 ½ days (Review team and state program staff)
9) Prepare draft report within 60 days following in-state interview (Non-observer team members, facilitator and GWPC representative)
10) Initial review of draft report by team within 30 days following draft completion
11) Submission of draft report to state program within 30 days following team review (GWPC)
12) Review and comment submission by the state to GWPC within 30 days of receipt of draft
13) Revision of draft within 30 days following receipt of state program input (Non-observer team members, facilitator and GWPC representative)
14) Approval of the final report within 15 days of revision completion (GWPC Executive Director)
15) Printing of copies of the final report per state request within 10 days following approval by GWPC Executive Director (GWPC)
16) Posting of the final report on the GWPC website within 10 days following approval by GWPC Executive Director (GWPC)
17) Distribution of 25 copies of the printed report to the state program (GWPC)
The general rules of a review include the following:

- Review team members agree to operate under rules of confidentiality and may not discuss the review findings or draft report with persons who are not members of the team until the final report is published.
- Observers are entitled to submit questions to the review team as part of the in-state interview but are not permitted to participate in drafting of the report.
- Observers may submit comments on the draft report at their discretion.
- Preparation and approval of the draft report will be accomplished using a consensus approach.
- Minority reports, other than those that may be published by the reviewed state, are not allowed.
- Comments in the report will not be attributed to any individual team member.
- The GWPC is solely responsible for the content of the final report.
- The report is the intellectual property of the GWPC and any distribution of or quotation from the report may only be done with the express permission of the GWPC.
West Virginia Class II UIC Peer Review

Review Team
The following persons conducted the West Virginia Peer Review:

State team members:
Robert P. (Bob) Koehler, PhD., UIC Lead – Geology Advisor, Colorado Oil and Gas Conservation Commission

Larry E. Organek, Engineer, Oil, Gas, and Minerals Division, Michigan Department of Environmental Quality

GWPC staff and consultants:
Mike Nickolaus, Special Projects Director, GWPC
John Taylor, Former USEPA Region 5 UIC Program Manager and GWPC Facilitator

Observer:
Mark Nelson, Geologist, USEPA Region 3

Executive Summary
The peer review of the Class II UIC program administered by the West Virginia Department of Environmental Protection, Office of Oil and Gas (OOG) was conducted by a review team made up of UIC managers and technical staff from state Class II agencies of states outside of the USEPA region in which West Virginia resides (Region 3). This included an in-state interview of OOG staff and management at the OOG office in Charleston, West Virginia on March 21, 2017. The in-state interview was based on responses to a comprehensive questionnaire completed by the state UIC staff and follow-up questions posed to the UIC staff during the interview. In addition, the interview team members reviewed the state’s statutes and rules governing the UIC program and other materials provided by the state.

Program Overview
The West Virginia Class II UIC program is managed by OOG under West Virginia Code Chapter 22 “Environmental Resources,” with specific authorities found under Article 6, and more general authorities under Articles 11 and 1. Most of the rules applicable to the Class II UIC program can be found in the West Virginia Legislative Rule Title 47, Series 13, and Title 35, Series 4 “Oil and Gas Wells and Other Wells.” West Virginia obtained primacy for the Class II UIC program under Section 1425 of the SDWA in 1984.
Management of the UIC program is led by the two Assistant Chiefs of OOG, one for permitting and one for inspections and enforcement. However, due to retirements one Assistant Chief’s position was vacant and the other one was due to become vacant about a month after the review team’s visit. Under the Assistant Chiefs, section supervisors direct day-to-day activities. Most technical reviews including permitting are performed in the Charleston central office and one of the five technical positions responsible for performing this work is currently vacant. Field inspectors are assigned specific counties, and they have the primary responsibility for identifying well violations, and resolving the violations through enforcement actions.

In 2017, overall funding for the UIC program was $223,117. This consisted of funds from two sources:

1. $142,834 in state funds. To date, OOG has been able to cover these costs primarily through a variety of fees, which are assessed on well operators and are deposited into the oil and gas operating account. West Virginia levies an oil and gas production severance tax, but the OOG does not receive any of these funds. At present, only a small amount of general revenue funds are provided.

2. $80,283 in grant funds from USEPA

The current inventory of Class II UIC wells in West Virginia includes a total of 59 Class IID (salt water disposal) wells, including 14 commercial wells and 45 non-commercial wells, and 461 Class IIR (enhanced recovery) wells in 17 fields. Over the past several years OOG has been receiving approximately 12 applications per year with 10 applications being renewals and 2 being new permits.

In 2013, the OOG initiated an internal review of their UIC program. This review included all UIC and ground water regulations and policies at both the State and Federal levels. Based, in part on this review, a number of actions were initiated, some of which are still being developed. These included preparing guidance manual and permit templates for Class II wells, and electronically fillable forms and web based monthly reporting forms. One of the most significant decisions reached was the agreement to develop detailed Standard Operating Procedures (SOPs) for nearly every facet of the UIC program. A very detailed Permit Review SOP has been developed, and at least a dozen additional SOPs are currently being developed covering everything from well and permit transfers to document retention. Completion of the inspection SOP is considered a high priority as is the Risk Based Data Management System (RBDMS) SOP.

An important step in OOG’s efforts to improve the UIC program has been the recent
adoption of Phase 1 of RBDMS. This system now fully supports the broad range of UIC activities including modules which allow for complete management of entities, financial security, wells, permitting (including UIC), inspections, incidents and compliance. OOG is currently proceeding with efforts to improve the ability of RBDMS to communicate with the agency’s legacy database for certain aspects of entity management. Several more enhancements are planned including a compliance calendar to provide for automatic notification of any time-sensitive milestones, eForms to provide for electronic reporting and data reporting by operators, mobile Inspection to allow for tablet-based inspection and interfacing with the database, RBDMS Environmental for analytical data storage and analysis, and a Wellbore Visualizer.

The review team urges OOG to give strong consideration to the following actions:

1) Filling the vacant positions, especially the management positions, which have a large impact on the direction of the UIC program.

2) Proceeding with RBDMS enhancements as quickly as possible, in order to allow the UIC program to further streamline operations by taking advantage of the savings that RBDMS can offer. Use of a RBDMS implementation spreadsheet to track actions that are completed, in progress and projected could be valuable in helping set goals and milestones.

3) Increasing the effort to complete the various SOPs which are currently being worked on, especially the one covering inspection activity.

**Permitting and File Review**

All UIC permits are issued from the Charleston central office. All permits are effective for 5 years, after which an entire new permit application and application review process is required before a permit can be re-issued. The UIC application review process is well conceived and designed to provide a good technical and administrative judgment of any proposed Class II well. The detailed UIC Permit Application Package and UIC Permit Review (draft) manuals augment the process very well. Although portions of the permit review may be conducted by more than one individual, routine communication is maintained between staff responsible for permit decisions. This insures consistent application of the principles used to determine permitting outcomes.

Reviews include a thorough technical review of well construction and operating specifications and a pre-drilling site evaluation and inspection process designed to insure protection of natural resources and the environment. In addition, the OOG requires pre-drill sampling of all domestic water wells located within 1000’ of the
proposed well or an EOR project boundary as part of a permit application. This is commendable and a strong point of the program. The OOG requires water well sampling of all wells within the AOR as part of the permitting process. OOG has also worked closely with the West Virginia Geological and Economic Survey (WVGES) to minimize the potential for any adverse seismic activity resulting from injection well activity. This has included review of permit applications by WVGES, as well as an extensive network of seismic monitoring stations.

While OOG does not have a different process for processing commercial disposal wells, these wells have specific permit conditions such as security (fences, cameras) and approval of third party haulers, which would not apply to non-commercial wells.

OOG does not have a formal file review process. However, all Class II well files do receive an intensive review as part of the 5 year permit renewal process. In addition, the well files are reviewed for relevant items whenever significant activities occur such as issuance of a NOV or running of a MIT. Approximately 25% of all Class II files receive such an activity driven review each year, and any deficiencies identified are promptly addressed.

The review team believes that the permitting process implemented by OOG provides appropriate protection for USDWs. However, the review team suggests that the five year renewal of UIC permits, which includes a public notice, may pose a burden on both state staff and operators and that staff time might be better utilized. Accordingly, the OOG may want to consider amending the Rule and incorporate the same review elements of a renewal permit into a five-year file review plan.

Financial Assurance
West Virginia law allows bonding requirements to be met through a variety of financial assurance mechanisms. The method used is at the operator’s discretion, subject to OOG approval. The OOG requires Class IID wells to have a $5,000 performance well bond and a $5,000 UIC operation bond. Only a $5,000 performance well bond is required for Class IIR wells. A $50,000 blanket performance bond can be used for Class II coverage for all of the Operator’s enhanced recovery wells, no matter how many are owned, although a separate bond is required for each disposal well. The performance well bond is actually a penal bond, and as such, cannot be taken to perform plugging on a specific well, and instead goes into the Oil and Gas Reclamation Fund.

The review team suggests that OOG consider increasing financial responsibility instruments to provide greater assurance that wells can be properly plugged and abandoned. Possible options include increasing bond amounts, limiting the number of
Public Outreach
If the OOG determines that a Class II UIC permit application may be approvable, a draft permit, fact sheet and public notice are written and issued. The public notice is provided to the Operator with an instruction to run the ad on a specific day in the newspaper with the greatest circulation within the area in which the well is located. OOG posts the complete application and fact sheet on the OOG webpage. The OOG also emails public notices to anyone who has registered to be on the mailing list, as well as posting a copy of the public notice on the WVDEP Public Information Office website.

A 30 day public comment period follows the day the advertisement is published. A hearing may be requested during the comment period. No specific standing is required to be allowed to submit a public comment for consideration. OOG tries first to resolve problems before resorting to a formal hearing. If the Chief finds that "significant" interest has been raised a public hearing is held at a public building, near the location of the proposed Class II UIC well. Hearings must be public noticed at least 30 days in advance. If the Chief determines that a hearing is not warranted, the commenter is notified in writing of the decision.

Public hearings are formal events, with a transcriptionist/court reporter. Written comments are also accepted. The public comment period is extended an additional 10 days after the public hearing to ensure all attendees have an opportunity to submit a comment. OOG staff is available for questions before and after the hearing, and maps, copies of the permit application, and supplemental information are available at the hearing.

OOG does not respond to comments at the hearing, although they may ask for clarification of public comments. Comments are answered by OOG in writing after a decision to approve or deny the permit is made. All transcripts, comments/questions, and agency responses are compiled and attached to the permit file. All commenter’s who request it are mailed or emailed a copy of the final approved permit with attachments or the denied permit with comment responses as appropriate.

The team believes the public notice and hearings requirements implemented by the OOG are sufficient to provide adequate public notice and input concerning the issuance of Class II permits.
Well Construction

The OOG requires that surface casing extend at least 30 feet below the deepest freshwater bearing zone above elevation and that it be cemented to the surface. Injection casing is required to be cemented through the injection interval, although no specific height above that point is required by current rules.

A tubing and packer system is required in all newly completed and converted Class II wells. The OOG does not allow injection directly through casing without a packer and tubing in any Class IID wells. However, there are approximately 120 existing Class IIR wells that lack a tubing and packer system. For these wells that do not meet current construction standards, more frequent MITs can be required, with continuous monitoring of annulus pressures and/or fluid levels, and monitoring of adjacent production wells in order to ensure that USDWs are protected. While OOG encourages operators of these wells to convert to a tubing and packer arrangement, current rules do not require it for these grandfathered wells.

The OOG does not allow injection through tubing with a packer set within the freshwater protection casing string. By policy, the packer is to be set no more than 100 feet above the injection zone inside cemented casing.

The review team believes the well construction requirements and policies are adequate to protect USDWs from contamination from injected fluids, however, it suggests that OOG consider the following:

1) While we acknowledge that this would likely require a rule change, setting a date certain to end the practice of allowing injection without a tubing and packer system;

2) Taking formal action to require the cement top of the injection casing to cover the injection zone to above the packer depth; and

3) Codifying the current policy of requiring a packer to be set no more than 100 feet above the injection zone by placing it into a rule. Further, the rule should state that packers must be set inside of cemented casing.

Mechanical Integrity Testing

For Part 1 of demonstrating mechanical integrity, standard annular pressure tests are required for all new UIC constructed wells prior to commencement of injection operations. Thereafter, a MIT is required once every five years from the last test date. If a well is modified by replacing the tubing and packer, a new MIT is required and the five year clock is restarted. A satisfactory test requires test pressures at 1 ½ times the maximum injection pressure with a bleed off of not more than 5% over a 20-minute
interval. For Part 2 of demonstrating mechanical integrity, noise and temperature logs, and a Cement Bond Log (CBL) may be required at the discretion of the OOG. The OOG places a priority on the witnessing of MITs; in practice nearly 100% are witnessed.

The review team believes the OOG program adequately addresses both parts of the mechanical integrity requirement.

**Inspections**

OOG maintains a strong field presence which plays an integral part in the effectiveness of West Virginia’s Class II UIC program. Inspections of Class II UIC wells are conducted by OOG inspection staff assigned to specific counties. Currently 17 inspectors and 2 inspector supervisors include UIC duties as part of their assigned workload. OOG’s goal is that all UIC wells are inspected either annually (Class IID) or every 2 years (Class IIR). Central office (Charleston) UIC Staff coordinate with field inspectors and field inspection supervisors as needed, including determining the frequency of wellsite inspections, and field inspection supervisors periodically accompany field inspectors on field assignments. OOG has a policy of responding to complaints within 24 hours, which includes a prompt follow-up by the assigned inspector.

Inspectors have received a variety of on-the-job and outside training, such as H2S, safety, well control, HAZMAT, and many inspectors have attended USEPA UIC Inspector Training.

With OOG’s former database management system, tracking of inspection priorities and compliance deadlines was difficult, and the use of RBDMS presents many opportunities for improvement in these areas. The Phase 1 RBDMS system currently includes these abilities through existing reports or database queries. OOG is planning on developing a "Compliance Calendar" to further assist tracking activities through automatic notification of any time-sensitive milestones. This tool is expected to positively impact OOG’s ability to identify, permit expirations, open compliances or lapsed MITs.

The review team believes that the OOG field inspection program provides an adequate level of protection to USDWs. The review team urges OOG to place priority on the completion of the RBDMS “compliance calendar” as it will further assist the inspectors in the performance of their duties.

**Compliance and Enforcement**

The OOG compliance and enforcement program relies heavily on the field presence of the inspection staff. For UIC violations, OOG has a tiered penalty matrix which uses an informal process initially. If the problem is not resolved, then formal actions are taken.
A Notice of Violation (NOV) is the first formal action taken with a 7 day reply deadline and a potential 30 day extension afterward if warranted. Inspectors are the only OOG employees with the explicit statutory right to issue a NOV, although the office staff in Charleston may consult with the field inspectors and have the inspector issue an NOV. Field and office staff are both responsible for coordinating enforcement of and documenting NOV’s; both resolved and non-resolved. If the NOV does not achieve compliance, a “Failure to Abate” notice is issued, also by the field inspector. For more serious violations, a “Cease and desist” order may also be issued. Civil penalty assessments are completed by inspector and supervisor, and the Chief signs civil penalties.

If an NOV or escalated enforcement action is issued, an operator can either sign a Consent Order, correcting the problem and paying a penalty, if applicable, or they may appeal the violation to the WVDEP Cabinet Secretary. However, OOG maintains the ability to order a well to be shut-in for cause.

The review team believes the compliance/ enforcement program implemented by the OOG is sufficient to ensure substantial compliance and has sufficient authority to compel a return to compliance in those cases where non-compliance does occur. West Virginia is unique in that field inspectors are the only staff with explicit statutory right to issue Notices of Violation. Since it would appear that a substantial portion of an inspector’s time is often devoted to writing, tracking, and resolving NOVs, the review team suggests that OOG consider whether a change allowing the Charleston central office staff, with proper legal support, to pursue violation management would let an inspector’s time be spent on more direct field duties. It is understood that this would require a change to West Virginia’s Code and Legislative Rules.

**Overall Program Findings**

The review team performed an in-depth review of the West Virginia UIC Class II program via a review of West Virginia laws and regulations, responses to a questionnaire, and a one day state interview of OOG staff and management involved in the UIC program. Information provided by the OOG prior to the state interview was of great assistance; and much of the understanding of the program was achieved during the actual in-state interview. The OOG has devoted substantial resources in recent years toward improving the UIC program through the development of standard operating procedures, a guidance manual and permit templates for Class II wells, as well as electronically fillable forms and the web based reporting forms. While much progress has been achieved, some challenges remain, including enhancements to the RBDMS data management system. The RBDMS system is now fully functional and supports the UIC program.
through modules that cover the broad range of activities included in the program. OOG currently plans to enhance this capability, to provide even greater efficiencies, which the review team fully supports.

OOG has developed a very knowledgeable and dedicated staff, and both managers and staff show great flexibility in covering a wide range of duties. The review team was impressed with the quality of staff and the manner in which the program was being implemented. The USEPA representative was also very helpful in providing a perspective on USEPA Region 3’s oversight of the West Virginia UIC program.

The suggestions and review team comments provided in this report represent opportunities to further strengthen the West Virginia Class II UIC Program. In all subject areas investigated as a part of this peer review, the OOG managed program has been found to provide the necessary elements from both a regulatory and activity standpoint to protect USDWs.

**Part I: General Administrative Overview**

**Statutory Authorities and Regulatory Jurisdictions**

Overall responsibility for West Virginia’s Oil and Gas program, including the injection of produced fluids for disposal or enhanced recovery (UIC Class II wells), has been delegated by the state legislature to the West Virginia Department of Environmental Protection (WVDEP). WVDEP administers all five well classes of UIC program, and the Office of Oil and Gas (OOG) administers the Class II and III well programs.

The OOG has authority to adopt rules and make orders as necessary to administer operations for and relating to the production of oil and gas, including UIC Class II wells. All proposed rules must be approved by the West Virginia legislature prior to adoption. The authority to administer the Class II UIC program is found in West Virginia Code Chapter 22 “Environmental Resources.” Most specific authorities are found in Article 6 of this Chapter “Office of Oil and Gas; Oil and Gas Wells; Administration; Enforcement.”, with some more general authorities contained in Article 11 “Water Pollution Control Act.”, and Article 1 “Department of Environmental Protection.” Section 2 (c) of Article 6 specifically provides the Secretary of the WVDEP with broad authorities under “powers and duties”. Most of the rules applicable to the Class II UIC program can be found in West Virginia Legislative Rules, Title 35, Series 4 “Oil and Gas Wells and Other Wells” and Title 47, Series 13 “Underground Injection Control”. 47CSR 13 became effective June 1, 2002. 35-4 was most recently updated on April 15, 2010.
The USEPA granted West Virginia primary enforcement authority (primacy) for permitting and regulating UIC Class II injection under Section 1425 of the Safe Drinking Water Act (SDWA) in 1984. This authority covers all lands of the state except those that are designated as Indian lands where the authority remains with USEPA Region 3. At this time there are no federally recognized tribes in West Virginia. At the time of this peer review, the OOG regulated a total of 59 Class IID wells, including 14 commercial wells, and 461 Class IIR wells.

**Administration, Staffing and Funding**

OOG funds the UIC program using both USEPA and state funds. The Class II portion of Fiscal Year 2017 USEPA UIC grant was $80,283, for which OOG provided a 25% state match of $20,071. The 2017 UIC budget was $223,117, which required the state to provide approximately 64% of the funds needed to run the UIC program. To date, OOG has been able to cover these costs primarily through a variety of fees which are assessed on well operators and are deposited into the oil and gas operating account. These fees include $500 for filing a UIC well application, a $400 well work permit fee and annual fee for each permitted well of $25 for salt water disposal wells and $10 for enhanced recovery wells, and an annual ground water fee of $75 for salt water disposal wells and $50 for enhanced recovery wells. West Virginia does levy an oil and gas production severance tax, but OOG does not receive any of these funds. At present, only a small amount of general revenue funds are provided.

Currently, 4.2 work years within the OOG are devoted to the UIC program. This includes 1.15 work years by 5 managers/supervisors, 2.2 work years by 4 permit staff and 0.85 work years by 17 inspection staff. Well violations are primarily identified by the field inspectors and they are responsible for resolving the violations through enforcement actions. Field inspectors are assigned specific counties and they are provided with yearly training. There has been a significant amount of turnover within the field staff and many of the inspectors are fairly recent hires.

There are currently some significant vacancies within OOG. The Assistant Chief of OOG for Inspection and Enforcement recently retired and the Assistant Chief for Permitting was due to retire about a month after our visit. These two positions are responsible for all the staff involved in UIC activities. In addition, a Geologist position is vacant in the group that handles UIC permitting. Since this is one of five staff positions responsible for all UIC activities performed in the Charleston central office, it is important to the operation of the UIC program. While it appears that actions will be taken to fill the
management positions, at this time approval has not been received to fill the geologist position.

Funding levels available to USEPA for the UIC program have been essentially unchanged for the past 25 years; as a result, states have had to assume increasingly greater amounts of the total cost of running the UIC program. This is the case in West Virginia, where the USEPA grant and required match would only be sufficient to fund one Environmental Resources Analyst position and one-third of an Inspector position. Since 5 other central office positions and many inspectors within OOG work directly with the UIC program, continued extra state support is essential to allow OOG to accomplish routine regulatory functions such as inspections, compliance verifications, witnessing mechanical integrity tests, and data entry. Relying solely on the USEPA grant and required match would also make it difficult to adequately perform thorough permit application reviews, and necessary monitoring and compliance actions. With the possibility of USEPA budget cuts, as well as state financial difficulties, maintaining the level of funding needed to continue an effective UIC program may be a challenge.

Data Management Program

On August 1, 2016, OOG began implementation of the Risk Based Data Management System (RBDMS). Through RBDMS, UIC data can be fully integrated with oil and gas data. Once fully implemented, data stored can include owner registration, applications, financial assurance, insurance, permitting, inspections, well construction, testing, logs, enforcement and compliance. Direct upload of the data from the operator to the database can save on data entry costs allowing a state to devote more time to monitoring the data. At this time, OOG has implemented the Phase 1 RBDMS system which includes modules which fully support all UIC activities, with plans to provide further modules to provide even greater efficiencies.

Phase 1 RBDMS modules allow for complete management of entities, financial security, wells, permitting (including UIC), inspections, incidents and compliance. OOG is currently proceeding with efforts to improve the ability of RBDMS to communicate with the agency’s legacy database for certain aspects of entity management. Several more enhancements are planned including a compliance calendar, eForms to provide for electronic reporting and data reporting by operators, mobile Inspection to allow for tablet-based inspection and interfacing with the database, RBDMS Environmental for analytical data storage and analysis, and a Wellbore Visualizer. It is recognized that the completion of all of these enhancements will take a major commitment of resources.

While the Phase 1 RBDMS system provides the ability to track all elements of the UIC
program, the compliance calendar was conceptualized by OOG staff as a means for automatic notification of any time-sensitive milestones. This requested feature will be tied to specific fields, such as date events, that can be viewed much in the same way MS Outlook stores meetings or appointments. The calendar, once developed, will make an immediate impact on OOG’s ability to identify permit expirations, open compliances, or lapsed MITs.

Previous to the adoption of RBDMS, OOG utilized the Environmental Resource Information System (ERIS), which had been in operation since the early 1990’s. While this system did not provide all the tools that RBDMS can, it allowed tracking of various field related activities by downloading the monthly UIC injection reporting forms (WR-40) which operators submit to the state through an electronic portal (ESS). While RBDMS has the same capabilities, the connection to ESS has not yet been established. In the interim, tracking must be done manually which has made the task significantly more difficult.

**Interagency Coordination**

West Virginia has received primacy for Classes I through V of the UIC program. The Division of Water and Waste Management (DWWM) is the official contact with USEPA. As such, they administer the annual UIC grant. Since OOG administers the Class II and Class III portions of the UIC program, they have entered into a Memorandum of Understanding (MOU) with DWWM, which includes all necessary coordination with respect to the USEPA grant and grant requirements.

An agency that has worked very closely with OOG is the West Virginia Geological and Economic Survey (WVGES). The WVGES serves as West Virginia's center for geology, energy resources, industrial minerals, geologic hazards, ground water, and topographic and geologic maps. OOG sends WVGES a complete copy of each permit application, which WVGES carefully reviews with emphasis on potential seismic risks. These reviews have been very helpful in proactively assuring that all reasonable precautions are taken to avoid seismic events due to injection activity. WVGES also provides assistance in determining USDW locations and depths through their extensive aquifer mapping. While an old MOU with WVGES is thought to exist, it is likely quite dated and would benefit from being updated to reflect the expanded level of coordination between the two agencies.

OOG has entered into a MOU with the West Virginia Oil and Gas Conservation Commission (WVOGCC). The WVOGCC is an independent body consisting of 5 members; a professional engineer, an oil and gas industry representative, and a public
member are appointed by the Governor; and the Chief of OOG and the representative of the Secretary of the WVDEP serve as ex-officio members. The WVOGCC regulates the drilling of deep wells in West Virginia. They approve drilling permits and conduct hearings on matters relating to the exploration for or production of oil and gas from deep wells. Hearings are held to determine the spacing of wells and to pool the interests of royalty owners and operators of a drilling unit. A deep well is defined as any well, other than a shallow well or coalbed methane well, drilled to a formation below the top of the uppermost member of the Onondaga Group, which is the largest confining zone in West Virginia. A shallow well by definition may extend no more than 100 feet into the Onondaga. The principal impact that the WVOGCC has on the UIC program is in unitization of the field boundaries.

OOG has always enjoyed an excellent relationship with the USEPA. In addition, OOG has also been an active member of national organizations involved with groundwater protection and the oil and gas industry. These include GWPC and the IOGCC. Through these organizations, OOG has interacted with state agencies from across the country, USEPA Headquarters and Regional offices, environmental organizations and industry groups. This has led to a productive exchange of experiences and approaches, which has been helpful to OOG in building and refining their UIC program.

**Changes in Program Activities since Primacy**

The OOG UIC program has continued to operate effectively since primacy was approved, with only minor rule changes. However, in 2013 the OOG initiated an internal review of their UIC program. This review included all UIC and ground water regulations and policies at both the State and Federal levels. Based on this review, a number of actions were initiated, some of which are still being developed. These included preparing guidance manual and permit templates for Class II (and Class III) wells, and electronically fillable forms and web based WR-40 monthly reporting forms, which are now electronically submitted by operators.

One of the most significant decisions reached was the agreement to develop detailed SOPs for nearly every facet of the UIC program. One of the first SOPs developed was the Permit Review SOP. This SOP provides 43 pages of detailed procedures to be followed when reviewing a permit application and assures that all factors that might affect the protection of ground water supplies are properly evaluated. It also ensures consistency of reviews and provides valuable training for new staff. At least a dozen additional SOPs are currently being developed covering everything from well and permit transfers to document retention. Completion of the inspection SOP is considered a priority as is the RBDMS SOP, as OOG works toward development of a compliance calendar to enhance
tracking of field activities. The largest impediment to completion of the various SOPs is the availability of staff to prepare them, given their other day-to-day duties.

On August 1, 2016, OOG began implementation of the RBDMS data management system, which is now fully functional and supports all UIC activities. The OOG UIC program is currently in the process of migrating UIC paper files to this system. Among future priorities are the implementation of electronic permitting and the use of inspection forms which can be electronically submitted. Both of these actions are dependent on the development of the appropriate RBDMS applications.

**Identified Strengths**

1) The West Virginia UIC program has been effectively administered by OOG since primacy was granted in 1984.

2) The intensive review of the entire UIC program initiated in 2013 by OOG has substantially strengthened the West Virginia Class II program. This includes developing SOPs, creating new forms and guidance documents, such as the UIC Permit Application and Guidance package, and adopting the RBDMS data management system.

3) The Class II program staff is knowledgeable and experienced and demonstrates a high degree of technical competency. They have benefitted from the many years of relevant experience provided by OOG management.

4) The UIC Permit Review SOP is a very valuable tool in assuring high quality reviews of permit applications, as well as serving as an invaluable training aid for newer staff.

5) The OOG has an excellent working relationship with other divisions/agencies, such as DWWM and WVGES. An example is the working relationship between WVGES and WVDEP wherein WVGES provides technical expertise/support through analysis of seismic events, faults, aquifers, etc., related to oil and gas and UIC program activities. In addition, the WVGES currently supports maintenance of fault and Underground Source of Drinking Water (USDW) maps and monitoring seismic activity within the state, which significantly assist OOG’s Class II program.

6) The adoption of the RBDMS data management system by OOG demonstrates a commitment to increasing the efficiency of program operations.

**Review Suggestions**

1) With the retirement of the Assistant Chief for Permitting of OOG about a month after our review, both Assistant Chief positions will be vacant since the Assistant Chief for Inspections and Enforcement had already retired. These positions are critical to the day-to-day operation of the Class II program and need to be filled as soon as possible. In addition, a key Geologist position in the Permit group is also vacant and we urge that it be filled as well in order to help address the high volume of work in that group.
2) The review team suggests increasing the effort to complete the various SOPs which are currently being worked on, especially the one covering inspection activity. While this would require time and effort in the short run, complete and up-to-date SOPs will bring substantial benefits in the long term by standardizing operations and serving as a key element of the training program for new staff.

3) Modern database systems are important tools for allowing state oil and gas regulators to do more work with fewer people, monitor compliance, and track enforcement. OOG has recently adopted the RBDMS data management system, which has allowed the agency to make substantial progress in meeting these goals. OOG is currently proceeding with efforts to improve the ability of RBDMS to communicate with the agency’s legacy database for certain aspects of entity management. Several more enhancements are planned including a compliance calendar to provide for automatic notification of any time-sensitive milestones, eForms to provide for electronic reporting and data reporting by operators, mobile Inspection to allow for tablet-based inspection and interfacing with the database, RBDMS Environmental for analytical data storage and analysis, and a Wellbore Visualizer.

The review team urges OOG to place a high priority on developing these enhancements as quickly as possible, in order to allow the UIC program to further streamline operations by taking advantage of the additional savings that RBDMS can offer. We believe that the proposed compliance calendar could be an especially valuable tool in this effort. We recognize that such an effort would require additional resources to complete in the short term. Use of a RBDMS implementation spreadsheet to track actions that are completed, in progress and projected could be valuable in helping set goals and milestones.

4) OOG may wish to consider seeking authority to increase the various fees used to support the operating budget to provide more long term stability to the program. Alternatively, other funding sources such as a per barrel disposal fee, as used by other oil and gas producing states, could be considered.

5) Important areas of informal policy, such as requiring cement above an injection zone up to the packer, should be more formalized either through official policy or regulation.

6) The review team suggests addressing areas of potential confusion in the regulations such as “fresh water zones” and “economically and feasibly recovered” which have been interpreted to mean the same as USDWs.
7) Since the MOU with the WVGES appears dated and not readily available, it might be useful to update it in view of the significant role that WVGES currently plays in support of OOG’s UIC program.
Part II Permitting and File Review

Permit/Compliance Review

Permit applications are submitted to the OOG by US mail, Federal Express, UPS, or by email. Staff is available to assist applicants with the requirements of an application. Detailed instructions for completing the application may also be found in the Underground Injection Control (UIC) Permit Application Package Class 2 & 3 which is posted on the OOG web site. A convenience checklist is also provided with each application package.

West Virginia Legislative Rule 47CSR13 requires that permits be reissued or renewed every 5 years. A reissued permit requires a complete new application with any updates since the previous permit. Criteria for a reissued permit are exactly the same as for a new application. A renewal application must be filed a minimum of 180 days prior to expiration of the existing permit for existing operations to continue until the permit is reissued or denied. OOG tries to send a notice to operators 1 year in advance of a permit’s expiration and does notify operators when they are approaching the 180 day limit. While the OOG does excellent work in renewing permits and reviewing well files every 5 years, having operators re-file a permit application every 5 years is not a common practice among other states and places an additional burden on both state staff and operators. Maintaining a thorough 5 year file review without the re-permitting requirement would likely reduce this burden.

Over the past several years OOG has been receiving approximately 12 applications per year with 10 applications being renewals and 2 being new permits. Currently West Virginia has 461 Class IIR wells in 17 fields and 59 Class IID wells, of which 14 are commercial. There was a backlog of unissued permits in 2014 that is nearly resolved.

West Virginia does not grant UIC area permits for Class IID wells. Enhanced recovery fields receive area permits.

Upon receipt of an application, administrative staff logs the application and date stamps each page. The application is then forwarded to an Environmental Resource Specialist for an administrative review and completeness check.

For an application to be considered administratively complete, it must contain all UIC application forms and corresponding attachments. In addition, the applicant must be registered with the West Virginia Secretary of State and must be registered with the OOG. The applicant will be reviewed to ensure an appropriate bond exists, that permit fees have been submitted, and a determination will be made as to whether any
violations exist at the wellsite if the permit is already in existence. If the violations are not abated, or the bonding and fee conditions are not met, the permit application can be denied.

When a UIC permit application is found to be incomplete, the Operator/Permittee is contacted and given an opportunity to submit or correct the deficiencies. The Operator/Permittee is given 15-30 days, depending on the nature of the deficiencies, to respond. Extensions can be requested and subsequently granted if the deficiencies can't be corrected within the allotted timeframe. The Operator/Permittee can be notified by any means of communication, but an official Notice of Deficiency letter or Permit Denial letter is mailed by certified mail. Minor corrections are usually made via telephone or email.

Complete UIC applications are forwarded to a permit reviewer/writer for processing. In addition, a complete copy of the application is sent to the West Virginia Geological and Economic Survey (WVGES) for an additional review and comment.

The WVGES provides technical expertise and support to the OOG by reviewing the UIC applications for potential induced seismicity issues, faulting, and by reviewing ground water aquifers relative to the location of the UIC application. The WVGES is the primary source for monitoring seismic events in the state and creating and updating ground water aquifer maps. The WVGES cannot deny a permit on their authority but may make a recommendation to deny a permit. They inform and issue an opinion with a focus on seismic and faulting issues. The OOG has an excellent working relationship with WVGES and other state agencies.

After the WVGES reviews, the application process continues with a technical review by an Environmental Resources Analyst (ERA) who is the person responsible for coordinating the permit review and writing the permit.

The ERA may conduct the technical review in association with an OOG Geologist or Program manager. In addition to WVGES input, specific consultations for technical or administrative issues can include various OOG staff including members of the UIC, permitting and enforcement staffs, the WVDEP Office of Legal Services staff, and/or outside agencies such as the USEPA. A detailed SOP titled Reviewing a Class II and Class III UIC Permit (Technical Review SOP) has been developed to further ensure completeness and to further ensure an adequate evaluation of each permit application is conducted prior to issuance. The Technical Review SOP has not yet been finalized but is near completion and full implementation. The GWPC review team supports having the Technical Review SOP being completed and fully implemented.
The permit application review process includes an on-site review conducted by personnel from the central office and/or by a field inspector. The on-site review typically consists of reviewing the casing and cementing program, monitoring gauges, facility schematic, ground water protection plan, and overall well site conditions. Physically the team inspects a variety of items including; wellhead, wellhead gauges casing, tubing, and packer arrangements; pipelines and facility components and equipment; site conditions, access, security (for commercial disposal wells), and secondary containment. If there are no water wells within the Area of Review but the well is located adjacent to a stream, sampling locations are determined with the intent of establishing background environmental conditions.

OOG uses an MS Excel spreadsheet to track the UIC permit applications and Condition of Approvals (COAs) attached to existing permits. The spreadsheet is saved on a shared drive that all staff can access and review. OOG uses a checklist feature of the RBDMS to track the permit application review process and progress. Historically the tracking spreadsheet and hardcopy of the permit application review checklist in the Application and Guidance Package were used.

ApplicationXtender (AX) is the agency’s electronic document management system. Approved active UIC injection permits are housed electronically in this system. Paper copies of permit applications are housed in the OOG file room. Working copies of permits in-process are kept on a shared drive.

While the current Phase I RBDMS system supports all program functions, the OOG is planning RBDMS enhancements to utilize built-in components like the activity review feature to track permit application progress. A compliance calendar is planned which will provide alerts that a task or an event is pending an outcome.

No designated time frame exists for OOG to issue or deny a permit application. The objective is to issue a permit is 180 days. However, the OOG internal goal is to issue permits in a “timely manner” thus the interest in tracking or monitoring the progress of a UIC permit application through RBDMS. Contributing factors to lengthy permit review periods are that some UIC applications are 700-800 pages long and public comment periods are 30 days.

Permits may be denied based on geologic or engineering reasons and/or if an operator is in violation. However, a violation or history of violations is seldom used as a basis to deny a permit. Common reasons for denial of a permit application include:

- where groundwater is not protected based on hydrology and geology;
• where there are technical questions regarding the well design for new wells or construction of existing wells to be converted to injection; or
• if there might be communication with productions wells (i.e. infringement of mineral rights).

OOG openly communicates with UIC applicants during the permit review process to better understand and resolve issues if possible. While most denials are due to technical reasons, inadequate bonding is another common reason for denial of a UIC permit.

Although permit decisions are appealable, any issues are usually worked out in advance. Challenges would be handled by the Environmental Quality Board (EQB) under the Administrative Procedures Act. The EQB is a quasi-judicial group. Among their many duties, the EQB hears appeals of OOG UIC permitting decisions. Historically, appeals referred to the EQB are rare.

Applications that are voided or denied are maintained as part of the permanent record through RBDMS and the operator receives either a Permit Denial or Permit Application Returned letter via certified mail. Upon request the operator can ask to have the application hardcopy returned. OOG does not retain the hardcopies, only the electronic version.

Permit applications must also include a Ground Water Protection Plan (GPP). Elements of the GPP include a characterization of groundwater quality, process operations and equipment usage, training (including spill reporting procedures), and inspection frequencies. The GPP is consistent with other states’ requirements for surface facility construction and operations.

Procedures to amend or modify an existing UIC permit fall into two categories, minor and major modifications. Minor modifications to an active permit only require that the request be submitted in writing. A written approval of the requested minor modification may then follow. Major modifications require full public participation including a public notice and a thirty day comment period. A major modification requires the same process as with a new permit including a draft permit and public notice; however, only the modification is subject to review and public participation. Legislative Rules define what modifications are considered a minor modification. All other modifications not referred to are subsequently classified as a major modification.

Legislative Rule 47CSR13 defines a minor modification as:
• Correct typographical errors;
• Require more frequent monitoring or reporting by the permittee;
• Change an interim compliance date in a schedule of compliance, provided the new date is not more than one hundred-twenty (120) days after the date specified in the existing permit and does not interfere with attainment of the final compliance date requirement;
• Allow for a change in ownership or operational control of a facility where the Director determines that no other change in the permit is necessary, provided that a written agreement containing a specific date for transfer of permit responsibility, coverage, and liability between the current and new permittees has been submitted to the Director; or
• Allow for a change in ownership or operational control of a facility where the Director determines that no other change in the permit is necessary, provided that a written agreement containing a specific date for transfer of permit responsibility, coverage, and liability between the current and new permittees has been submitted to the Director; or
• Change quantities or types of fluids injected which are within the capacity of the facility as permitted, and in the judgment of the Director would not interfere with the operation of the facility or its ability to meet conditions prescribed in the permit, and would not change its classification;
• Changes in construction plans during construction may be approved by the Director as minor modification. No such changes may be physically incorporated into construction of the well prior to approval of the modification by the Director; or
• Amend a plugging and abandonment plan

In general, operators prefer to renew existing injection permits instead of drilling new wells. Converting depleted production wells for Class II injection is preferred to drilling new wells. The same process for issuing new permits is used for converting existing production wells, with the same requirements as for newly drilled wells. In conversion permits, OOG uses COAs to ensure that injected fluids stay in the injection zone, that oil and/or gas from production zones does not migrate through the wellbore, and that groundwater doesn’t migrate out of zone along the wellbore or get contaminated.

Conversions may need additional remedial work prior to commencement of injection operations. Surface casing must be cemented to surface or evidence of integrity must be provided. For conversions where cement coverage across the producing zone is required, but is lacking, remedial action is required. There is an argument that
perforating and squeezing compromises intact casing and degradation of the cement in
the squeeze perforations may result in future leakage (water, oil, or gas) from one layer
to another and that therefore other techniques that don’t compromise the existing
casing are preferable. Additional protection to a casing could include addition of a liner
or internal casing patch. In some cases, monitoring of the appropriate annulus may be
more protective in that it indicates an actual problem as opposed to masking one if
leaks occur.

There are 14 commercial brine disposal wells in West Virginia. While OOG does not
have a different process for processing commercial disposal wells, such wells have
specific permit conditions which would not apply to non-commercial wells. Commercial
wells are required to have higher levels of security including gates, fencing, security
cameras, and locks on valves etc. These measures were implemented to prevent
disposal of non-Class II waste and non-approved brines in Class II wells. Third party
haulers may be used but the haulers must be approved by OOG and shipping manifest
documentation is required. Wells are sampled every 5 years and additional sampling
may be requested by OOG as part of the permit. Some wells are sampled monthly.

Since 1984 when West Virginia received primacy for Class II injection wells from
the USEPA, the State has been working to reduce the number of grandfathered
enhanced oil recovery wells permitted without a downhole packer and tubing
system. Originally there were approximately 400 such enhanced recovery wells.
As these wells have come up for renewal, the number has been reduced to about
120 wells; however, it has not always been a strictly enforced requirement since
West Virginia does not have a rule requiring the use of a tubing and packer system.
It may benefit OOG program goals to set a specific time frame to completely phase
out these wells without a tubing and packer arrangement.

**Technical Aspects of the Review Process**

The technical aspects of the UIC permit review process include identifying the depth of
the deepest USDW, evaluating well construction, reviewing the operating parameters,
and assessing induced seismicity considerations.

In order to identify and ultimately ensure isolation of USDWs, OOG determines the
depth of the deepest USDW at a specific location by reviewing a combination of
available records, logs, and ground water aquifer maps. The WVGES creates, updates,
and maintains the maps regarding aquifer/USDW which are available on the web. The
West Virginia Department of Health and Human Resources collects and maintains depth
and quality data for municipal water wells and the County Health Departments collect and maintain data for residential water wells. However, County records may only contain a street or Post Office Box address for the water well owner. Maps may also be available from the USEPA and/or the US Geological Survey.

In the event a map of the locale is not available, the OOG relies upon records and logs to evaluate USDW depth. The permittee is required to submit available logs with the permit application and the depth and name of all formations should be indicated on each log. The water resistivity calculations and TDS conversion factors should also be provided. In addition, location data of water wells is sometimes available from field inspectors since they carry GPS units with them when visiting sites. The OOG retains the final decision authority on USDW depths based upon a review of all factors, and any available information is shared with operators and potential permittees.

West Virginia currently does not have an electronic statewide database for documenting water wells and water well locations. If such a database were available, it would aid OOG in making USDW determinations, as well as assisting other programs within the state, and assure a more consistent protection of groundwater supplies.

The OOG requires pre-drill sampling of all domestic water wells located within 1000’ of the proposed well as part of a well work permit application. The OOG also requires sampling of water wells within ¼ mile of the EOR field boundary. This is commendable and a strong point of program and it provides further support to required investigations under area of review criteria. An applicant is required to submit a laboratory analysis of the water wells within the AOR that have the following parameters: pH, Chloride, Iron, Total Dissolved Solids (TDS), and Detergents (MBAS). OOG can also require further analysis as needed.

The sampling of water wells is also required for UIC permit renewals, which are required every 5 years. This sampling requirement for renewals may present an additional burden on operators and OOG may wish to consider a review of this rule/policy to determine whether it should be applied in all cases. As previously noted, criteria for permit renewals is the same as that required for new permits including an entire application and a new public notice, and must be submitted 180 days in advance of the expiration of the existing permit. Temporary orders to allow continued injection in the absence of a renewal can be issued. Notices are sent to operators as a reminder and it is presumed that RBDMS will assist with these notices.
If no water wells exist within the AOR, the applicant must still provide adequate water analysis of wells or streams in the vicinity of the proposed well or facility that will accurately describe the water quality.

No post drilling sampling is required but the OOG can request sampling on its own initiative. In the event a water well owner refuses to allow sampling, the refusal is documented.

As part of a permit application, electric logging is required of new wells to identify aquifers, coal beds, and oil and gas zones. Required electric logs include gamma ray, caliper, and cement bond logs. Resistivity logs are not required but are commonly requested. OOG witnesses drilling of new injection wells to assure that the proposed well construction of the permit is actually carried out and that aquifers, USDWs, and hydrocarbon bearing zones are therefore isolated.

Prior to an injection application being approved, OOG Field Inspectors review the casing and cementing plan. The permit reviewer/writer then reviews the casing and cementing plan prior to issuing the Well Work Permit which allows construction of the well. The Well Work Permit does not authorize injection. That is done via an injection permit.

Legislative rule 35CSR4-11.3 requires that casing be set a minimum of 30 feet below the deepest freshwater horizon. In identifying the deepest freshwater horizon, criteria used include will the horizon replenish itself and can useable water for domestic, industrial, agricultural, or public use be economically or feasibly extracted. While this does not match the definition of a USDW, OOG does not accept protection less than that provided by the USDW definition. This has been considered effective in that no known instances of contamination have occurred because of this 30-foot minimum. Cement is required to be circulated to the surface in the casing/formation annulus of the surface/coal protection string.

In general, the OOG does not allow a variance from the surface casing cement depth and associated top of cement requirement as above. However, if multiple casings are planned to protect multiple USDWs at different depths, then the set depth top of cement criteria may be modified.

West Virginia regulations allow for dual completion wells. Dual completions include wells with multiple injection zones, an injection zone and a production zone, or multiple injection zones and a production zone. At the time of this review, there were very few permitted dual completion wells in the state.
The maximum surface injection pressure is generally determined by subtracting the hydrostatic head from the bottom-hole pressure. OOG considers the regional fracture gradient to be 1.0 psi/ft. They use a fracture gradient of 0.8 psi/ft. as a safety factor. In some cases a step rate test or initial shut in pressure have been used to calculate a maximum injection pressure, especially when an operator requests a modification to the calculated maximum injection pressure. In these cases, the maximum injection pressure allowed is 90% of the parting pressure determined by the test. The injection formation is not allowed to be fractured by Class II injection operations. OOG also has the authority to decrease permitted injection pressure at any time.

An applicant is also required to submit an analysis characterizing the fluids that will be injected into the proposed UIC well. At a minimum, the injection fluid is to be tested for the following: Total Petroleum Hydrocarbons (DRO, GRO, ORO), BTEX, pH, Aluminum, Arsenic, Barium, Calcium, Chloride, Iron, Manganese, Sodium, Total Dissolved Solids (TDS), Total Suspended Solids (TSS), Total Organic Carbon (TOC), Sulfate, Detergents (MBAS), Dissolved Methane, Dissolved Ethane, Dissolved Butane, Dissolved Propane, Bacteria (total coli form), Radiation (NORM), and specific gravity. In addition, the applicant is required to submit a description of all fluid additives including concentrations and MSDS sheets.

**Area of Review (AOR) Consideration and Procedures**

By Legislative Rule 47CSR13-5, a fixed radius minimum of a ¼ mile AOR is required for all disposal wells (commercial and private) as well as enhanced recovery project wells. Alternatively, the applicant may calculate ZEI (Zone of Endangering Influence) as a method to define the AOR. The ZEI method has determined that relatively few applications have required an AOR of greater than ¼ mile. The OOG has in practice required the greater distance in these instances to be the AOR. In addition, OOG utilizes the Prescone Plume Model, a tool developed by USEPA Region 3 that OOG utilizes to verify the adequacy of AOR. The OOG UIC Permit Reviewer is responsible for completing the model and OOG may require an AOR greater than ¼ mile or reduce the injection volume based on this calculation.

Area permits may be approved for EOR wells considering those wells have a common geological formation and are within the same general location. Individual UIC permits for EOR may also be approved and are required for all disposal wells. For area permits issued for Enhanced Recovery Projects, the AOR is a standard ¼-mile radius around the field. ZEI or Prescone calculations are inappropriate for enhanced recovery situations because both injection (fluid in) and production (fluid out) occur simultaneously.
West Virginia requires that wells be plugged so that fluid migration of oil, gas, or water is prevented. Specific attention is paid to wells plugged and abandoned within the AOR. The adequacy of a well plugging for wells that penetrate the injection zone within the AOR is determined by a review of the well completion report and plugging affidavit(s). General criteria for plugging wells include the separation of all production zones, the setting of cement plugs between oil, gas, and water bearing formations, the removal of all recoverable casing, and a minimum of 100 feet of cement at the surface casing shoe and at the surface. Specific plugging requirements can be found in West Virginia Code §22-6-24 and Legislative Rule 35CSR4-14.

An Operator/Permittees application is not necessarily denied if they cannot obtain permission to effect corrective action to wells in the AOR that need correction. If OOG determines that corrective actions are required for a well or wells they issue a Notice of Deficiency (NOD) letter. The Operator/Permittee must then respond with a Corrective Action Plan. If the Operator/Permittee cannot secure the right to perform the actions in their Corrective Action Plan then the Operator/Permittee may receive their permit with a Condition of Approval that does not give them permission to inject until the issues in the Corrective Action Plan have been addressed.

OOG tries to resolve situations where one operator needs permission from a second operator to perform a corrective action by requiring the two operators work out a cooperative solution to the problem. This policy has largely been successful for the OOG.

Any plugging or remediation activities that result from AOR requirements are captured using the regular reporting requirements for these activities in general. In rare cases where a well within an AOR requires plugging but the well cannot be properly plugged, the OOG may work with the Operator/Permittee to reduced injection pressures to a level where the unplugged well should not cause an impact. Occasionally OOG finds plugged and abandoned wells without plugging documentation. In these cases OOG verifies what it can via a field inspection, checks drilling and historical records in the area, and uses professional judgment to determine if re-plugging is necessary.

**Induced Seismicity Considerations**

In its evaluation of the permit application the OOG considers criteria such as structural features, location, depth, injection zone, injection pressure, rate, and built environment as part of the application review and permit writing process. Induced seismicity considerations are also part of the technical review process. Historically, Class II injection wells have been permitted in counties where a history of seismic activity has
occurred; however, these events have been of low magnitude. West Virginia has had no confirmed induced seismic events and no reported personal injuries or property damage. OOG includes evaluation of the potential for seismic activity in their injection well permitting process. A total of eight West Virginia counties have both injection wells and seismic activity.

West Virginia does not consider itself a seismically active state so at this time OOG believes there is little danger to the public. West Virginia has had 5 seismic events greater than 4 on the Richter scale and only 3 events since 1853. West Virginia's largest event was in 1976 and was recorded as a 4.7, and was not near any known Class II UIC activity. The only Class II injection operation that has been investigated is a Class II brine disposal well (API#: 47-007-02539) in Frametown, WV (Braxton County). In 2010 earthquakes ranging in magnitude from 2.2 to 3.4 on the Richter scale within a relatively close proximity to this well resulted in a reduction of the permitted monthly injection volume. Adjustment of monthly injection rates had suggested a connection between injection rate and seismic activity. Seismic activity declined until in January 2012 when a 2.8 magnitude event occurred. The monthly injection rate was then further reduced to half the original permitted volume. There were two more seismic events in 2013 of magnitude 3.4 and 2.2, before the well was plugged in 2014.

Injection at or near Precambrian basement is thought to increase the potential for induced seismicity. West Virginia currently has no Class II wells that penetrate the surface of the Precambrian basement, or inject fluids into a reservoir directly overlying basement rock.

Since the internal program review in 2013-2014, additional information, such as a detailed geological investigation by a knowledgeable professional is required as part of the application. The geological data includes characteristics or information describing the injection and confining zone(s) including lithological description, geological name, thickness, depth, and fracture pressure. Special attention is given to the distance between a fault and injection well, the permeability of the strata in the surrounding injection formation within the area of review, the proposed injection volume, and historic seismic event magnitudes and locations.

The OOG can require additional testing if a Class II injection well is proposed in an area where a seismic event had historically occurred or an area within relatively close proximity to a fault or other geologically significant structure. OOG may also require a more detailed assessment of reservoir properties at sites that may pose greater seismic risk (e.g. pore pressure, permeability, breakdown pressure, Instantaneous Shut-In
Pressure, lithostatic pressure, hydrostatic pressure, horizontal stress magnitudes and azimuth).

The OOG has a MOU with the WVGES whereby the WVGES reviews all Class II permits for their potential to cause induced seismicity and in cases where existing injection may have caused seismic activity to assist in any investigation. The WVGES works in an advisory capacity only. The OOG is the sole regulatory authority. Should the OOG and/or WVGES present concern about the location of a Class II injection well/facility then the Operator/Permittee would be instructed to provide additional information and/or clarification.

**Administrative Aspects of Permit Application Review**

If the OOG approves a Class II UIC permit application, a draft permit, fact sheet and public notice are all written and issued. These items along with the permit application are then posted on the WVDEP website. In addition, the public notice is provided to the operator with instruction to run the ad in a specific newspaper on a specific day. The newspaper chosen is the one with the greatest circulation within the county or area in which the well is located. The Class II UIC draft permit public notice/legal advertising requirement is that a Class I legal advertisement must be published. A Class I legal ad consists of an advertisement that must be published once with a 30 day comment period which starts upon publication.

Direct notice of a draft permit must be provided by the operator to offset operators and mineral right owners. Unlike drilling permits issued for oil and gas wells, direct notice is not required to be sent to landowners alone. Since one concern that is often raised by the public (landowners) is the increase in truck traffic, OOG may wish to consider requiring operators to also notice land owners adjacent to the permit location.

A 30 (thirty) day public comment period follows the day the advertisement is published. A hearing may be requested during the comment period. No specific standing is required for one to be allowed to submit a public comment for consideration. OOG tries to resolve problems before resorting to a formal hearing. If the Chief finds that "significant" interest has been raised then a public hearing is held at a public building near the location of the proposed Class II UIC well. The venues tend to be public schools, auditoriums, or other public buildings. “Significance” is determined at the discretion of the Chief, although the Chief may also schedule a hearing if it will help to clarify outstanding issues.
Hearing dates and times are scheduled to try and allow the greatest number of the public to attend. Hearings must be publically noticed at least 30 days in advance. Normally OOG waits for the permit public comment period to expire before scheduling a hearing but if the Chief is aware of concern a hearing announcement may be published at the same time as the permit announcement is published.

If the Chief determines that a hearing is not warranted, the commenter is notified in writing of the decision.

Public hearings are formal events. Written comments are also accepted at the hearing. A transcriptionist/court reporter collects and converts all verbal comments to a public transcript. The public comment period is extended an additional 10 days after the public hearing to ensure all attendees have an opportunity to submit a comment. As part of the hearing process, OOG staff makes themselves available for questions before and after the hearing proper. Maps, copies of the permit application, and supplemental information are available at the hearing.

OOG does not respond to comments at the hearing, however, they may ask for clarification of public comments at the hearing. Comments are answered by OOG in writing after a decision to approve or deny the permit is made. All transcripts, comments/questions, and agency responses are compiled and attached to the permit file. All commenters who request it are mailed or emailed a copy of the final approved permit with attachments or the denied permit with comment responses as appropriate.

The OOG also circulates and posts the public notice to the WVDEP List Serve, which is an electronic notice tool that emails public notices to anyone who has registered to be on the mailing list as well as posting a copy of the public notice on the WVDEP PIO (Public Information Office) website.

Emails containing the public notice and draft permit are also sent to USEPA, Federal and State and interstate agencies with jurisdiction over fish and wildlife resources, public health, the State Historic Preservation Unit of the Department of Culture and History, and other appropriate government authorities, including any affected states, and persons on the agencies mailing list including the National Park Service, WVDEP DWWM, WVDNR and US Army Corps of Engineers. While, these agencies may provide comments, as the responsible regulatory agency OOG makes the final determination to approve or reject deny a UIC permit application.

Public comments are filed by letter, fax or by email. Public comments are filed digitally in AX and a hard copy in the OOG file room. An excel spreadsheet is maintained on the
shared drive to record the name and contact information of all the public commenters. Comments can also be filed in person. The OOG has a UIC comment email address that, if utilized, will direct emails to the ERA, and the Office of Environmental Advocate, and the WVDEP PIO.

The OOG requires the financial assurance in the form of bonds either be in the form of a surety bond, collateral bond (including cash and securities), and letter of credit, establishment of an escrow account, self-bond or a combination of these methods. The method used is at the operator’s discretion, subject to OOG approval. The OOG requires Class IID wells to have a $5,000 performance well bond (as is the case for all OOG wells) and a $5,000 UIC operation bond. Only a $5,000 performance well bond is required for Class IIR wells. A $50,000 blanket performance bond can be used for Class II coverage for all of the Operator's wells enhanced recovery wells, no matter how many are owned, although a separate bond is required for each disposal well.

The performance well bond is actually a penal bond, and as such, cannot be taken to perform plugging on a specific well, and instead goes into the Oil and Gas Reclamation Fund. Plugging of abandoned wells where no responsible party can be found is done using the relatively small special reclamation fund, which is funded by permit fees and bond forfeitures. State funded plugging is reimbursed by the US Coast Guard in certain cases under the Oil Pollution Act of 1990.

Aquifer Exemptions
West Virginia allows aquifer exemptions under Legislative Rule 47 CSR13. Historically, only one request has been received and the request was denied. To date, no further aquifer exemption requests have been received and none are anticipated.

Data Management Systems Used in Permit Application Review
The transition to and implementation of RBDMS is relatively new to OOG as RBDMS replaced the ERIS database in August 2016. The OOG uses the UIC Permit module built into RBDMS database to record permit and permit review activities. The role of RBDMS during the permit review is largely limited to storing event information such as notices of deficiency, technical review approvals, and maintaining a review item checklist. RBDMS does identify wells within an "area of review" based upon distance to a subject well. The OOG is working towards further implementation of RBDMS including use of the built-in components such as the application tracking feature. A compliance calendar is planned that will provide alerts that a task or an event is pending an outcome and provide notifications, as well as assisting with alerts of upcoming
renewals. OOG also plans to use the RBDMS database to automate the populating of U.S. EPA 7520 Forms.

**Periodic File Review Process**

OOG does not have a formal file review process. However, all Class II well files do receive an intensive review as part of the 5 year permit renewal process. In addition, the well files are reviewed for relevant items whenever significant activities occur such as issuance of a NOV or running of a MIT. Approximately 25% of all Class II files receive such an activity driven review each year and any deficiencies identified are promptly addressed. Among the items which may be reviewed as part of an activity driven review are permit conditions, compliance requirements, MIT schedule, all monitoring and reporting requirements, injection history, the inspection history, violation history, correspondences, and production (or lack of production in the case of watered off wells) of surrounding active production wells in the AOR.

If OOG finds a deficiency during a file review, the operator is informally contacted and given a chance to correct the deficiency. Usually an email or letter is sent based on conversations with the operator. The letter outlines expected actions and deadlines for compliance. If the operator does not complete the actions in the requested timeframe, a Notice of Violation may be issued and the operator may be required to shut-in the well.

**Changes and Modifications to Program since Primacy**

West Virginia has had few statutory or regulatory changes in their program since primacy was granted in 1984. In 2013, the OOG conducted a UIC program review which included reviewing all UIC, State and Federal groundwater regulations as well as policies. This led to the updating of many OOG policies and procedures. SOPs were developed, a Class II and Class III UIC SOP and UIC permit templates for Class II and Class III were created, thus ensuring greater consistency. Electronically fillable forms were created as phase one, in preparation for future electronic permitting. Web based electronic monthly reports (WR-40) were established and required for permits issued after 2013. These reports can be electronically processed and evaluated when a link is established. When there is a discrepancy(s) identified through these forms, the ERA and UIC program manager are notified for further evaluation and, if necessary, enforcement actions may ensue. Additionally, the OOG UIC program is in the process of migrating UIC paper files to the AX electronic filing system.
Identified Strengths

1) The UIC application review process is well conceived and provides for a thorough analysis of all aspects of the application. The detailed UIC Permit Application Package and UIC Permit Review (draft) manuals augment the process very well.

2) The OOG requires pre-drill sampling of all domestic water wells located within 1000' of the proposed well as part of a well work permit application. The OOG also requires sampling of water wells within ¼ mile of the EOR field boundary for UIC permits. These are commendable and strong points of the program. In addition, the OOG requires water well sampling of all wells within the AOR as part of the permitting process.

3) The OOG conducts a thorough and formal site review prior to issuing a draft permit.

4) The fact that there have been very few appeals to the Environmental Quality Board demonstrates OOG’s commitment to working closely with operators to resolve issues rather than engaging in protracted legal disputes.

5) The OOG requires an analysis of injected fluids for an extensive list of parameters which could potentially be present.

6) The OOG implements and supports a very responsive public participation process.

7) By publishing the draft permit applications and fact sheets on the agency’s website, OOG provides for a more thorough evaluation of the applications by the public and other operators.

8) The Legislative rule requiring all new drilling permits, to utilize tubing and packer is commendable and appropriate.

9) OOG’s permitting process is enhanced by their excellent working relationship with the WVGES and other agencies.

10) Through the permitting process, OOG has implemented a number of measures to provide for increased security and monitoring for commercial wells, including fences, cameras, injectate sampling and approval of third party haulers.

11) The 2 step permitting process used by OOG requiring first a well work permit and then a UIC permit may cause operators to have well developed plans before filing their permit applications thus limiting the number of incomplete filings or excessive changes to submitted permits that waste time in review.

12) Except for one possible case, induced seismic activity in West Virginia is limited. OOG is aware that induced seismicity in almost all cases is associated with underground injection directly or indirectly into Precambrian basement rocks. West Virginia’s geologic column contains suitable injection zones above the Precambrian basement so the deepest injection zones are no closer than 2000 feet from Precambrian basement. To prevent injection in Precambrian rocks, OOG will
not approve permit proposals for wells designed to inject directly or indirectly into this interval.

**Review Suggestions**

1) The review team finds that five (5) year renewal of UIC permits which includes public notice may pose an unnecessary burden on both state staff and operators and may prevent staff time from being better utilized. As a solution, the OOG may want to consider amending the Rule and incorporate the same review elements of a renewal permit into the five-year file review plan. Under this approach, Public Notifications and Comments may not be needed if no major modification is intended or has occurred.

2) The transition to RBDMS has led to increased efficiency in the administration of the UIC program; however, at present it cannot yet be utilized for some permit related functions such as filing and tracking UIC permit applications. The review team recommends creating tracking software. Since available resources to complete these tasks have been a constraint, we urge that every effort be made to obtain additional resources from all sources including GWPC, USEPA and the Department of Energy.

3) Current financial responsibility instruments do not provide enough assurance that wells can be properly plugged and abandoned. OOG may want to consider increasing bond amounts, limiting the number of wells on the blanket bond and/or establishing a well plugging fund with a reliable funding mechanism to address this need.

4) The OOG may want to consider having a direct notice of draft permits provided to landowners within the AOR of a proposed well as many other states have done.

5) The review team encourages OOG to continue efforts to increase the transparency of their website. Currently, document links are available on the website, and the Application Extender document management system is also available to the public to view documents. While many documents are presently available, it would also be helpful to link map locations to the database.

6) The WVDEP may want to support the development of a statewide database for water well data in order to provide integrated statewide access to water well information. Currently this information is housed in several places; USDWs with the West Virginia Geologic and Economic Survey, municipal water wells with the
Department of Health and Human Resources, and most critically residential water wells by county health departments. In addition to the OOG UIC program, this data would be useful to many individuals and organizations within the state if it was available with modern GPS locations and distributed using a modern GIS mapping system. The OOG staff and oil and gas operators they work with would save time if water well data were available in this manner. Also, statewide data might help level the playing field in that responsible operators would not have to expend extra energy locating water well information and less responsible operators who ignore available data could be identified.

7) While recognizing that it may largely be beyond OOG’S control, the review team urges OOG to support to the extent possible efforts to develop more permanent Seismic Monitoring locations in the state, since funding for the current temporary locations cannot be guaranteed past the end of 2017. It is also important for the state to maintain the current level of seismic review and notification.

Part III Well Construction

Casing, Cementing, Tubing, and Packer Requirements

The typical construction practice for a new Class II injection well has surface casing that is set a minimum of 30 feet below the lowermost freshwater bearing zone above elevation and then cemented to surface to isolate all fresh water zones. Legislative rule 35CSR4 (11.3) requires that casing be set a minimum of 30 feet below the base of the lowermost freshwater bearing zone above elevation. Cement is then required to be circulated in the casing formation annulus to the surface. The depth minimum of 30 feet below the base of lowermost freshwater bearing zone above elevation has been considered effective in that no known instances of contamination have occurred resulting from this minimum. The OOG does not require a minimum hole size relative to the outside casing diameter. Typically, the lowest freshwater bearing zone above elevation is less than 250’ deep; however, there are certain areas in West Virginia that the lowermost freshwater bearing zone above elevation may be up to 1,000’ in depth.

Cement placed in the annular space around the casing is required to set to a minimum compressive strength of five hundred (500) pounds per square inch, using approved engineering data for the type of cement used. Cement used to fill the annular space around the casing is required to be American Petroleum
Institute Class A Ordinary Portland cement with no greater than three percent (3%) calcium chloride and no other additives; provided, that if the well operator furnishes satisfactory proof that different cement types are adequate, the Chief may approve use of such different cement types.

Production casing (injection string) is required to be cemented through the injection interval. Legislative Rule 35 CSR4-7 has been interpreted to require that cement cover the injection zone, without a specific height above being specified. The OOG requires that the cement on the production string at least cover the injection zones(s). At present, no minimum height for cement top is required above the injection zone, with the only requirement being that cement covers the injection zone.

Legislative Rule 35CSR4-7 requires a tubing and packer arrangement in all newly completed and converted Class II wells. The OOG does not allow injection directly through casing without a packer and tubing arrangement in any Class IID wells. However, there are approximately 120 Class IIR grandfathered wells that lack a tubing and packer. For these wells that do not meet current construction standards, more frequent MITs can be required, with continuous monitoring of annulus pressures and/or fluid levels, and monitoring of adjacent production wells in order to ensure that USDWs are protected. Also, only wells with cement behind the long string can continue to operate in this fashion. While OOG encourages operators of these wells to convert to a tubing and packer arrangement, current rules to not require it for these grandfathered wells.

The OOG does not allow injection through tubing with a packer set within the fresh water protection casing string. Ideally the packer is to be set no more than 100 feet above injection zone. By policy, the packer must be set inside cemented casing.

The OOG can require logs (temperature logs, noise logs, and cement bond logs) to be run to verify integrity of cement work. The OOG requires an Operator to submit all logs (driller’s logs, geophysical, cement evaluation logs and all other electric logs) that have been run. Logs are submitted in either paper or digital format and are made publicly available on the West Virginia Geological and Economic Survey web site.

**Well Construction Inspection**
The Operator/Permittee must notify the OOG inspector at least 24 hours prior to
the construction of roads, locations, pits and any permitted well work. The OOG inspector must also be given notice 24 hours prior to running and cementing casing. In the event that cement does not return to the surface on the surface casing string, the OOG inspector is to be notified within 24 hours. The OOG is to be notified no less than 24 hours prior to the commencement of an MIT.

Data Management for Well Construction Operations
The OOG requires that after well construction and/or when the wellbore integrity is evaluated, an Operator/Permittee must submit a completed WR-35 Well Construction Record, WR-37 Pre-Operation Certification for MITs, and all logs (drillers’ logs geophysical, cement evaluation logs and all other electric logs). The OOG tries to witness casing and cementing operations whenever possible and estimates that approximately 60% are witnessed.

The WR-37 Pre-Operation Certification for MITs includes information or data identifying the formation zone by name, top and bottom of zone, perforations or open hole data, MIP, max injection rate, fluids injected, corrosion control measures, and certification that the mechanical integrity of the well has been tested and by what method.

Logs can be stored in electronic or hard copy format. Generally, logs are submitted in hard copy, but electronic copies can be submitted. Well logs are forwarded to WVGES to be scanned and made publicly available on their website.

The current version of RBDMS being utilized by OOG does not include a module to generate wellbore schematics based on construction information, although a wellbore visualizer is included in future RBDMS enhancements. The previous OOG database did not allow for the entry of completion data. Therefore, there are no data records upon which to base a schematic.

OOG intends to implement an e-submission system to allow operators or permittees to enter completion data into RBDMS. Operators are required to file proposed wellbore diagrams with the application, but not for as-built construction. It is recommended that the OOG require as-built diagrams to be submitted.

MIT Procedures and Exceptions
For Part 1 of demonstrating mechanical integrity, standard annular pressure tests are required for all new UIC constructed wells prior to commencement of injection operations. Thereafter, a MIT is required once every five years from the last test
date. If a well is modified by replacing the tubing and packer, a new MIT is required and the five year clock is restarted. A satisfactory test requires test pressures at 1 ½ times the maximum injection pressure with a bleed off of not more than 5% over a 20-minute interval. For Part 2 of demonstrating mechanical integrity, noise and temperature logs, and a CBL may be required at the discretion of the OOG. The OOG places a priority on the witnessing of MITs: in practice nearly 100% are witnessed.

As previously noted in this report, the WR-37 Pre-Operation Certification for MITs includes information or data identifying the formation zone by name, top and bottom of zone, perforations or open hole data, MIP, max injection rate, fluids injected, corrosion control measures, and certification that the mechanical integrity of the well has been tested and by what method.

There are some Class II injection wells with multiple zones completed. Most of the dual completions are multiple injection zones, but a few exist that are completed in a producing and injection formation. More frequent MITs are required for wells with multiple completions. For dual/multiple completion wells, the water/oil ratio method and/or annulus monitoring may be required. Radioactive tracer surveys can also be run.

For the Class IIR wells without a tubing and packer system, a MIT is required to demonstrate Part 1 of mechanical integrity at least every five years, but may be required more frequently. In addition, more frequent annulus monitoring can be required. As these wells have become due for a MIT, the operator has been notified that installation of a tubing and packer arrangement is strongly recommended and would both provide better assurance of continued mechanical integrity as well as potentially providing a long term cost saving to the operator.

Tracking and scheduling of a MIT is currently done utilizing RBDMS. Following a successful MIT, staff will send an authorization to inject letter to the operator.

**Identified Strengths**

1) The OOG is working to encourage the elimination of grandfathered enhanced recovery wells without tubing and packer through the 5 year permit renewal process.

2) Converted wells are held to the same construction standards as newly permitted wells.
3) The OOG requires that surface casing extend at least 30 feet below the deepest freshwater bearing zone above elevation and that it be cemented to the surface.

4) The OOG places a high priority on witnessing MITs and estimates that nearly 100% are witnessed.

5) The OOG carefully reviews MIT reports involving both field supervisory and central office staff.

**Review Suggestions**

1) The review team finds that the legacy issue of allowing injection without a tubing and packer system creates potential risks to USDWs. Given that this issue is limited to approximately 120 injection wells utilized for secondary recovery, it is unlikely that this practice has resulted in any USDW contamination, especially since OOG has taken steps to protect USDWs by only allowing wells cemented behind the long string and also requiring more frequent MITs. Although OOG encourages operators through the 5 year file review process to phase out the practice for these wells, the review team suggests setting a date certain to end this practice. We recognize that this would likely require a rule change.

2) The review team finds that the informal policy or convention of requiring the cement top to exceed “cover the injection zone” should be formalized to require the cement top to cover the injection zone at least up to packer depth. This would include providing more clarity to the rule.

3) The OOG may want to consider requiring as-built well bore diagrams to be submitted inclusive of stratigraphy, USDWs, perforations, bridge plugs, squeezes, and abandoned zones.

4) The OOG may want to codify current policy of requiring a packer to be set no more than 100 feet above the injection zone by placing it into a rule. Further, the rule should state that packers must be set inside of cemented casing.

5) The OOG may want to consider allowing injection into horizontal wells to take advantage of formation capacity at lower injection pressures thus reducing the risk of USDW contamination.
Part IV: Inspections

Management of Inspections
Inspections are managed by field inspectors out of their homes. Some SOPs for routine well inspections have been created but more are yet to be developed. A draft SOP for inspection of UIC wells has been written and is currently (as of the week of the review) undergoing testing. Charleston UIC Staff coordinate with field inspectors and field inspection supervisors as needed, including determining the frequency of wellsite inspections, and field inspection supervisors periodically accompany field inspectors on field assignments. Communication between field inspectors and UIC staff responsible for permit review in Charleston is done via email, telephone, or in person.

There are 461 Class IIR wells in West Virginia and 59 Class IID wells. There are 21 field inspectors when all positions are filled. On average, each inspector is responsible for about 32 injection wells. There are currently 17 field inspectors with UIC duties, and the actual number of injection wells varies depending on the geographic area assigned to each inspector. All field inspectors and inspector supervisors perform all types of inspections.

Inspection reports consist of a combination of check boxes and text fields. UIC Inspection reports are reviewed by the Inspector’s Supervisor and the Environmental Resources Specialist for the UIC program in Charleston before being placed in the well file. These reports are currently entered into RBDMS and saved as scanned images.

Inspectors receive annual Well Control, Hazmat, and H2S training. They also receive training during semi-annual staff meetings and on the job. New regulations and industry techniques are conveyed to Field Inspectors by their Supervisors and Charleston Office Staff as needed. Nearly all current inspectors have undergone USEPA UIC Inspector training. Currently none of the OOG inspectors have taken the IOGCC Inspector Certification course, but OOG will look into sending representatives to take the course and get the certification.

Operator compliance history and selection of wells for inspection are coordinated by Charleston and Field Staff. OOG’s goal is that Class IID wells are inspected annually and Class IIR wells are inspected every 2 years. Complaints or problems with a well will result in more frequent inspections. For example, if an injection well is located in proximity to a source water protection area or other environmentally sensitive area and the West Virginia Department of Health and Human Resources writes a letter to the
OOG, then an inspection to address any questions will be scheduled. In addition, priority is placed on witnessing MIT tests, well plugging, and the setting of new casing.

**Routine/Periodic Inspections**

Currently, OOG is meeting its goal of inspecting Class IID wells annually and Class IIR wells every 2 years. Environmental Resources Specialists in Charleston track inspections via RBDMS to assist the field staff in completion of these inspection goals. OOG intends to use RBDMS to create tracking calendars for inspections, but at this time has no firm date for implementation of this function.

Field Inspectors review well files for issues including compliance with permit conditions and MIT requirements prior to routine inspections. In the field, they visually inspect casing, pipelines, gauges, pumps, tanks, secondary containment, pits, off-loading pads, site security, onsite records, and housekeeping. Any leaks or spills are recorded. Inspections currently are documented on forms UIC-IR-1, IR-6, and IR-7 for routine inspections, and IR-9e for other situations. Inspection reports are reviewed by the Field Inspection Supervisors and UIC-Environmental Resources Specialists in Charleston. Inspection reports are stored as scanned documents in the AX program and data is being entered manually into RBDMS.

Since RBDMS was implemented in August 2016, evaluating compliance for maximum allowable injection pressures (MIP) has been done manually. While the previous data management system (ERIS) was in use, MIPs were evaluated automatically when the Operator/Permittee submitted the monthly reporting WR-40 form through the Electronic Submission System (ESS) and an email would be sent to the UIC staff if the pressures reported were higher than permitted. The connection between ESS and RBDMS for the WR-40 form is being developed with a goal is to have the system functioning by the end of 2017.

Operator/Permittees are rarely given advanced notice of an inspection. OOG inspectors have the statutory right of ingress and egress on leases and UIC well locations to make unannounced inspections.

Up to 10 of the field inspectors have their own gauges. For personal safety reasons and to protect expensive equipment, OOG prefers to have Operator/Permittees operate wells and equipment with OOG staff as observers. Operators are required to replace defective gauges or face penalties.
Compliance and Enforcement
For UIC violations, OOG has a tiered penalty matrix, which uses an informal process initially, and if the problem is not resolved, then formal actions are then taken. A Notice of Violation (NOV) is usually the first formal action taken, with a 7 day reply deadline and a potential 30 day extension afterward if warranted. The Field inspection staff are the only OOG employees with the statutory authority to issue a NOV, although the office staff in Charleston may consult with the field inspectors and have the inspector issue an NOV. Field and office staffs are both responsible for coordinating enforcement of and documenting NOV’s; both resolved and non-resolved. Staff has the ability to use professional judgment in issuing NOV’s and penalties. Professional judgment includes an assessment of the nature of the potential violation and the Operator/Permittees response and history of violations if any. If the NOV does not achieve compliance, a “Failure to Abate” notice is issued, also by the field inspector. For more serious violations, a “Cease and Desist” order may also be issued. Civil penalty assessments are completed by inspector and supervisor, and the Chief signs civil penalties.

If an NOV or escalated enforcement action is issued, an operator can either sign a Consent Order, correcting the problem and paying a penalty, if applicable, or they may appeal the violation to the WVDEP Cabinet Secretary. However, OOG maintains the ability to order a well to be shut-in for cause.

Response to Citizen Complaints and Emergency Situations
Complaints or emergencies (“complaints”) may be submitted in person, over the telephone, in writing, or by email. One Inspection and Enforcement staff member is assigned to receive complaints, track them, and assign resolution to the appropriate staff member. No matter how a complaint is received, it is entered into RBDMS. Complaints are entered in a shared MS Excel spreadsheet and RBDMS for tracking. The staff member receiving the complaint initiates a Complaint Form (C-1), a copy of which is then sent to the appropriate field inspector to begin the investigation. OOG strives to, and is largely successful at, responding to complaints within 24 hours of receiving them.

The investigation may include a field inspection and interviews with the operator, witnesses, or others as needed, and these are scheduled as soon as possible. Actions by any staff member on a complaint are then recorded on the C-1 form. Upon resolution of the complaint, the field inspector sends the completed C-1 form containing all documentation back to the initiating staff member. The entire complaint process is managed within the RBDMS incident module and the completed C-1 Form is stored on the AX system. A copy of the completed C-1 is sent to the complainant and is available to the operator and other interested parties on request. Inspectors use professional
judgment to determine whether an operator needs to be notified or not. If enforcement action results from a complaint, then follow-up requirements are determined by the abatement schedule. Otherwise, field inspectors assess follow-up requirements.

**Reporting and Follow-Up Procedures**

OOG’s policy is that all electronic OOG records (direct electronic submittals and scanned documents) are saved indefinitely. Paper copies of submittals are scanned and uploaded, but the paper is not retained. The AX program is used to store scanned images of documents. RBDMS was initially linked to AX; however, this ability has temporarily been lost due to internal connectivity issues related to an AX upgrade. OOG is working to resolve the problem. In the interim, field staff are currently tracking compliance issues manually and UIC related matters are also monitored by UIC staff in Charleston. AX remains fully functional through a web service and is available to everyone, including the public.

**Data Management Systems: Field Access and Use**

On August 1, 2016, West Virginia adopted RBDMS; this system allows the state to store and track data related to wells and ancillary facilities. RBDMS is accessible through a VPN connection where Wi-Fi or 3G cellular signal is available, although in some West Virginia locations such internet access is not possible. Field inspectors can collect and upload GPS data in the field and also have offline access to GIS tools such as ESRI’s ArcReader which is routinely updated from RBDMS. OOG utilizes a web-accessed document management system, AX, for storage of all documents related to a well. OOG is currently working on reestablishing a link between AX and RBDMS.

OOG field staff use laptops and smartphones. Most, if not all, inspection forms have been converted to fillable PDFs, which are generally completed on-site during an inspection. The PDF forms currently do not enter data directly into the RBDMS system; they only provide the equivalent of a scanned image. Therefore, data capture from PDF forms is a future goal. Smartphones equipped with location/date/time stamping applications are used when taking pictures. Laptops can upload data to the RBDMS system, while smartphones cannot.

With OOG’s former database management system (ERIS), tracking of inspection priorities and compliance deadlines was difficult, and the use of RBDMS presents many opportunities for improvement in these areas. The Phase 1 RBDMS system currently in place provides tools which can be utilized for this purpose. OOG plans to use a contract
with GWPC to design a "Compliance Calendar" to further assist tracking. The conceptual design of this tool will allow deadlines to be set and visualized. Specifically, OOG intends to link the calendar to all compliance actions (e.g. Notices of Violation, Consent Orders, etc.) and UIC inspections (i.e., scheduled MITs). OOG does not currently have an inspection priority schedule in place.

Changes and Modifications to Inspection Program since Primacy
In the mid-1990’s, the UIC-1 Inspection Form was created for Class IIR and IID injection wells. Despite funding limitations, such as no increase in USEPA funding amounts, this form has recently been revised, and is now the form UIC IR-7.

Identified Strengths
1) OOG UIC program inspections are performed and reviewed by well-trained and dedicated professionals.

2) OOG has a three tiered review process for UIC inspections; field inspector, field inspector supervisor, and Charleston UIC Staff. Completeness, consistency, and fairness are improved via this process.

3) OOG recently began using UIC Inspection Form IR-7 and has historically documented UIC inspections on a form (UIC-IR-1). Use of these forms again promotes completeness, consistency, and fairness.

4) All West Virginia UIC wells are inspected either annually (IID) or every 2 years (IIR) and all inspections are up to date per state schedules.

5) The OOG policy that all complaints are answered within 24-hours is exemplary. Furthermore, tracking and resolution of complaints is excellent with all information being documented and all parties being informed of the results in a timely manner. Tracking and resolution should be improved as additional tools are added to the RBDMS system.

6) Given that OOG has no statutory authority to issue financial penalties outside of a civil court proceeding, it is exemplary that OOG has been able to resolve a large majority of compliance issues through Administrative Orders and agreements between OOG and operators, without recourse to the EQB (which handles appeals) or ultimately to civil courts.

7) OOG uses a statewide penalty matrix for violations, which helps assure consistency and fairness.
Review Suggestions

1) OOG should endeavor to assure continued technical competency of their staff by having all inspectors as well as all individuals responsible for writing and/or reviewing UIC field inspection reports take the National USEPA Inspector Training Course and/or the IOGCC Inspector Certification Course. Given that these courses are presented by outside parties, as much as possible, the courses should be tailored to the needs of the West Virginia primacy program for Class II wells.

2) All inspectors should carry their own set of gauges thus allowing them to detect problems and confirm pressure values reported by operators. Having its own set of gauges should not prevent OOG-staff from requiring that operators install and/or remove gauges in situations where safety or damage to operator equipment is concerned.

3) West Virginia is unique in that field inspectors are the only staff with legal authority to issue Notices of Violation. While this seems to work for West Virginia, it would appear that a substantial portion of an inspector’s time is often devoted to writing, tracking, and resolving NOVs. With the understanding that this would require a change to West Virginia’s Code and Legislative Rules, it seems that a field inspector’s time could be better spent in the field, while allowing the Charleston central office staff to pursue violation management. Centralized compliance and enforcement by current staff might improve consistency and fairness. An additional consideration, subject to financial constraints, would be to add legal staff familiar with West Virginia Oil and Gas Codes and Legislative Rules to the NOV team who would be able to write legally defensible NOVs. Other states have chosen to add legal staff for this reason.

Overall Program Findings

Overall the review team finds that the West Virginia Class II UIC program managed by the OOG is well run and managed. The review team finds that the program provides appropriate protection for USDWs in accordance with the provisions of federally delegated UIC program requirements. The staff of the OOG has the professional and technical knowledge and experience needed to implement the program in a manner that is efficient and meets the requirements for an effective Class II UIC program under Section 1425 of the SDWA. The program is well organized and makes excellent use of professional staff and is transitioning to the latest data management processes to assure that USDWs are adequately protected.
Suggestions made in this report are intended to provide the state with considerations the team believes would make the program even better than it is currently. They are not intended to convey shortfalls in the program.
Appendix A: List of Acronyms

AO – administrative order
AOR – area of review
API – American Petroleum Institute
AX – Application Xtender
BBL. – barrels
CBL – cement bond log
Class IID – salt water disposal well
Class IIR – enhanced recovery well
COAs – condition of approvals
DI – direct implementation
DWWM - Division of Water and Waste Management (of WVDEP)
EOR – enhanced oil recovery
EQB – Environmental Quality Board
ERA – Environmental Resources Analyst (within OOG)
ERIS – Environmental Resource Information System
ESRI – a GIS company
ESS - Electronic Submission System
E+P – exploration and production
GIS – geographic information system
GPP – Ground Water Protection Plan
GPS – global positioning system
GWPC – Ground Water Protection Council
IOGCC – Interstate Oil and Gas Compact Commission
MIP – maximum injection pressure
MIT – mechanical integrity test
MOU – memorandum of understanding
NOD – notice of deficiency
NOV – notice of violation
NPDES – National Pollution Discharge Elimination System
OOG – Office of Oil and Gas (of WVDEP)
PIO – Public Information Office (of WVDEP)
RBDMS – Risk Based Data Management System
RCRA – Resource Conservation and Recovery Act
SAPT – standard annulus pressure test
SDWA – Safe Drinking Water Act
SOP – standard operating procedure
TDS – total dissolved solids
UIC – Underground Injection Control
USDW – underground source of drinking water
USEPA – United States Environmental Protection Agency
UPS – United Parcel Service
WVDEP – West Virginia Department of Environmental Protection
WVGES – West Virginia Geological and Economic Survey
WVOGCC – West Virginia Oil and Gas Conservation Commission
ZEI – zone of endangering influence