INL/EXT-10-19395

American Recovery and Reinvestment Act (ARRA)

FEMP Technical Assistance

United States Department of Defense
United States Army
Letterkenny Army Depot
Letterkenny Methane Project

Robert P. Breckenridge
Thomas R. Wood

August 2010

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FEMP
Federal Energy Management Program

Letterkenny Army Depot
"Center of Industrial and Technical Excellence for Air Defense and Tactical Missile Systems"

Idaho National Laboratory

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EXECUTIVE SUMMARY

The purpose of this document is to evaluate the opportunity for Letterkenny Army Depot (LEAD or the Depot) to utilize biogenic methane, which may be available in shale formations under the Depot, to provide a supplemental source of natural gas that could allow the Depot to increase energy independence. Both the Director and Deputy of Public Works at the Depot are supportive in general of a methane production project, but wanted to better understand the challenges prior to embarking on such a project. This report will cover many of those issues. A similar project has been successfully developed by the U. S. Army at Ft. Knox, KY, which will be explained and referred to throughout this report as a backdrop to discussing the challenges and opportunities at LEAD, because the geologic formations and possibilities at both sites are similar.

Letterkenny Army Depot, located northeast of Chambersburg, PA (see maps 1, 2, and 3), asked the Federal Energy Management Program (FEMP) for technical assistance to conduct a preliminary assessment on the potential for an onsite renewable methane gas production operation, similar to the existing Ft. Knox facility. Idaho National Laboratory (INL) is supporting FEMP in providing technical assistance to a number of different Federal agencies, which includes the LEAD project. Scientists from INL visited both Ft. Knox and LEAD in late October 2009 to gather technical information for the evaluation of opportunities and challenges in developing biogenic methane at the Depot.

Prior to discussing the opportunity at LEAD, it is important to briefly discuss the successful methane recovery operation at Ft. Knox, because it is applicable to the projected approach for the LEAD methane system. The Ft. Knox project is an excellent example of how the U. S. Army can use an onsite renewable resource to provide a secure energy source that is not dependent on regional energy networks and foreign oil. At Ft. Knox, the U. S. Army contracted (through a utility co-op) with an energy production company to drill wells, establish a distribution infrastructure, and provide the equipment needed to prepare and compress the produced methane gas for use by base operations. The energy production company agreed to conduct the exploratory investigation at Ft. Knox with no cost to the government, as long as they could be granted a long-term contract if a reliable energy resource was established. The Depot is located, in part, over an Ordovician Age shale formation that may have the potential for producing biogenic methane, similar to the Devonian Age shale found beneath Ft. Knox. However, the Ordovician Age Shale beneath LEAD is not known to have any currently producing gas wells (see maps 4 and 5).

LEAD has a high demand for natural gas to heat boilers used for the steam-cleaning of vehicles (vehicle repair/maintenance is a major mission at LEAD), heating buildings, and for processing in dip tanks and paint booths. LEAD has an extensive road network that supports munitions storage. Institutional support and infrastructure at LEAD appears to be a good match for the requirements needed for construction and maintenance of an onsite methane production system.

On the basis of the October 2009 site visits, a comprehensive search of published literature, conversations with shale gas developers, and other sources of information, several challenges and key baseline assumptions have been identified that will need to be addressed; these include:

- The assumption that LEAD can identify a utility company willing to work with them in support of a natural gas production system. All other aspects of the system design and contracting will follow from this relationship.

- The assumption that the Depot will be able to identify the appropriate contracting mechanism for gaining access to an energy exploration and production company that is willing to take the risk of establishing a project; the existing Ft. Knox process can serve as a good example for this.
- The assumption that an exploratory test well can be drilled and that it will establish that biogenic methane can be produced in a sufficient enough volume and rate to support a secure, onsite system. A preliminary geology review conducted for this report did not reveal any nearby examples of commercial methane gas production from the rock types found beneath the Depot; however, some encouragement was found that the subsurface conditions may be right for a new discovery in this area.
- The assumption that at LEAD there will be a high-level internal champion identified that will support the entire process of the development of a secure, natural gas system, because there are undoubtedly many unforeseen hurdles that will need that high-level support to overcome. At the outset, it is important that management support is maintained throughout the three-year development schedule.

As a part of this project, it was recommended that LEAD invite the key players from the Ft. Knox project to the Depot so that a concrete strategy for moving forward could be established and agreed to by senior-level management and the appropriate contracting officers. Additionally, the geologic exploration company should soon present technical information justifying the optimism for finding a commercial quantity of methane gas beneath the Depot. Both of these recommendations were acted upon by LEAD during the latter-half of FY-2009 and the early-half of FY-2010.

The funds used to support this project help to create/maintain about 0.13 FTEs at INL during FY-2009 and FY-2010.

The conservative measures for annual energy and cost savings are based upon the assumption that the type of project developed at Ft. Knox could also be developed at LEAD. This is used to calculate a simple payback. If a system similar to that developed at Ft. Knox were to be developed at LEAD, the annual gas production would be about 204,000 MMBtu (200 MCF of gas at 1020 BTU/CF of gas). The annual energy savings for this amount of gas would be about $1,674,840/yr (assuming replacement costs of $8.21/MMBtu).

There would not be any net reduction in green house gas (GHG) emissions due to the fact that this project would result in a one-for-one exchange of commercially available natural gas with biogenic natural gas collected from under the Depot; however, a small reduction in GHG emissions might be anticipated by the reduction in piping natural gas from existing fields.

The energy usage at LEAD for FY-2003 was 109.26 MMBtu/KSF of energized space; the usage rate in FY-2009 was 98.8 MMBtu/KSF. LEAD is an Army Working Capital Fund (AWCF) production site, and must respond to mission requirements. Due to the variety of these missions, vehicle output is not a reasonable means of measuring production per item produced, nor is the measurement of energy consumption per square foot a reasonable indicator of success in achieving conservation goals. Direct maintenance man-hours are the most reasonable means of measuring production requirements. During FY-2003, direct labor man-hours (DLH) expended in the mission activities totaled 1.23 million. That total has increased dramatically over the past several years, with direct labor hours exceeding 3.75 million during 2009. The calculation of energy consumption per direct labor hour is therefore the most logical means of measuring energy efficiency, and that average has decreased steadily as follows: 0.30 MMBtu/DLH in FY 2003 compared with 0.13 MMBtu/DLH in FY-2009. While workload has grown and energy consumption per square foot has obviously increased as additional shifts have been added to meet demand, consumption per DLH has decreased by 57% ([0.30 - 0.13]/0.30).

During FY-2009 (from quarter 1-4), the annual use of energy utilities by major group at LEAD are as follows:

Utility group	**FY-2009 Q1-Q4 cost ($000)**	**FY-2009 Q1-Q4 consumption (MMBtu)**	**$/MMBtu**
Electric	3,976	180,880	21.98
Natural gas	1,897	230,965	8.21
Propane	188	7,670	24.47
Petroleum	741	69,207	10.71
Total	6,802	488,722	13.92

As Letterkenny Army Depot moves forward with this biomethane project, the energy manager at the Depot should contact David McAndrew and/or Tracy Logan at FEMP. David has had experience with a similar type of project and would be a great resource for the staff at LEAD. The contact information for the staff at FEMP is:

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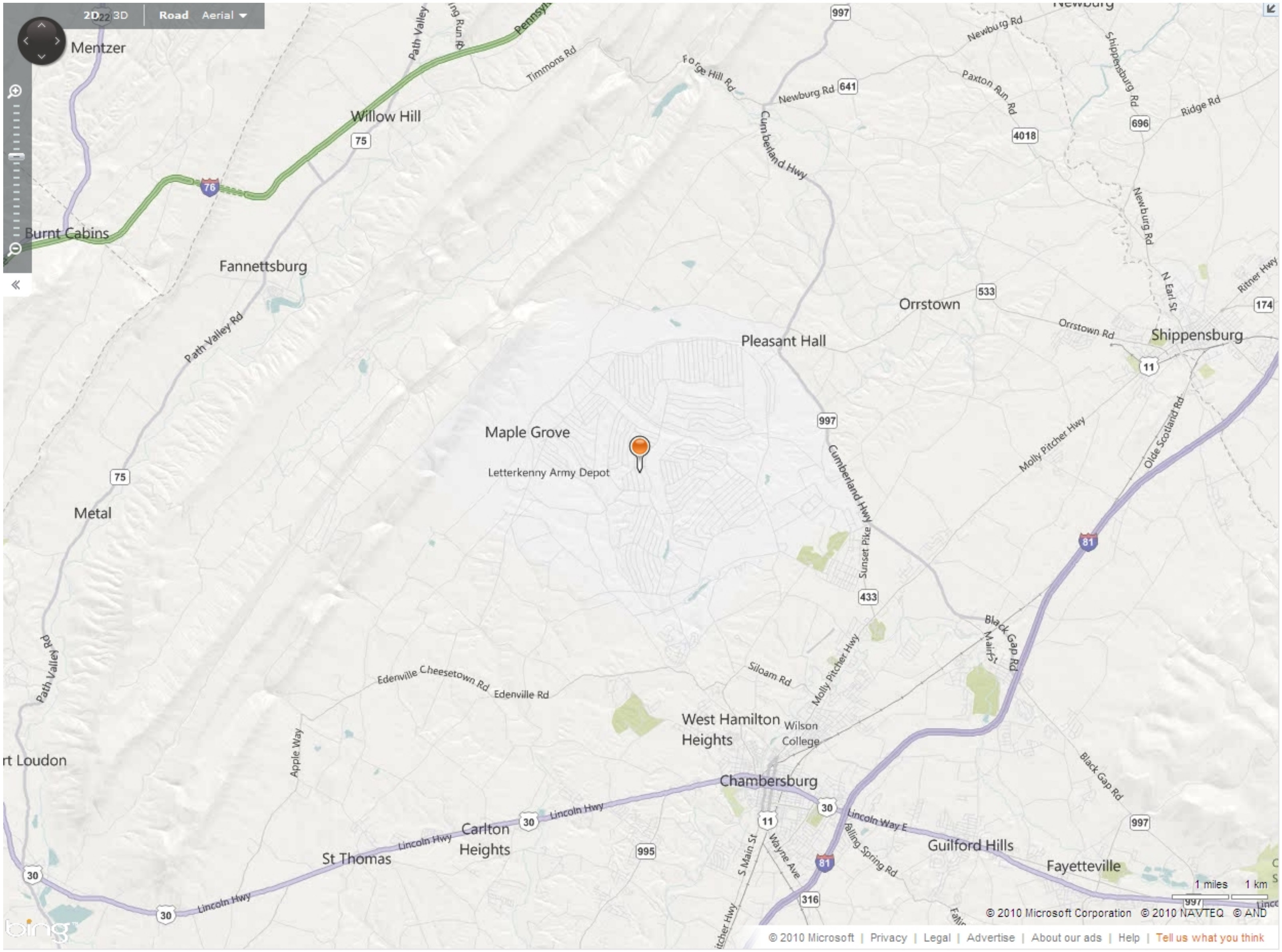
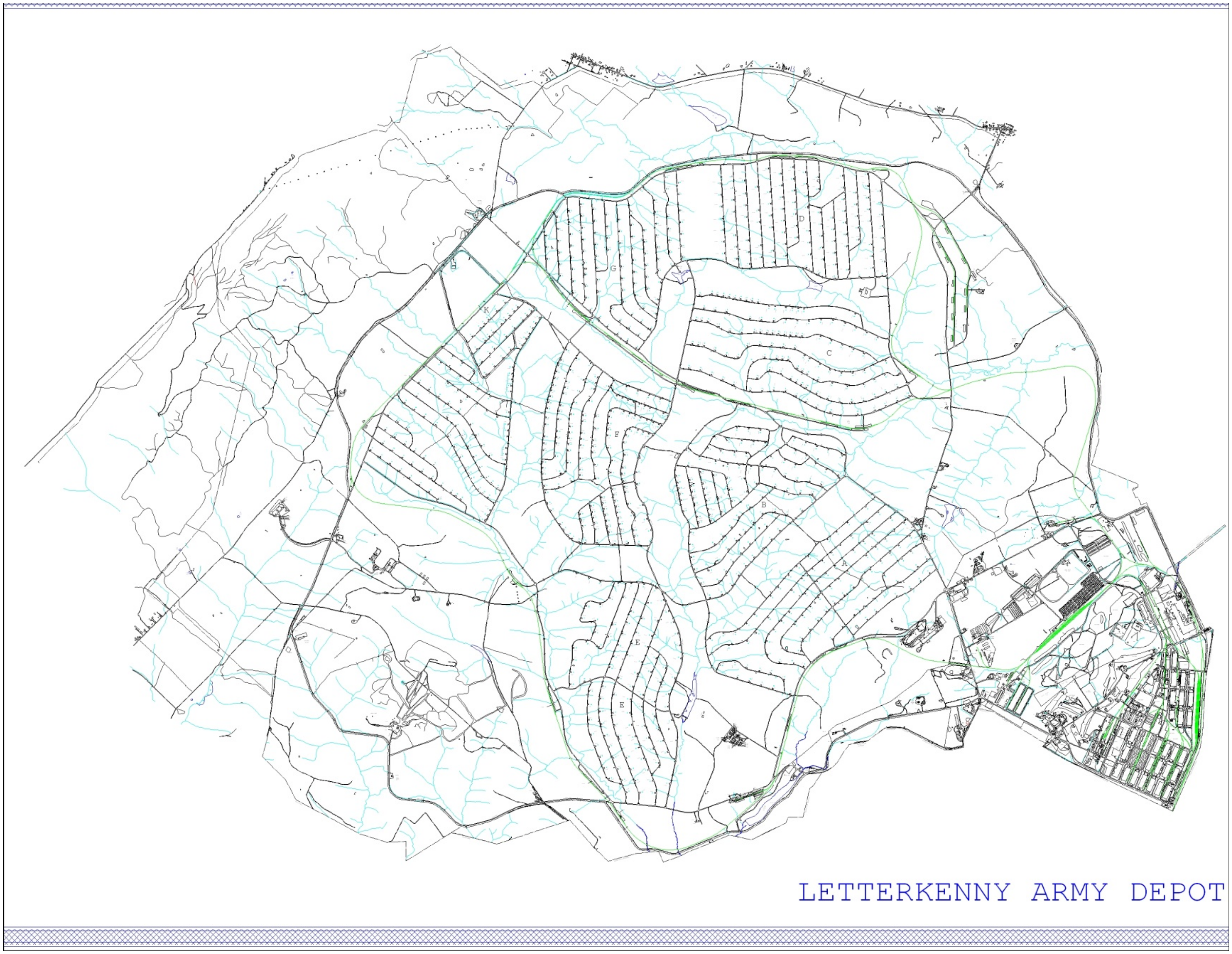
ACRONYMS

AA	Ammunition Area (LEAD)
AMCOM	U. S. Army Aviation and Missile Command
ARRA	American Recovery and Reinvestment Act
AWCF	Army Working Capital Fund
BIDS	Biological Integrated Detection System
BRAC	Base Realignment and Closure
DMH	Direct maintenance man-hours
DoD	U. S. Department of Defense
DOE	U. S. Department of Energy
EERE	Energy Efficiency and Renewable Energy
EIA	Energy Information Administration
ESPC	Energy Savings Performance Contracts
FEMP	Federal Energy Management Program
INL	Idaho National Laboratory
LEAD	Letterkenny Army Depot
MCF	M Cubic Feet
MMBtu	Million BTU
MRAP	Mine Resistant Ambush Protection
PDO	Property Disposal Office Area (LEAD)
PGS	Pennsylvania Geological Survey
PPA	Power Purchase Agreements
SE	Southeastern Area (LEAD)
TPS	Total Petroleum System
UESC	Utility Energy Service Contracts

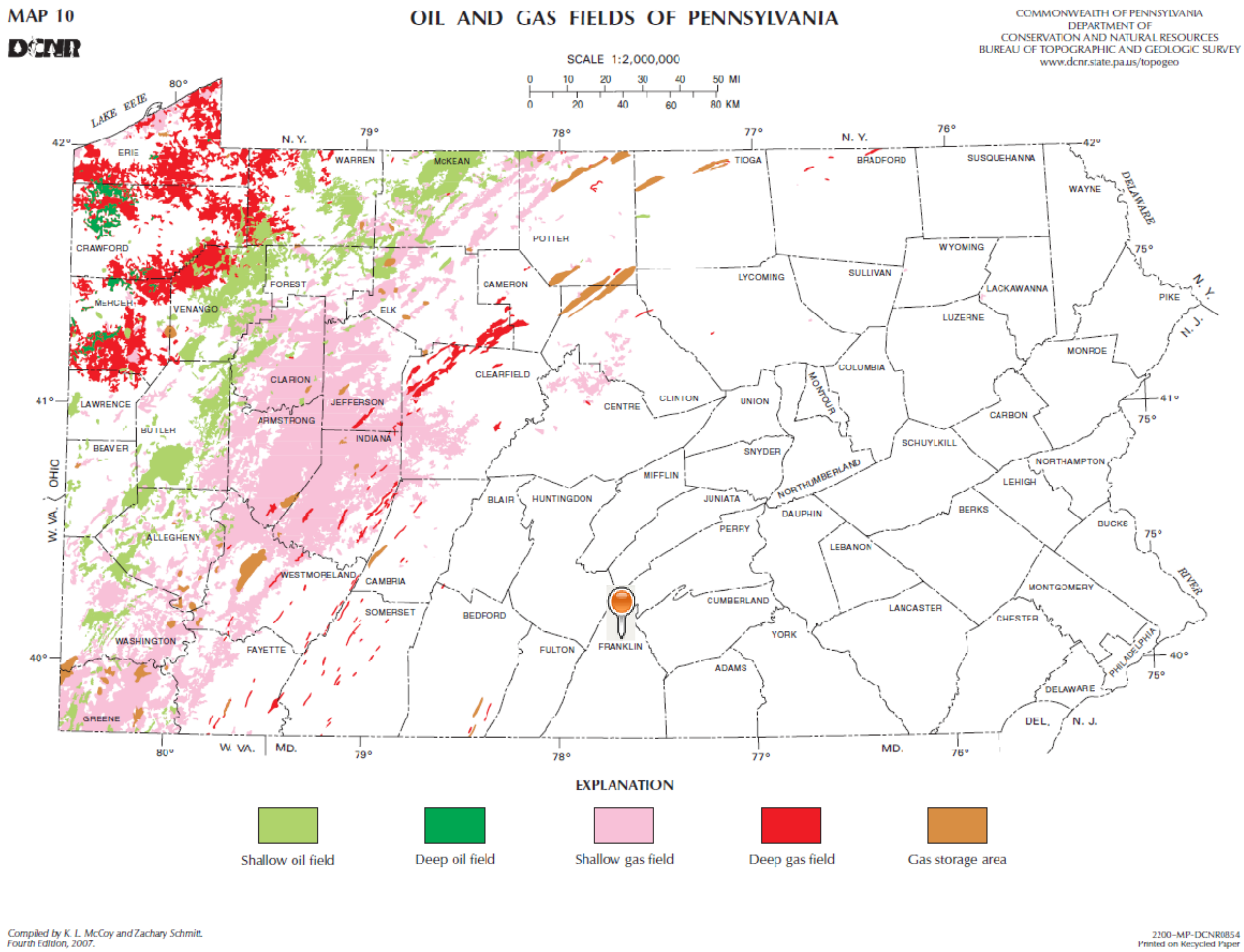


Map 1. The Letterkenny Army Depot (LEAD) is located northeast of Chambersburg, PA.

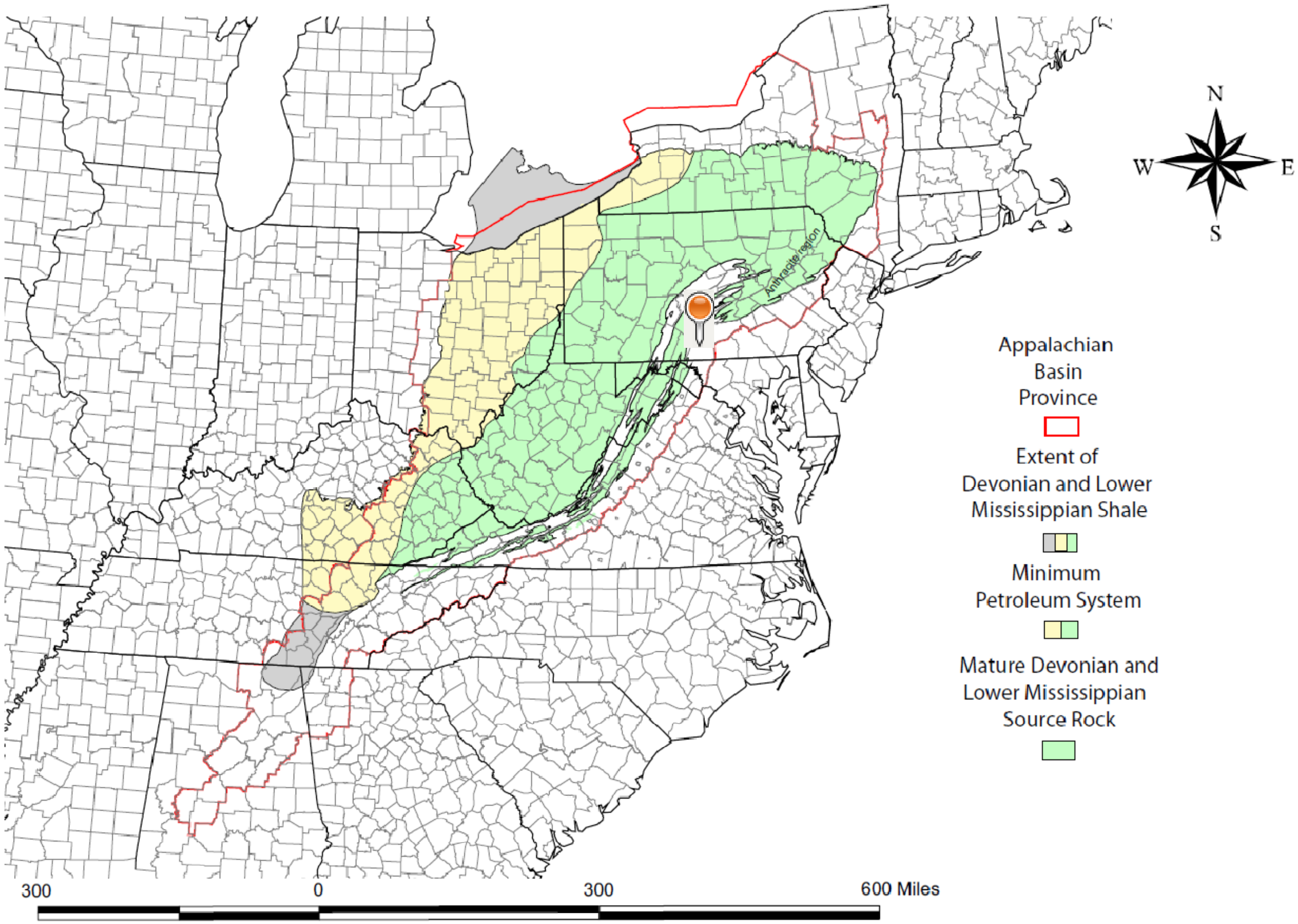
Map 2. Aerial view of the Letterkenny Army Depot (LEAD).



Map 3. Network of roads at the Letterkenny Army Depot (LEAD) that could support the installation of a gas collection system.



Map 4. Oil and gas fields in the State of Pennsyslvania. (http://www.dcnr.state.pa.us/topogeo/maps/map10.pdf).



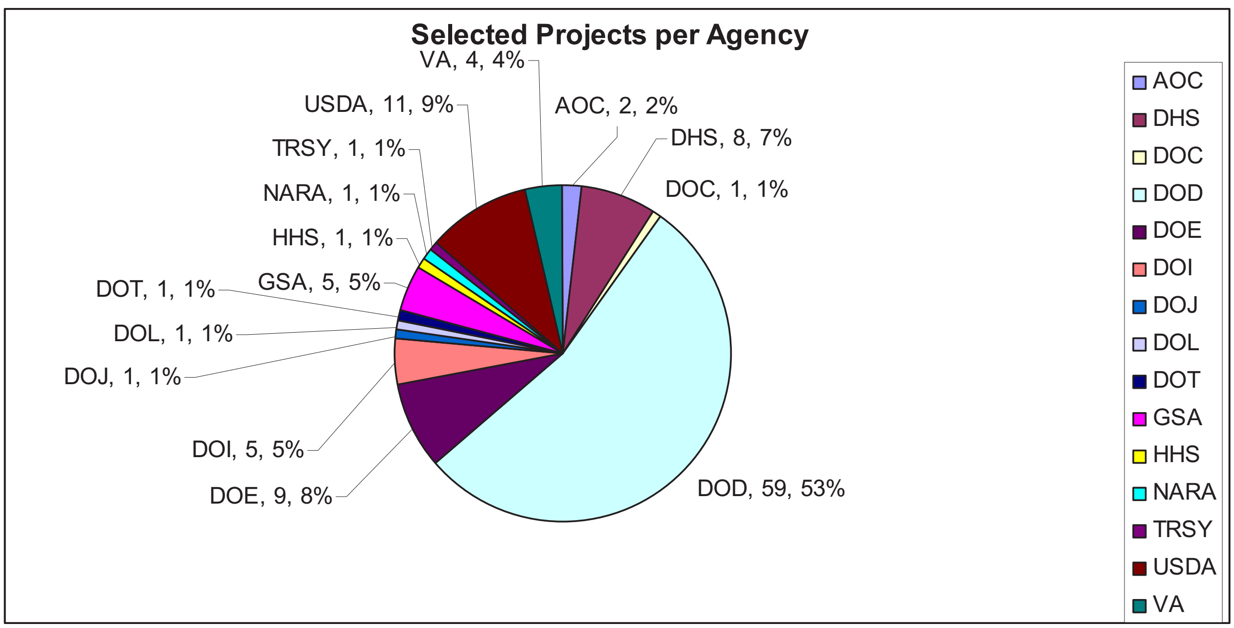
Map 5. The Devonian shale-middle and upper Paleozoic total petroleum system (TPS). The minimum petroleum system is the area of known generation, accumulation, and production of petroleum and natural gas (green and yellow). The mature source rocks of the TPS are all of Devonian age (green). Gray areas were not assessed.

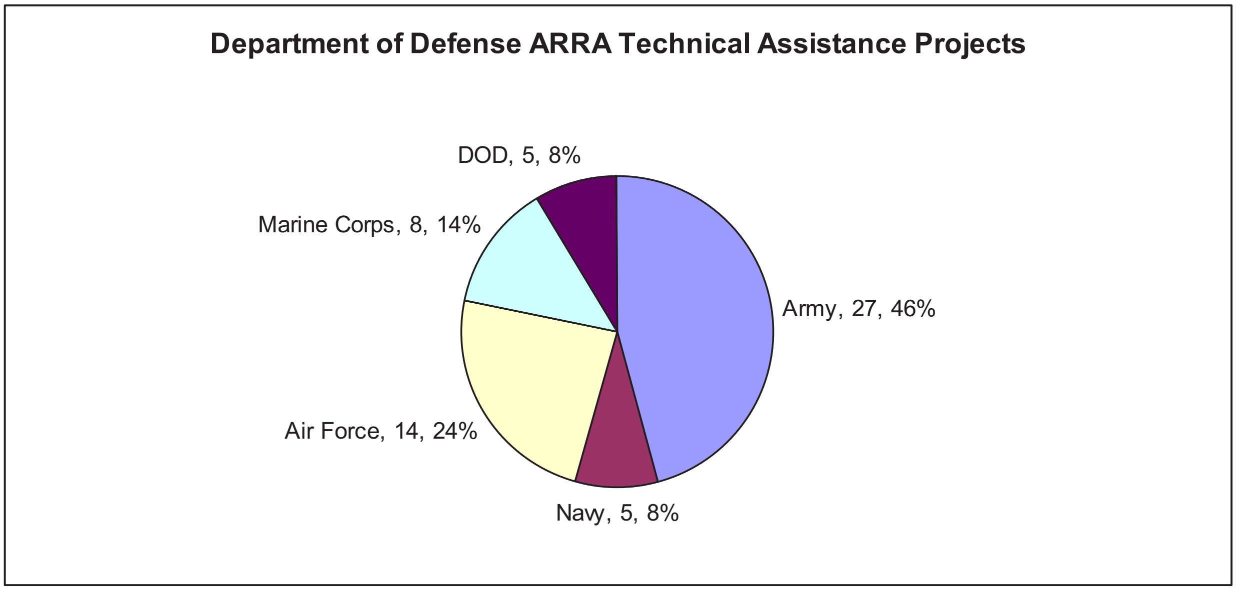
1. AMERICAN RECOVERY AND REINVESTMENT ACT (ARRA)

1.1 Description of ARRA program

The U. S. Department of Energy (DOE) Federal Energy Management Program (FEMP) received funding through the American Recovery and Reinvestment Act (ARRA) to enhance and accelerate FEMP service functions to the Federal Government for the following projects: Enhanced Technical Assistance, Communications and Training, Energy Savings Performance Contracts (ESPC), Utility Energy Service Contracts (UESC), and Power Purchase Agreements (PPA) project support. ARRA funding enabled increased scope and tempo for FEMP support for other Federal Agencies as they make energy management and investment decisions using their Recovery Act funding.

FEMP issued an initial ARRA request for project submittals at the Interagency Task Force meeting on March 18, 2010, and subsequently announced the Call for FEMP Technical Services to Federal Agencies. In addition, FEMP reviewed applications from viable FY-2008 projects. Of the over 300 applications received, one hundred and ten (110) projects were selected and approved to use ARRA funding, as shown in the following graphs.





1.1.1 Technical Assistance Description

FEMP facilitates the Federal Government's implementation of sound, cost-effective energy management and investment practices to enhance the nation's energy security and environmental stewardship. The FEMP Technical Assistance activity helps Federal Energy Managers identify, design, implement, and evaluate new construction and facility improvement projects. These projects involve: energy efficiency; renewable energy; distributed energy and combined heat and power; sustainable design practices; and water-saving technologies. The objective is to help the Federal Agencies to meet the goals set by Federal Legislation and Executive Order.

2. GENERAL BACKGROUND

The Letterkenny Army Depot (LEAD or the Depot), the Center of Industrial and Technical Excellence for Air Defense and Tactical Missile Systems, was established in 1942. The Depot is under the command structure of the U. S. Army Aviation and Missile Command (AMCOM). The facilities at LEAD are used to conduct maintenance, modification, storage, and demilitarization operations on tactical missiles and ammunition.

Site Description – LEAD is located in south-central Pennsylvania in Franklin County, five miles north of the Borough of Chambersburg, PA, and shares boundaries with the following three townships: Greene, Letterkenny, and Hamilton. The Depot is considered part of the western side of the Great Valley, known locally as Cumberland Valley, which is part of the Valley and Ridge Physiographic Province. Cumberland Valley extends northeast to southwest across central Pennsylvania and is bordered to the west by the Appalachian Mountain section (Broad Mountain) and to the east by the Blue Ridge section (South Mountain), which is located east of Chambersburg. The principal land use surrounding LEAD is agricultural, except to the west, which is state forest and game land.

The Depot is comprised of over 17,500 acres and consists of three areas: the Ammunition Area (AA), the Property Disposal Office (PDO) Area, and the more natural Southeastern (SE) Area. A large land portion of the Depot is used to conduct maintenance, modification, storage, and demilitarization operations on tactical missiles and ammunition. On occasion, LEAD partners with industry to offer the benefits of their unique capabilities and skills. The Depot remains among the top three employers in Franklin County with about 3,500 employees. LEAD originally covered approximately 19,243 acres; however, roughly 16,614 acres of this land was subsequently transferred as a result of the Base Realignment and Closure (BRAC) 1995 Action to realign part of the Depot's mission. Most of this transferred land will continue to be devoted to ammunition storage. Meanwhile, the industrial, maintenance, and recreational areas of LEAD, which are primarily located in the southeast corner of the Depot (including the PDO and SE Areas), encompass about 2,500 acres. The BRAC parcel located in the southeastern corner of LEAD (designated for property transfer) consists of approximately 1,235 acres. Prior to the establishment of the Depot, this area consisted of agricultural and forest lands and was predominantly made up of single-family farms used for both subsistence and commercial purposes.

Facility Type – The Depot has unique capabilities for repairing a variety of U. S. Department of Defense (DoD) missile systems, including the MIM-104 PATRIOT missile and its ground support and radar equipment. Most recently, LEAD has expanded its product line to include the overhaul of tactical wheeled vehicles (i.e., HMMWVs), material handling equipment (7.5-ton cranes), and mobile kitchen trailers. In addition, as the Center for Industrial and Technical Excellence for Mobile Electric Power Systems, the Depot repairs and remanufactures power generation sets. LEAD has also expanded its capabilities to include aviation ground power units. Other vital DoD products that the Depot supports include the Force Provider (the U. S. Army's mobile, fully-enclosed base camp and subsequent buildings that supply food, dining, and heating/cooling systems, etc.), mobile power generators, and the Biological Integrated Detection System (BIDS).

Operations – The Depot also has a major role in the refurbishment of vehicles. Consequently, LEAD has a fairly high energy usage rate due to its numerous natural gas boilers, which support general building heating and steam-cleaning associated with vehicle repair and maintenance operations. The steam-cleaning operation runs on an almost continual basis with brief shut-downs occurring only on selected holidays and during scheduled maintenance. The energy usage for the natural gas boiler operations at the major gas usage building (#349) at LEAD ranges from a low of 8,270 M Cubic feet (MCF) (8,270 Dekatherms) of gas per month in the summer to a high of 20,781 MCF (20,781 Dekatherms) during the winter.

The Depot Director of Public Works has the responsibility for energy conservation and supervises and coordinates the planning, organizing, direction, and control of all facility engineering and housing functions that are part of LEAD's mission. Any new energy production system that would be considered for the Depot would need to be supported and managed through the Director of Public Works. As part of this evaluation, meetings were held with both the LEAD Director (Rodney Gettig) and Deputy Director (Glenn Trego) of Public Works to assess their support and identify opportunities and concerns about the possible development of a methane gas production project for the Depot. Both the director and his deputy are supportive in general of a methane production project, but wanted to be briefed in further detail about the potential liabilities and risks prior to embarking on such a project. A similar project has been developed at Ft. Knox, KY, and will be discussed and referred to throughout this report to discuss similar challenges and opportunities where the U. S. Army has already been successful.

Land Use – Land use at LEAD varies for the areas that are intensely used for refurbishment of vehicles to areas that are in mostly a natural state that are used for recreational (hunting) (see Figure 1) purposes. The Depot has a number of lay-down and bone-yard areas that could serve as good areas for drilling wells and equipment storage to support gas development activities (see Figure 2). Some of the land at LEAD that was used as pasture land is still maintained in that state (see Figure 3). Some of these areas have gravel roads that would support the development of gas drilling and collection activities. There are also a number of locations on the Depot that have good locations and access that could support potential drilling operations and supply the necessary power requirements to the site for supporting gas pumping operations (see Figure 4). There are a number of gravel roads located on LEAD that would provide good access to well drilling locations (see Maps 2 and 3); these roads could be used to bury gas collection pipelines along the ground to transfer gas to a collection facility (see Figure 5). There are a number of gravel pull-outs located along existing roads at LEAD that could serve as good locations for the possible placement of a gas well (see Figure 6). To reduce the risk of fire and to keep wildlife off the paved roads, LEAD mows the shoulders of most of these roads (see Figure 7). Power access exists along many of these roads (see Figure 8a), but there is little additional development existing in many of these locations (see Figure 8b), which make them ideal for either placing well pads or for potential location gas collection systems. The description of the methane production system at Ft. Knox that is presented in the following sections summarizes the amount of disturbance that occurred and the size of the well installations that could be expected to be placed at LEAD if a viable gas source can be located.

Figure 1. Picture from the Southeastern Area of the Depot that is maintained in a more natural ecological condition; this area has limited road access that could be used for development of a gas well and collection system.

Figure 2. Lay-down areas located along roads at the Depot that could serve as well drilling and equipment storage areas to support gas drilling and collection activities. (Note: Power is available to many of these locations).

Figure 3. Pasture areas with gravel roads that would support drilling and gas collection activities if developed at LEAD.

Figure 4. Locations on LEAD that could be used for drilling locations that have access to power to support pumping operations if needed.

Figure 5. Gravel access road located on LEAD proper that could be used to support location of drill pads or to bury gas collection pipes.

Figure 6. Gravel pull-out that could be used for the drilling and placement of a gas collection well.

Figure 7. Most of the roads on the Depot have shoulders that are mowed making the placement of gas collection systems in these areas a very viable option.

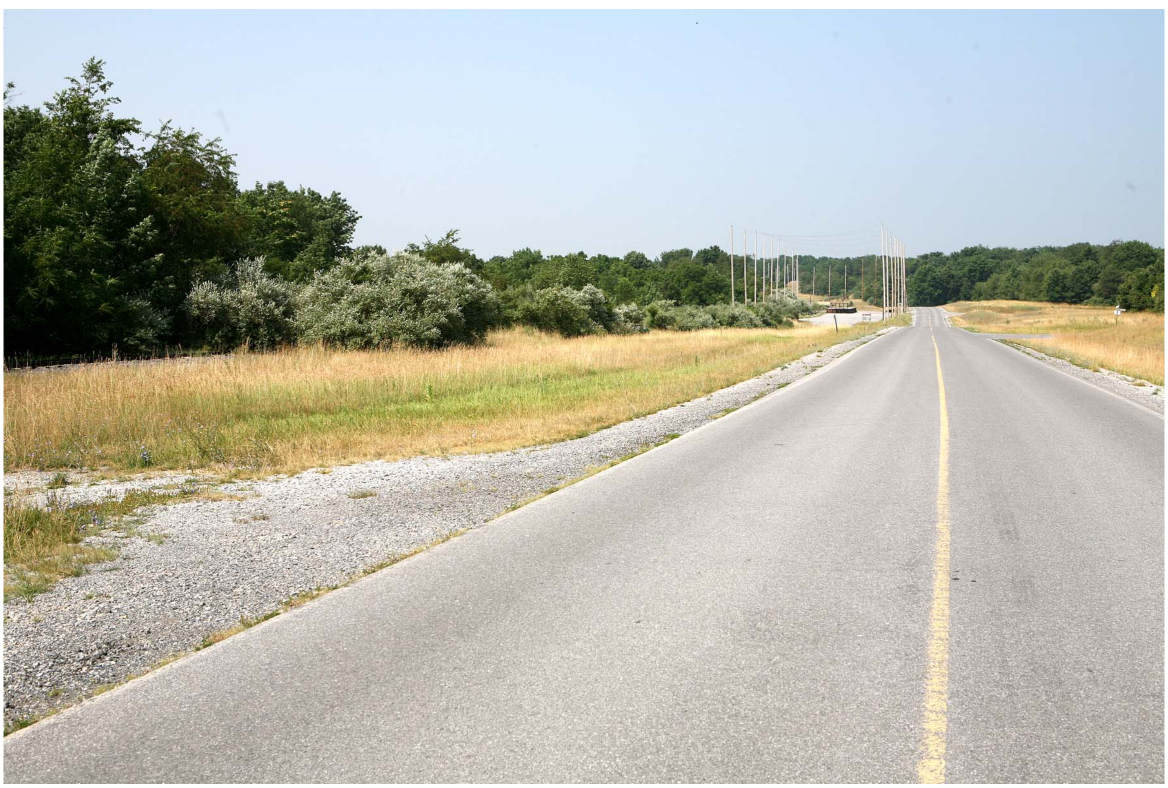


Figure 8a and 8b. At LEAD, there is little development along many of the roads once you get away from the main facilities, making this area very amenable to the development of a gas collection operation.

Climate – According to the U. S. Department of Energy (DOE), the city of Chambersburg has a cold climate (DOE 2009), where the area receives anywhere from 38 to 42 inches (1,100 mm) of precipitation per year. The average January low is 20°F (−7°C), while the average January high is 37°F (3°C). The average July high is 85°F (29°C), while the average July low is 62°F (17°C).

Geology – A number of wells have been drilled on the Depot site for environmental projects, generally less than 500 ft below ground surface. These wells, in conjunction with regional studies, provide an understanding of the likely geologic strata beneath the site. The onsite wells penetrated the upper part of the bedrock, which generally consists primarily of limestone, dolomites, and shale (with siltstone/sandstone interbeds) of the Middle Ordovician age. The Martinsburg Shale Formation underlies a majority of the AA at LEAD and the upland or hilly portions in the PDO and SE Areas. The limestones of the Chambersburg Formation and St. Paul Group underlie the valleys or low-lying areas in the PDO and SE areas of LEAD. The Martinsburg Shale Formation, ranging in thickness from several feet (near fault contacts) to an estimated 1,000 ft (in the AA), consists predominantly of black carbonaceous shale interbedded with sandstone and siltstone. The Chambersburg Limestone Formation is a dark-gray, argillaceous, cobbly limestone with abundant irregular shaly partings, while the St. Paul Group consists of a micritic and fossiliferous limestone with some black chert and dolomite.

Two folds dominate the structural geology in the northeastern portion of Franklin County, the South Mountain anticlinorium to the east and the Massanutten synclinorium to the west. The Depot is located within the Massanutten synclinorium. Two major faults (the Letterkenny fault and the Pinola fault) and several other unnamed faults are located within the LEAD boundary. These faults have resulted in extensive fracturing and jointing of the formations underlying the LEAD site. Six major joint directions have been reported in the carbonates underlying LEAD (ERM, 1995).

A review of the Energy Information Administration (EIA) Oil and Gas Field Code Master List of 2008 (EIA, 2009) and a database maintained by the Pennsylvania Geological Survey (PGS, 2001) failed to show any oil or gas fields in Franklin County, PA. The lack of producing gas fields in this area is also confirmed by the map of oil and gas producing areas in the State of Pennsylvania (see Map 4). However, no records of wells using modern fracing procedures and/or horizontal drilling techniques were found; this may explain why no gas has been found in the area. It should be noted that the Depot is located along the general southwest to northeast trend of the major petroleum fields in the region. The lack of gas production in Franklin County does not preclude the existence of natural gas beneath the Depot, but it does suggest that drilling a gas well should be considered a "wildcat" operation.

Although the Martinsburg shale is sometimes described as "black carbonaceous shale," it is unclear if it is a petroleum source rock in the Letterkenny area. The Martinsburg shale is of Ordovician age, which makes it considerably older than the Devonian age shale tapped by the Ft. Knox methane gas system. Ordovician age formations (i.e., the Utica Shale) to the north in the State of New York do produce methane gas. The older rocks may be capable of producing methane in this area and only drilling into the surface is capable of making this determination. Another possible target is the Marcellas Shale, which is of Devonian Shale that commonly produces gas further west. It is possible that in valleys between the mountain ranges that some of the younger formations are still present, but not known from surface mapping. The geologic mapping in the area is based on mapping of the elevated mountain areas and not on deep well data. Thus, the elevated formations are subject to erosion, but formations beneath the valley floors would have been protected from erosion. The Devonian Shales are a continuous formation for the main part of the deposit, but towards the edges of the trend, isolated elongate wedges or pieces can be found. This can be caused by deposition and/or ancient folding and faulting. Mature source rocks of younger shales of Devonian and middle upper Paleozoic age are mapped in the area and provide another potential target for gas production. There isn't enough deep well data to actually confirm the exact lithology of the subsurface in this area, however there are indications that sources of gas may exist here. Trico Energy's (the shale gas development company that operates Ft. Knox) investors are willing to take the chance to find out what is available at depth, drilling to 9,000 ft if necessary. Figures 6 and 7 show a sample area of where this drilling might take place.

Based on the available data for this investigation, there is uncertainty on whether or not Ordovician age or the younger shales can produce gas beneath LEAD. Certainly, there is not enough evidence to design a well or estimate the number of wells needed. Map 5 shows the distribution of the Devonian Shale-Middle and Upper Paleozoic Total Petroleum System (TPS). This system identifies areas of known generation, accumulation, and production of petroleum and natural gas (green and yellow). The mature source rocks of the TPS are of Devonian and lower Mississippian age (green). As can be seen, these rocks appear to be less mature to the west and become more mature to the east. Both Ft. Knox and LEAD are off the sweet spot for methane gas production from Devonian shales. But as is known, Ft. Knox has a viable methane gas production system in place.

Frank Irvin, Trico president, told INL that his company's geologic assessment indicated that the right types of rocks may be present beneath the Depot to produce methane. Our geologic assessment confirms that there is uncertainty relative to the success of a methane gas production well at the Depot. It is difficult to quantify chances of success and there may be other factors or data that we are unaware of that could help bracket this uncertainty. However, the best, most recent information is proprietary and not available for our review. Trico, as an exploration company in this area, has access to these data. It is recommended that Trico give a geology presentation to LEAD staff citing the basis for their optimism regarding methane production in this area. It is recommended that the LEAD project move forward with the understanding that drilling for methane in this area is an exploratory process.

Ft. Knox Methane Production Project – As part the evaluation and assessment of methane production on U. S. Army bases and the Depot, an INL team visited Ft. Knox in October 2009. Ft. Knox has an existing project where a series of seven deep wells (600–700 feet) were drilled into the Devonian Shale Formation located under the base, and where biogenetic methane is collected and processed in a manner that meets quality standards for gas consumption on the base or for sale back to the local gas utility. Contacts at Ft. Knox are Emmet Holley, Deputy Garrison Commander; Gary Meredith, Energy Manager; and Robert (R.J.) Dyrdek, Energy Program Manager. Ft. Knox set up a contracting agreement with the regional gas utility and Trico Energy, an energy exploration and production company. Under this agreement, Trico Energy accepted all of the risk and liability for the exploration for methane. Once Trico found what they were looking for, they would be responsible for setting up an infrastructure to monitor the methane production at each well and transport that methane to a centralized processing area. At the processing area (see Figures 9 and 10), the gas is dewatered, compressed, analyzed for quality, odorized, and metered. The base biogenetic methane is compressed to a slightly higher pressure than the gas that comes in from the utility; in this manner, the base uses all of the gas it can from its production system first, and if there is an additional demand, gas from the regional gas utility is accessed.

Figure 9. Drilling operation at Ft. Knox showing the size of the area required for establishment and conducting drilling operations.

Figure 10. Drill pad design and rig used for drilling gas well down to the 600-700 ft. level.

Trico and LEAD worked out a contractual arrangement that encouraged Trico to take the risk to explore for gas under Ft. Knox. In return, they were given preference to development rights if gas was found. Trico worked with local drilling contractors to bring in rigs to drill the deep wells. The equipment used for the drilling operation usually consisted of three to four rigs, as shown in Figures 9 and 10. Trico worked with the driller on location regarding specifications for the drilling operations. The drilling sites were located in areas that did not disturb operations at Ft. Knox and did not require a very large footprint. Usually, all that was needed to prepare the site was a small gravel area, as shown in Figure 10. Once the well was found to be an adequate producing location, it was connected to a piping and collection system, while the pad was instrumented and serviced with power. Figure 11 shows how large an area would be needed for a completed well (in yellow on the ground), the pump house, and the electrical connection. Each of the wells are identified and protected with a metal enclosure (see Figure 12) to reduce any risk that training operations at Ft. Knox might potentially cause. The gas collection system is buried under or along the side of existing roadways. Because the pipe size is not very large (usually only 4–10 in.) and is all plastic, the roadways and shoulders are returned to a usable condition (see Figure 13) in a very short amount of time. In fact, without a yellow marking, in most cases it is difficult to know that a gas line even exists.

Figure 11. Complete gas well (yellow metal structure on the ground along right side), pump house, and electrical connection. Collection system buried along existing road.

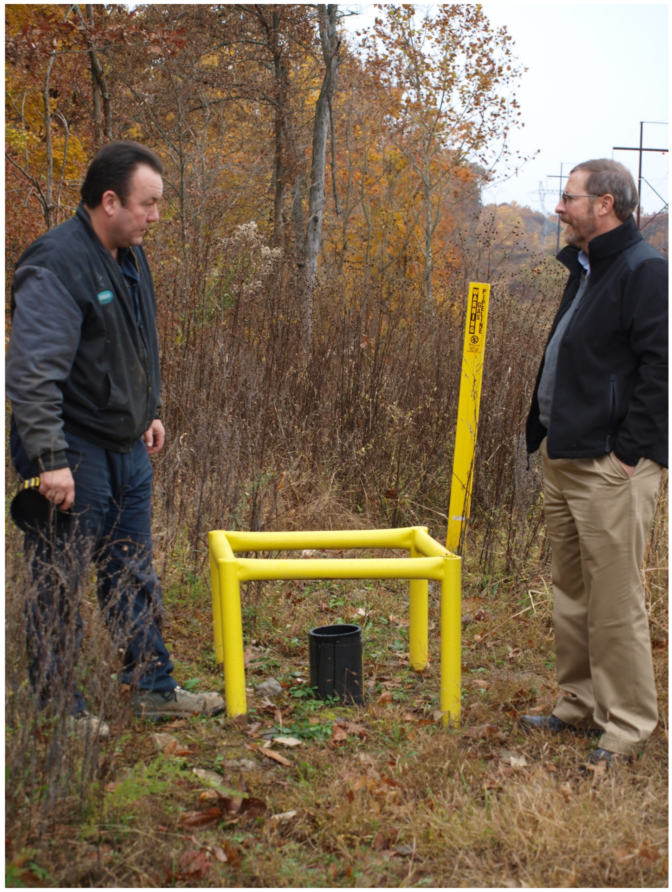


Figure 12. Frank Irvin, President of Trico (left), shows INL's Bob Breckenridge (right) how the gas collection wells are protected to ensure training operations at Ft. Knox do not impact the well heads.

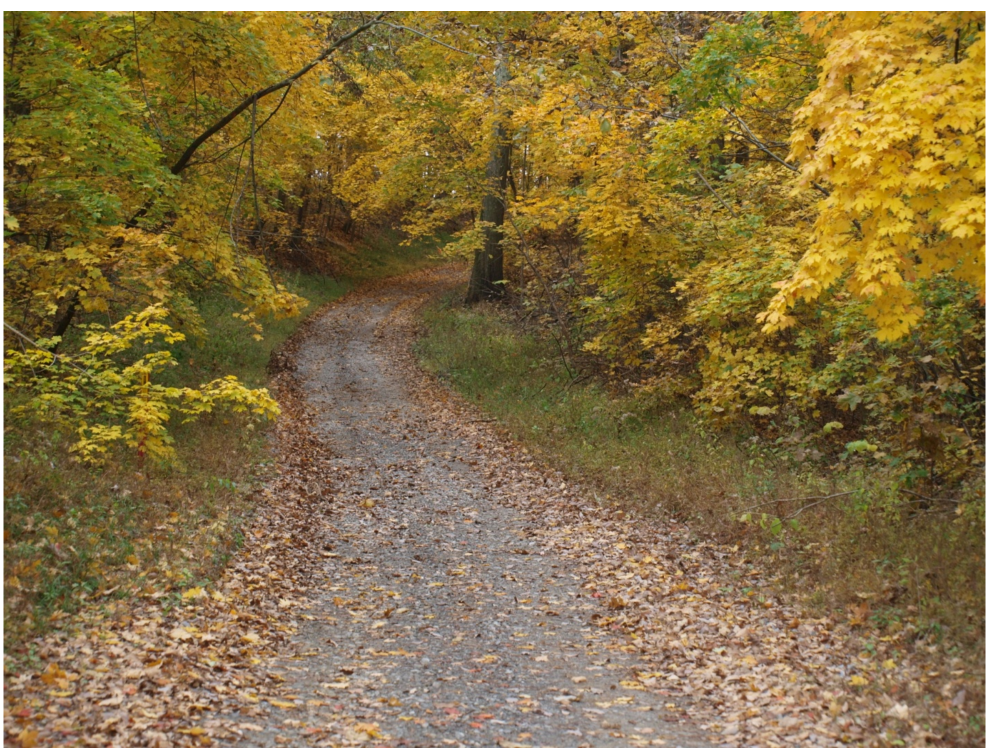


Figure 13. Location of gas collection system buried either under or alongside existing roads.

Once the gas is collected, it is then piped to the gas treatment and pressurizing plant that is located onsite at the Depot (see Figure 14). The overall system is sized (see Figure 15) to handle all existing gas and has some extra capacity to allow Trico to consider adding an additional well that would allow for additional gas production capacity. The system is set up with dewatering and pressurizing equipment (see Figure 16) that allows Trico to produce gas that is of equal or better quality than the Depot would be receiving from the local natural gas distributer. The entire gas treatment system is set up to operate and be monitored (see Figures 17 and 18) by a computer system that can be accessed either locally or by using a remote terminal.

Figure 14. Gas collection and processing facility location.

Figure 15. Gary Meredith, Ft. Knox Energy Manager (left), and Frank Irvin, Trico President (center), discuss with Bob Breckenridge, INL (right), how the gas collection system is operated at Ft. Knox.

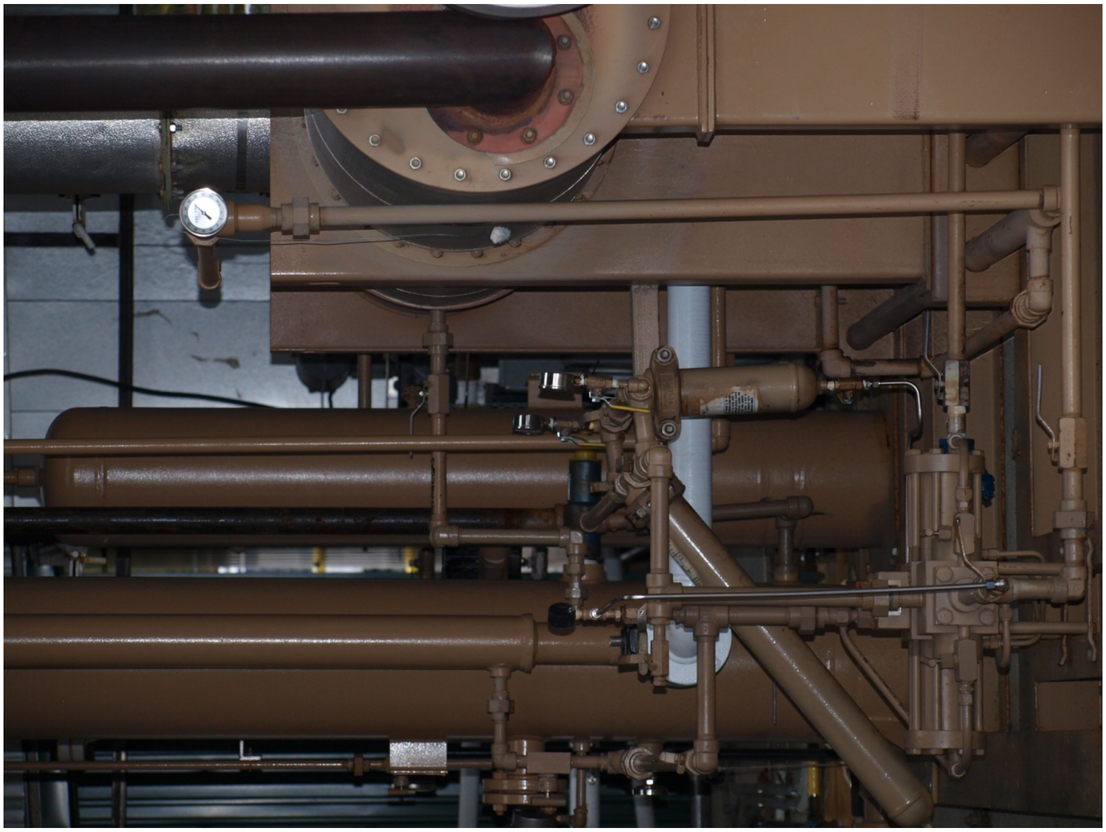


Figure 16. Gas dewatering and purification system at Ft. Knox.

Figure 17. Frank Irvin explains how the gas metering and monitoring system is computer-controlled.

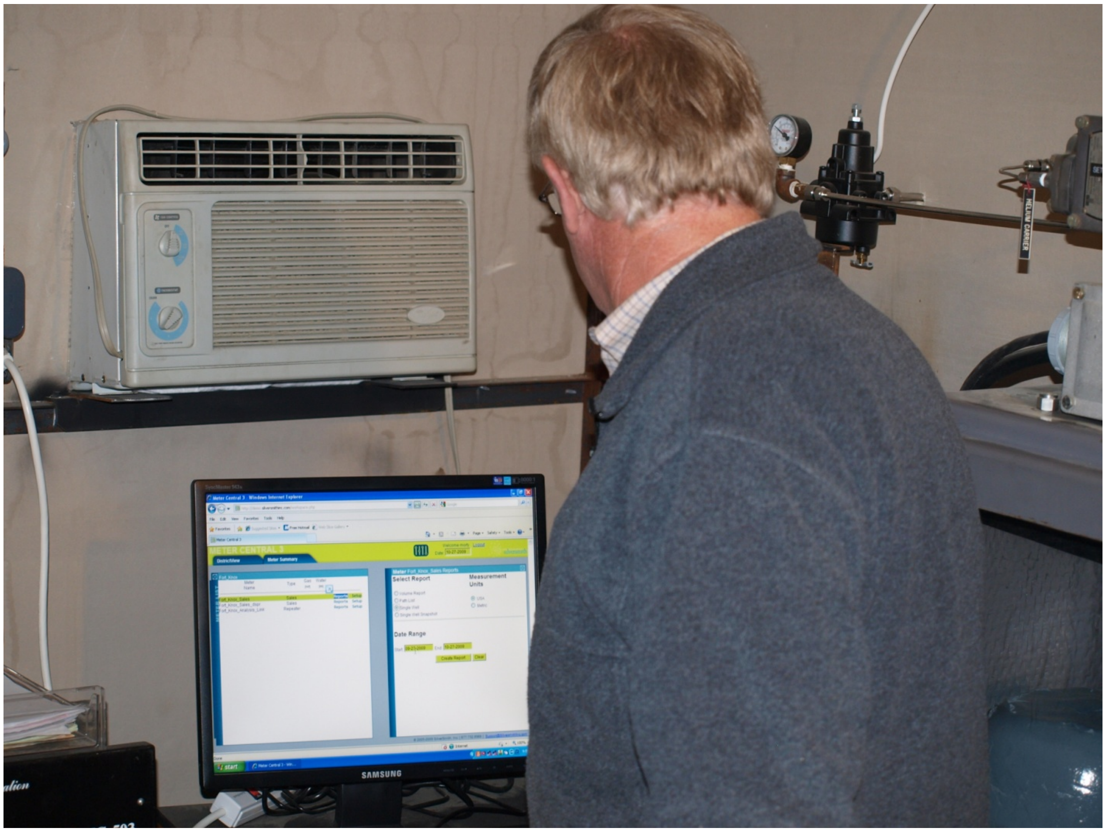
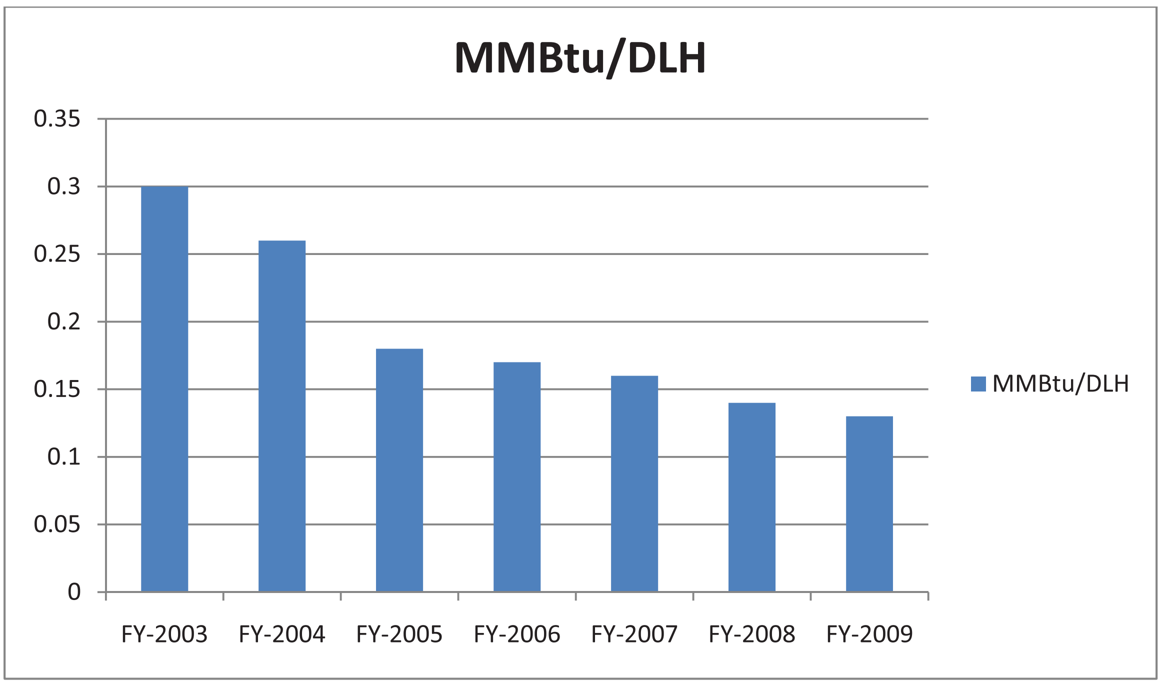


Figure 18. Gary Meredith checks the operating parameters, quantity, and quality of the computer-controlled gas collection system.

Opportunity for LEAD to follow the Ft. Knox model – LEAD has the infrastructure and areas onsite that would allow them to follow the same approach as that designed for Ft. Knox. The road structure and layout of the current design of the Depot would allow for wells to be located in a number of different locations, and for the gas collection system to be collocated with the roads. There is also adequate space at the Depot that would allow for the placement of a gas treatment plant. The existing utility gas line enters the Depot near existing facilities and is easily accessible to be tied into. Trico and Ft. Knox have expended a lot of resources in getting the gas collection and treatment system into the current configuration, which is highly functional. It is recommended that LEAD develop a close working relationship with the Ft. Knox Energy Manager to determine if it is appropriate for him, as well as Trico personnel, to visit LEAD to make suggestions regarding how the Ft. Knox model could be implemented at the Depot. The main unknown with developing a gas collection and treatment system for LEAD is the presence and extent of gas existing below the Depot.

3. ENERGY USE ACCOUNTING

Current Use of Energy – LEAD is an Army Depot that must respond to mission requirements for the U. S. Army. Their mission space involves renovation and repairs of tactical missile and ground support equipment, as well as for the overhaul of High Mobility Multi-purpose Wheeled Vehicles (HMMWVs), tactical forklifts, tactical generators, Force Providers, Mine Resistant Ambush Protection (MRAP) units, and other troop support equipment. Due to the variety of missions, vehicle output is not a reasonable means of measuring production per item produced, nor is the measurement of energy consumption per square foot a reasonable indicator of success in achieving conservation goals. Direct maintenance man-hours (DMH) are the most reasonable means of measuring production requirements. During FY-2003, direct labor man-hours (DLH) expended in mission activities totaled 1.23 million. That total has increased dramatically over the past several years, with DLH exceeding 3.75 million during FY-2009. The calculation of energy consumption per direct labor hour is therefore the most logical means of measuring energy efficiency, and that average has decreased steadily, as shown in the following chart. While workload has grown and energy consumption per square foot has obviously increased as additional shifts have been added to meet demand, consumption per DLH has decreased by 57% ([0.30 - 0.13]/0.30).



The energy usage for LEAD in FY-2003 was 109.26 MMBtu/KSF of energized space. FY-2009 usage, as shown above, was 98.8 MMBtu/KSF.

During FY-2008, LEAD started the replacement of two large gas-fired boilers with new energy-efficient equipment. Installation was completed in FY-2009.

Proposed Use of Energy – The proposed use of energy is based on the assumption that LEAD can develop a biogenic gas field under the Depot of a similar size and production potential as that developed for Ft. Knox. At the Ft. Knox facility, the current monthly production of biogenic methane is about 17,000 MCF; this is just about the current demand for methane usage at Ft. Knox. At LEAD, the Depot is currently using between 8,270 and 20,781 MCF of gas per month to support the two high-efficiency gas-fired boilers. The Depot also uses additional gas to support the heating of buildings and for processing in the dip tanks and paint booths. Thus, if a similar gas field could be developed at LEAD, the production amount would just about equal the demand from the main boiler facility. During the low energy-usage period in the summer, there may be some gas available to either use in the painting operations, sell back to the utility, or to use in a gas-fired air conditioning unit.

Rate Structure for Energy Usages – During FY-2009 (from quarter 1-4), LEAD annual use of energy and costs by major group are shown in Table 1.

Table 1. Energy usages and costs by major utility group for FY-2009 at LEAD.

Utility group	FY-2009 Q1-Q4 cost ($000)	FY-2009 Q1-Q4 consumption (MMBtu)	$/MMBtu
Electric	3,976	180,880	21.98
Natural gas	1,897	230,965	8.21
Propane	188	7,670	24.47
Petroleum	741	69,207	10.71
Total	6,802	488,722	13.92 (average)

4. ENERGY CONSERVATION MEASURES (ECM)/OPTIONS CONSIDERED/AUDITED SYSTEMS

The current energy usage at LEAD for a variety of different fuel and energy sources are shown in Table 1. The amount of natural gas that LEAD used in FY-2009 was 230,965 MMBtu's at a cost of $3,976 k. This amount of gas is equal to about 19,247 MMBtu/month (ranging from a low of 8,270 to a high of 20,781 MCF of gas per month). Based on the assumption that the Ft. Knox project would serve as a successful model, the Depot could theoretically produce 17,000 MMBtu/month. Then, on average, the monthly energy that would need to be purchased from the regional gas utility could be reduced to 2,247 MMBtu/month. The annual energy replacement based on 17,000 MMBtu's/month would be a total of 204,000 MMBtu's per year. The cost savings for the Depot, based on the data available in Tables 1 and 2, would be about $1,674,840/yr (17,000MMBtu's x 8.21$/MMBtu). These values are displayed in Table 2 and will be the only recommendation discussed for this project.

Table 2. Detailed Savings at LEAD.

	Recommendation
Specific energy replacement/ savings /yr	204,000 MMBtu/yr
Specific fuel/energy savings ($/yr)	$1,674,840/yr
General fuel/energy savings (MMMBtu/yr)	204,000 MMBtu/YR
O&M savings ($/yr)	0
Productivity improvements ($/yr, materials/yr)	0
Labor savings (hours/yr, $/yr)	0
Other savings as identified	
Total energy savings (MMMBtu/yr)	204,000MMBtu/yr
Total cost savings ($/yr)	$1,674.840/yr
Conceptual implementation costs ($)	TBD
Simple payback (years)	TBD

Recommendation – Letterkenny Army Depot has an excellent opportunity to pursue the development of a methane extraction and recovery project that, if successful, could provide the Depot a level of energy security that does not currently exist, while drastically reducing natural gas costs. The Depot has a long history of being innovative in the ways it has supported the nation's military missions, as well as excellent institutional and infrastructure categories that would facilitate exploration and installation of a methane recovery system with minimum impact to Depot Operations. The Depot should move quickly to set up a meeting with key players from the successful Ft. Knox project and identify the contracting officer and mechanism that will be critical for moving this project forward. The quicker the Depot can move forward in establishing a testing program to evaluate and verify the extent of the resource located below LEAD, the quicker LEAD can develop its energy source and improve its energy security.

The conceptual implementation costs for this project have not been developed. However, at Ft. Knox, the project costs were all paid for by the developer. The only cost Ft. Knox incurred was to pay for the salaries of the staff that were needed to support and manage the project. The project at Ft. Knox took three years to come on-line; thus, the savings were not realized until the fourth year of the project. Based on these facts and the assumption that the system at LEAD would be similar to that at Ft. Knox, the simple payback would look very favorable.

5. POTENTIAL GREEN HOUSE GAS REDUCTIONS

The potential for GHG reductions with this project would not be significant mostly due to the fact that the project is not a replacement of a petroleum-based fuel, but a one-for-one substitution on one source of natural gas with another. If this project is successful and the Depot is capable of setting up a network of wells and a collection system, the biogenic gas that would be produced and used for fire boilers would be a direct replacement for the natural gas that is presently purchased from the regional gas utility. Although there is no way to accurately calculate the GHG reduction due to reduced length of transport from existing gas fields, the conversion to biogenic onsite methane will probably have some benefit in reducing the net national GHG load.

The production and use of the biogenic gas does help the Depot and the DoD complex gain energy independence and security. Currently, LEAD is reliant on regional utility companies for almost all of its energy requirements. Improving energy security is a very high priority for DoD.

6. ACTION PLAN FOR IMPLEMENTATION OF ECMS

Priorities needing attention in assessment of methane production potential at LEAD:
A field visit was made to the Depot in October 2009 to assess the potential of installing a system similar to the methane gas collection and distribution system at Ft. Knox. Two major categories of institutional and infrastructure issues were evaluated to identify priorities that would need to receive attention if the potential for development of a gas field under LEAD is to become a reality.

Institutional – One of the most important components in having a successful methane exploration and recovery project is to have strong support at very high levels within the institution considering the project. At Ft. Knox, the Garrison Commander and his Deputy have been very supportive and instrumental in making that project successful. At LEAD, both the Director and Deputy Director of Public Works showed strong support for the methane recovery project and felt that there would be a strong foundation in the upper ranks to support such a project. Another important component within the infrastructure is to have a contracting officer and the appropriate mechanism to put the legal paperwork into place to allow the project to move forward. At Ft. Knox, contracts were put into place with the local cooperative gas utility and Trico Energy. It appears that since most, it not all, of the gas that could be produced at LEAD could be used by the Depot, the main contractual agreements would need to be with Trico Energy or a similar exploration company that is willing to take all the risk for exploration. The next step is to have the energy manager at LEAD work with the contracting office and identify a contracting officer that has experience in working these types of unique agreements. If such an officer is not available, LEAD should identify a contracting officer that could go to Ft. Knox and be educated on how the process works there and then bring that knowledge back to LEAD to make the project a reality.

Infrastructure – The formation of both the maintenance operations and munitions storage at LEAD provides an excellent structure for a methane exploration and recovery project. The Depot has an extensive amount of roads around and throughout the Depot that support current operations. This road network could provide an excellent system to transport drill equipment, as well as to allow a network of gas collections pipes to be buried along the shoulders of the roads. The natural gas connection is located near the boiler plant for the Depot. This configuration could make compression and treatment of the methane gas prior to use at the Depot an easy task to accomplish. It should be feasible to locate all of the equipment required to produce and treat the methane gas prior to use in the boilers inside the Depot fence with minimum impact to current Depot operations. Since the Depot operates one to three boilers on an almost continual basis, there would be a full-time demand for the use of this natural gas.

Path Forward – LEAD has a very strong facility structure, with the infrastructure in place to help move forward on a renewable shale gas project. The Depot has excellent staff capable of taking all the appropriate steps towards developing a viable project. It must be realized that moving forward with this effort would be a multiple year commitment by the Depot. However, the effort, if successful, will no doubt return benefits many times over given that the Depot has been in operation since the 1940's and will be in need of a reliable and secure energy source far into the foreseeable future.

The U. S. Army has a wealth of knowledge that has been developed at Ft. Knox as a result of their developing a methane recovery system. One of the outcomes from this effort was to discuss with the staff at LEAD the importance of inviting senior-level representatives along with the base energy program manager from Ft. Knox to LEAD to share and extract the appropriate knowledge that would allow the Depot to move forward in a timely manner. In addition, it was recommended that LEAD invite Frank Irvin, president of Trico Energy, to visit the Depot either at the same time or in the very near future to explain how they teamed with Ft. Knox staff to address engineering, environmental, and institutional challenges. Both of these visits have recently occurred and LEAD is moving forward with getting contracting mechanisms to allow Trico Energy to come onto the Depot and drill a test well.

7. FUNDING ASSISTANCE AVAILABLE

There are a number of different funding mechanisms that could be used to make this project successful. Probably the best option is to follow the example for how the project at Ft. Knox was funded. At Ft. Knox, a private developer approached the base energy engineer and offered to enter an agreement where all the environmental, safety, and health documentation and permits, along with exploration, gas collection, and processing costs, were to be paid by the developer. This was possible because the developer was given an exclusive agreement to allow development and operation rights for a specific period of time if they were able to find gas under the DoD site.

At LEAD, the energy engineer and management have already met with the same developer. He has offered to take all of the financial responsibility for drilling a test well at LEAD. The critical next steps will be to develop a contractual agreement between Trico Energy and the Depot to allow Trico to make the appropriate arrangements to come onto the Depot and drill an exploratory well to evaluate if gas is located there. The energy manager at LEAD will need to work closely with senior management to ensure that they are engaged in all aspects of any gas evaluation and development project.

8. CONTACT INFORMATION

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APPENDIX A

Assumptions, Methodology, References, and Parameters Used

Assessment of Methane Production Opportunity – In order to provide an assessment of the methane production potential at LEAD, it is important to understand the opportunities and challenges that the group at Ft. Knox experienced as they evaluated and developed their project. The Ft. Knox project will be discussed first and then the opportunity for LEAD will be discussed.

Assessment of Ft. Knox Methane Production System – The development of the methane production system at Ft. Knox has taken over three years to reach a point where a substantial amount of gas is being produced to offset the amount of gas the base purchases from the regional gas utility. The goal of the project is to improve energy security by reducing dependence on foreign fuels and increasing the use of on-site produced natural gas. The project team at Ft. Knox was very proactive in their communication to address environmental, historical, and base mission issues. Whenever possible, existing easements, roads, and right of ways were used to bury gas and power lines. The Environmental Assessment for the project was developed by the Trico Energy team and was provided to the U. S. Army and stakeholders for their evaluation and acceptance. Trico conducted an analysis of the quality and quantity for the potential gas resource. Once the resource potential was verified, the Trico team moved in larger drill rigs to access the shale formation and maximize methane production for the Ft. Knox base. An important step in the process was to have Trico install test wells and determine viability of the project. All liability for the well testing effort was born by Trico Energy; there were no costs to the government. Trico located most of the wells in areas that were along existing right of ways with fairly small intrusions. The gas is collected through a network of pipes and transferred to the gas compression and scrubbing operations.

To date, the base has experienced about a 30% reduction in their power bill due to the production and use of on-site produced natural gas. The entire well and gas handling operation is managed under a private contract and there is no cost to the government. The effort has produced a long-term renewable energy source since the biogenetic methane is produced by methanogen microorganisms that use the carbon in the shale as their primary energy source. The methane production helps the U. S. Army meet its green energy goals and support Presidential Executives to increase sustainability. Although it is too soon to tell, the project has all the makings of a sustainable production system that should allow Ft. Knox to have a secure energy resource for many years into the future.

APPENDIX B

Resources

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