EXPLORATION

- Identify a potential oil or gas reservoir and geologic area to evaluate.
- Assess past exploration and development in the area.
- Obtain and analyze seismic and other data to see if potential for gas or oil exists.
- If analysis indicates the potential for economically viable hydrocarbons, obtain land rights and state regulatory permits to drill one or more test wells.
- Work with landowners and community to explain operations and understand concerns.
- Conduct exploratory drilling, including drilling and completion phases described at right (but on limited scale).

DEVELOPMENT

Drilling
- Evaluate geographical and topographical attributes of site, to pinpoint best well locations.
- Obtain appropriate permits, conduct baseline water-quality testing and build roads to the well location, or pad.
- Typically, drill multiple wells on a single well pad, to decrease surface footprint and truck traffic. The following are typical steps for an unconventional natural gas well:
  - Install conductor casing¹ and cement it in place.
  - Move in small drilling rig to drill to a set depth and install surface casing. The cemented-in surface casing seals off wellbore from any shallow, freshwater aquifers.
  - Drill vertical section of well. (In Fayetteville Shale, vertical portion typically extends down nearly 5,000 feet.)
  - Bring in larger rig to drill horizontal portion of the well, which may extend out horizontally several thousand feet.
  - Throughout process, pump “drilling mud” into hole to cool wellbore and build rock.
  - When targeted distance is reached, cement in steel production casing.

Completion²
- Perforate steel production casing at select locations in target horizontal portion of well, deep beneath the surface.
- Conduct multi-stage hydraulic fracturing, whereby fracturing fluid and sand are pumped into well at high pressure, exiting well casing at perforations and fracturing the rock. The fracturing opens up small pathways in rock, and sand helps keep pathways open so gas can be extracted. The bedrock that has trapped the oil and gas deep underground also prevents the flow of fracturing fluid to the surface, except through the well bore.
- Conduct fracturing in stages, starting at farthest point in horizontal section and working backward. Isolate each section after it is fractured, using a plug, and then perforate and fracture next segment.
- Drill out plugs and clean out wellbore, to allow gas to flow to surface. ³

Production
- Extract natural gas from underground reservoir to surface. The flow often occurs naturally, but sometimes artificial lift (pumping) is needed.
- Manage “production brine” – either through recycling and reuse; by injecting into underground disposal wells; or, for a small portion, by treating, testing and discharging pursuant to permitting requirements.
- After final well on pad is placed on production, reduce size of well pad by half or more.
- Monitor casing integrity through life of the well.

Well Closure
- After well ceases to produce, cut off well casing below ground, seal well with cement as per regulatory guidelines and rehabilitate and re-contour the surface area to previously agreed-upon conditions.

GATHERING AND PROCESSING

- For this “midstream” phase, construct and install gas gathering lines underground to move gas from wells to interstate pipelines, and ultimately to regional markets.
- As needed, treat gas for impurities, dehydrate to remove excess water vapor, and/or compress to higher pressures for transport into transmission pipelines.

USE

- Natural gas is used to heat and cool homes and commercial facilities, cook food, generate electricity, and even power motor vehicles.
- Natural gas is a feedstock in many manufacturing processes, such as in the production of fertilizers and plastics.

¹ See www.swv.com to view a video (“Learn about Horizontal Drilling”) with more detail and visuals illustrating the development phase. Also note that development can involve the drilling and completion of hundreds of wells, depending on size of the area and whether we are horizontal drilling, which expands the area from which a well draws and thus reduces the number of wells needed, compared to vertical drilling.
² Casing is a hollow steel pipe. Proper casing and cementing prevents fluids from leaking into surrounding rock or soil.
³ Completion includes activities that prepare the well for production, which, in tight rock formations such as shale, involves hydraulic fracturing.
⁴ A concern at this stage is venting of natural gas into the atmosphere, before production equipment capable of capturing the gas is fully installed. In both the Fayetteville Shale and Marcellus Shale regions, we conduct only “green completions”—that is, reduced-emission completions.