WELL CHARACTERIZATION AND EVALUATION PROGRAM FOR NEW YORK STATE OIL AND GAS WELLS

Draft Report

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EXECUTIVE SUMMARY

The history of oil and natural gas production in the State of New York dates back to the nineteenth century. Although most of the State's oil wells and many of the natural gas wells are marginal producers, the petroleum industry remains a valuable mineral industry for the State. New York has approximately 15,000 known commercial oil and gas wells. In 2001, more than 3,277 oil wells and 5,916 gas wells were reported to be active and producing, in addition to approximately 960 storage and solution mining wells. The status of the remaining wells was inactive or unknown.

New York's inventory of drilled wells is both a potential asset and a potential liability. The "drilled well resource" allows industry to respond to and benefit from upswings in oil and natural gas prices as occurred during 2000 and 2001. However, the current inventory of aging, inactive and sub-economic wells will need to be plugged and abandoned at some point, and the future cost of well plugging and site restoration will be substantial. Well plugging and abandonment costs in New York can range from $5,000 per well to more than $50,000 per well depending on the well depth, well condition, site access, and site condition. To the extent that New York operators cannot comply with requirements to plug idle wells or to maintain the mechanical integrity of their inactive wells, the growing inventory of long-term idle wells represents a potential future plugging liability to the State and local governments.

Recognizing both the potential value and the potential risks presented by New York's drilled well inventory, the New York State Energy Research and Development Authority, in coordination with the New York State Department of Environmental Conservation, Minerals Division and the New York Independent Oil and Gas Association, undertook a project to characterize New York's oil and gas wells and to review regulatory and technology options for managing the State's marginal and inactive wells. The goal of the well characterization system is to balance the potential viability of a well - the likelihood of producing commercial quantities of oil or gas - against the potential for the well to become a future financial or environmental liability to the State. The objectives of the project are the following:

- Ensure that New York's marginal and shut-in wells do not become environmental or financial liabilities to the State or local governments.
- Ensure that marginal and inactive wells, which represent a "drilled-well resource", are not prematurely abandoned before the wells can be evaluated for by-passed production and alternative uses.
- Identify cost-effective technologies that could reduce the cost to evaluate, rework, or plug and abandon marginal and uneconomic wells.

This project was conducted between February and August 2002 and culminated in the development of a Well Characterization Tool and methodology to identify and rank wells according to criteria that imply potential liability or potential future value. The Well Characterization Tool can also be used to evaluate the potential impact of proposed regulatory changes and policy initiatives on the current population of oil and gas wells. Additional components of the project included a review of various state and federal requirements for well plugging, inactive or shut-in wells, and well bonding, as well as other state programs for the management of long-term inactive wells. New and emerging technologies were reviewed that have potential application in New York to extend the productive life of marginal fields, return inactive wells to production or reduce the costs of plugging and abandonment of uneconomic wells. Four categories of technologies were reviewed:

- Reservoir and field evaluation; well performance optimization
- Alternative lift systems for marginal wells
- Miscellaneous technologies to enhance or extend production from marginal wells
- Well plugging and abandonment technologies

New York's oil and gas wells were characterized according to a variety of criteria using the Well Characterization Tool, which is a Microsoft Access Visual Basic Module developed for this project to perform quick and efficient queries of New York's current oil and gas database. The Well Characterization Tool was originally designed as a stand-alone desktop analysis tool to be updated periodically with a current version of New York's oil and gas Risk–Based Data Management System (RBDMS). NYSDEC has fully implemented the Well Characterization Tool into New York's SQL Server RBDMS. A stand-alone desktop version of the Well Characterization Tool is available from NYSERDA. The Well Characterization Tool was initially intended to serve as tool to categorize and rank wells to meet the task objectives of this project. The data available to characterize New York wells and to address the objectives of the project include well type; well status; age of the wells (completion date); production data; years out of production; well operator and compliance with well bonding requirements; well depth; producing formation; and cased and cemented intervals in the well. Using the Well Characterization Tool, New York wells were grouped into a number of categories according to well type and well status using criteria such as the age of the wells, years out of production, owner compliance with financial security, etc. These criteria (completion date, number of years inactive, production rate, insufficient bonding, and lack of basic well data) are assumed to represent risk factors that indicate the potential for a well to become a financial or environmental liability.

Following are the key recommendations arising from the well characterization component of this project and the regulatory and technology overviews:

- Develop and implement a regulatory program to manage and eventually reduce New York's current inventory of long-term inactive wells. A long-term inactive well management program could have the following components: increased enforcement of New York's current bonding requirements; increased financial security requirements or additional idle well fees; regulatory provision for long-term inactive status of up to twenty-five years; and requirements for monitoring, integrity-testing, and individual well management plans for long-term inactive wells.
- Conduct comprehensive analyses of reservoir performance and field operations in oil and gas producing fields to identify the remaining productive potential within New York's non-productive and marginal oil and gas fields and develop "best practices" guidelines to extend and enhance New York production.
- Develop a comprehensive well plugging and abandonment strategy to streamline the plugging process, set a realistic plugging schedule, and reduce costs as much as possible for fields where well plugging and abandonment is determined to be the best alternative.
- Expand the capabilities of the Well Characterization Tool to characterize and rank individual wells according to direct risk factors for environmental contamination. This would allow the New York Minerals Division to take full advantage of the environmental management capabilities of the State's Risk-Based Data Management System (RBDMS).

INTRODUCTION

BACKGROUND

As one of the earliest petroleum producing regions in the United States, the State of New York has a long history of oil and natural gas production. Although New York's oil production has been in decline since the first half of the twentieth century and annual gas production has declined from the peak production levels of 1985-1986, the petroleum industry remains a valuable mineral industry for the State. In 2001, 3,277 oil wells and 5,916 gas wells were reported to be active and producing.[1] New York's crude oil production during 2001 was 186,000 barrels,[1] an average of less than one sixth of a barrel per well per day, far below the ten barrels per day normally used to define marginal or "stripper" oil production.[2, 3] During 2001, the average wellhead price of oil was $22.76/barrel,[1] and the estimated market value of New York's crude oil production for 2001 was more than $4.0 million.

New York's natural gas production has rebounded since 1999 to mid-1980's levels due to the emergence of the prolific Trenton-Black River natural gas play, as well as a substantial increase in gas price. During 2001, New York's marketed natural gas production climbed to 27.9 billion cubic feet (Bcf),[1] which at the average 2001 wellhead price of $4.85 per thousand cubic feet (Mcf), had an approximate value of more than $135 million, more than thirty-two times the value of the State's oil production. Average Trenton-Black River production for 2001 was 1,156 Mcf per well per day. Average gas well production from other formations was only 5.9 Mcf per day, much less than the 60 to 90 Mcf/day[3] commonly used to define marginal natural gas production.

New York currently has approximately 15,000 known commercial oil and gas wells. More than 9,100 wells are reported to be active, producing wells, in addition to approximately 960 storage and solution mining wells. The remaining wells are inactive (shut-in or temporarily abandoned) or their status is unknown. New York's inventory of drilled wells is both a potential asset and a potential liability. On one hand, the existing "drilled well resource" allows industry to respond to and benefit from upswings in oil and natural gas prices as occurred during 2000 and 2001. On the other hand, the advanced maturity of the oil and gas industry in New York, as well as the sub-economic average oil and natural gas production, suggest that the current population of aging, marginal wells represents a potential plugging liability to the State, local governments and landowners.

Recognizing both the potential value and the potential risks presented by New York's drilled well resource, the New York State Energy Research and Development Authority (NYSERDA) in coordination with the New York State Department of Environmental Conservation, Minerals Division (NYSDEC) and the

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1 Unpublished Draft 2001 NYSDEC Division of Mineral Resources Annual Report.
2 American Petroleum Institute, *Basic Petroleum Data Book*, Volume XXII, No. 2, August 2002, Section IV, Table 4.
3 National Petroleum Council, 1994. *Marginal Wells*.

Independent Oil and Gas Association of New York (IOGA), undertook a project to develop a technology-based system to characterize New York's oil and gas wells. The goal of the well characterization system is to balance the potential viability of a well - the likelihood of producing commercial quantities of oil or gas - against the potential for the well to become a future financial or environmental liability to the State or local governments. This project was conducted between February and August 2002 and culminated in the development of a Well Characterization Tool and methodology. The Well Characterization Tool can be used to identify and rank wells according to criteria that imply potential liability or potential future value. The Well Characterization Tool can also be used to evaluate the potential impact of proposed regulatory changes and policy initiatives on the current population of oil and gas wells. This project also suggests alternative technological approaches that might be applied in New York State to revive and extend the productive life of marginal wells or to reduce the cost of plugging and abandonment. The Well Characterization Tool can also be used to for initial screening of wells and fields to identify potential candidates for new technology applications.

PROJECT OVERVIEW

Project Objectives

The majority of oil and gas wells in New York produce at rates that suggest the wells are at or near the end of their economically productive lives. At the same time, the wells represent an important asset to the New York oil and gas industry. These facts define the challenge presented by New York's aging and marginal well infrastructure – when should the wells be viewed and managed as an asset, and when as a potential liability? This question is addressed by the three objectives of this project:

- Ensure that the large population of marginal and shut-in wells does not become an environmental or financial liability to the State or local governments.
- Ensure that marginal and inactive wells are not prematurely abandoned before they can be evaluated for by-passed production and alternative uses.
- Identify cost-effective technologies that could reduce the cost to evaluate, rework, or plug and abandon marginal and uneconomic wells.

Tasks

This project was accomplished in eight tasks including two project management tasks and six analytical tasks. The analytical tasks are briefly described below.

1. *Characterize New York State Oil and Gas Wells.* The purpose of this task was to review and characterize all New York oil and gas wells into various categories. Wells were categorized according to criteria that imply potential risk posed by the wells within each category. Potential risk was defined either as risk to the State of New York or local governments to incur the financial responsibility to plug the well, or as the risk of lost opportunity to return the well to production or alternative use.

2. *Review New York and Other State Regulations Pertaining to Well Status and Well Plugging.* This task compared New York regulations pertaining to well status, and plugging and abandonment with other state and federal regulations.

3. *Review Other Well Characterization and Evaluation Programs.* The purpose of this task was to review relevant well characterization and evaluation programs that have been developed and implemented by the American Petroleum Institute and other oil and gas producing states.

4. *Review Innovative Technology.* Various new and innovative technologies for well characterization, reservoir evaluation, well integrity testing, well recompletion, and plugging and abandonment were reviewed to identify technologies that could potentially be applied to extend the productive life of New York's marginal oil and gas fields.

5. *Develop Specific Recommendations for a Well Characterization and Evaluation Program for New York.* The purpose of this task was to develop specific recommendations for a well characterization program for New York. Components of the well characterization program include:

   - Methods and tools to identify and rank marginal producing wells and idle wells at risk of becoming future plugging liabilities,
   - Recommended technologies and practices to evaluate marginal and idle wells for incremental production potential or for alternative uses,
   - Suggested alternatives to plugging and abandonment.

6. *Policy Implication and Direction.* The purpose of this task was to evaluate the recommended well characterization program in the context of New York State legislative and regulatory realities. This task examines the policy implications of the recommended well characterization program and estimates some of the costs of implementation.

Report Structure

This remainder of this report is divided into five sections. The first section describes the project's final policy and program recommendations. Subsequent sections provide a characterization of New York State wells and the results of the regulatory, other program, and technology overview. Appendix A provides a description of the Well Characterization Tool developed for this project. Appendix B provides miscellaneous tables generated using the Well Characterization Tool, which offer "snapshot" characterizations of oil and gas wells according to well type and well status for individual oil or natural gas fields.

RECOMMENDATIONS

Following are four key recommendations arising from the well characterization component of this project and the regulatory and technology overviews:

- Develop and implement a regulatory program to manage and eventually reduce New York's current inventory of long-term inactive wells.

- Implement a comprehensive analysis of reservoir performance and field operations in oil and gas producing fields to identify the remaining productive potential within New York's marginal oil and gas fields and to develop "best practices" guidelines for applying new technologies and practices to extend and enhance New York production.

- Develop a comprehensive well plugging and abandonment strategy.

- Expand the capabilities of the Well Characterization Tool to characterize and rank individual wells according to direct risk factors for environmental contamination. This would allow the New York Minerals Division to take full advantage of the environmental management capabilities of the State's Risk-Based Data Management System (RBDMS).

The remainder of this section discusses the various recommendations in more detail.

MANAGEMENT PROGRAM FOR LONG-TERM INACTIVE WELLS

New York is one of the few oil and gas producing states that have no specific regulatory provisions for long-term shut-in wells (more than two years). New York's current regulations allow an initial shut in period of one-year and an extension of up to one year, renewable for additional successive periods, after which the well must be returned to active operation or plugged. In fact, New York has a large population of long-term inactive or "idle" wells. No production or injection operations have been reported since 1994 for more than 1450 oil wells, 1200 gas wells, and 800 injection wells. Recognizing that more than twenty percent of New York's total population of oil, gas, injection and storage wells have been inactive for at least nine years, it is recommended that New York develop and implement a program to manage these long-term inactive wells. The goals of such a program would be two-fold: (1) to provide the regulatory framework and authority to identify and manage such wells to prevent them from becoming financial and environmental liabilities, and (2) to reduce the number of long-term inactive wells without causing premature abandonment of potentially viable wells.

Long-Term Inactive Well Program; Potential Components

Following is a list of program components that might be considered for an effective long-term inactive well management program. One or more of the program components listed below have been implemented by other states either via special idle well management programs or via the states' shut-in well regulations.

- *Regulatory Framework and Expanded Regulatory Agency Authority.* A regulatory framework is needed to implement an inactive well management program that would allow long-term inactive well status of five years or more. Other oil and gas states have been successful in expanding the authority of their regulatory agencies for developing, administering and enforcing idle well management programs.

- *Annual Inactive Well Fee.* Operators pay a small annual inactive well fee for each well maintained in the program. Such a fee might be on the order of $25 to $100 per well per year, and would be waived for wells covered by individual well bonds, or for wells scheduled to be plugged or returned to production under an inactive well management plan. The purpose of an inactive well fee in states with inactive well management programs is to defray some of the program administration costs, as well to encourage operators to seriously evaluate which wells are worth maintaining in long-term inactive status.

- *Demonstrate Mechanical Integrity and Level of Contamination Risk.* To maintain long-term inactive well status, operators should be required to demonstrate that their inactive wells are mechanically sound and capable of being returned to production and present little risk of surface or USDW[4] contamination. At minimum, operators could be asked to provide the results of periodic fluid level tests accompanied by a determination of the wellbore depth of the lowermost USDWs. Fluid level tests might be required every one to two years and mechanical integrity tests every three to five years. Operators could be required to demonstrate that wells proposed for long-term inactive status are capable of production. The wells should have no obstructions that would prevent production (for example, no junk in the well, collapsed casing, sand fill, or blocked perforations). Some states have identified minimum standards for oil and gas production and injection operations that wells must meet in order to maintain "active producing" status.

- *Annual Plan to Reduce Inactive Wells.* For each inactive well, operators could be required to file an annual plan to either return the well to production or other active operations, plug the well, or maintain the well in a long-term idle well management program. If an operator submits a plan to either plug and abandon or re-activate a well, the annual inactive well fee could be waived. For large numbers of wells requiring plugging, a long-term inactive well

[4] A USDW is an underground source of drinking water. USDWs include drinking water aquifers, aquifers with total dissolved solids (TDS) less than 1,000 ppm, in addition to aquifers with TDS less than or equal to 10,000 ppm, which represent potential drinking water supply after water treatment.

program could offer a multi-year plugging and abandonment schedule, which would spread the operators' cost burden over several years while accomplishing the State's goal of eventually reducing the number of idle wells.

- *Orphan Well Prevention Program.* Implementing a long-term inactive well program may increase the number of effective "orphan" wells, resulting from recalcitrant well owners who may refuse to comply with program requirements, or from insolvent, absentee, or non-responsive well owners who may be incapable of complying with program requirements. Some states offer such wells to other operators willing to attempt returning the well to production within a specified time. California has termed this concept "take an orphan well for a test drive." If the "test drive" is successful, the operator gains the well production. If unsuccessful, the operator incurs no plugging liability for the well. Variations on this concept might be developed and tailored for New York's laws and leasing structure.

CONDUCT COMPREHENSIVE, TECHNOLOGY-BASED ANALYSES OF RESERVOIR PERFORMANCE AND FIELD OPERATIONS

The primary recommendation arising from the technology overview task is that NYSERDA facilitate comprehensive, integrated evaluations of New York's marginal and sub-economic oil and gas fields, focused on wells and fields where operators are unwilling or unable to identify and implement opportunities to increase production. This recommendation has three related components:

- Undertake integrated analyses of reservoir performance and current field operations for marginal and sub-economic oil and gas fields.
- Develop technology-based 'best practices' guidelines to increase production.
- Conduct a comprehensive evaluation of fluid lifting technology and well stimulation practices in current producing fields.

Reservoir Performance and Engineering Analyses of Marginal and Sub-Economic Oil and Gas Fields; Technology 'Best Practices' Guidelines

One of NYSERDA's objectives was to develop a well characterization system that prevents the premature abandonment of New York's marginal and non-performing wells. A crucial element of such a well characterization system is to undertake a parallel effort to determine the remaining productive potential of New York's poor performing fields and develop 'best practices' or technology guidelines for these fields. Such an effort could result in a portfolio of oil and gas producing fields ranked according to the potential for additional economic oil or gas production. Potential candidate wells and fields for specific diagnostic techniques and production technologies would also be identified.

The goal of this recommendation is to inventory New York's remaining oil and gas resource base; estimate the potential productivity; diagnose the obstacles and problems on an individual field level; and recommend field-level, reservoir-level, or individual well-level techniques and technologies to boost production. For those fields and individual wells with potential to return to productive status or increase current production, the resulting 'best practices' guidelines might include minimum production criteria for active wells, in addition to suggested diagnostic surveys, potential workover or secondary recovery target formations, and recommended technology applications and demonstration projects. For other fields, reservoir and field operations analyses may result in recommendations to plug the wells and abandon the field, or to convert the field to an alternative use.

The Well Characterization Tool developed for this project (and described later in this report) can be used to initially identify and prioritize areas for further study. For example, the Well Characterization Tool could be used to locate and rank oil and gas fields, townships, and/or producing formations from 'most prospective' to 'least prospective' in terms of current oil and gas production or other criteria. The Well Characterization Tool also allows rapid identification and classification of active wells. For gas wells, production queries can be structured to quickly pinpoint wells that may have an anomalous production history compared to neighboring wells. Understanding the production profiles of individual oil wells is more complex because oil production is typically not reported on an individual well basis. Multiple oil wells with active status are often connected to oil tanks for which marginal or sub-economic levels of production are reported. In such cases it appears that only one well or a handful of wells may be contributing to the tank production and the remaining wells are, in effect, non-producing wells. Well Characterization Tool queries can be used to locate the most productive oil wells within a field.

Comprehensive Technical and Economic Evaluations of Selected Technology in Current Producing Fields

While the focus of the previous recommendation is boosting production in poor performing fields, the focus of this recommendation is to improve the production efficiency of the better-performing oil and gas fields, thereby improving field economics and extending the producing horizon of individual wells within the fields.[5] Again, NYSERDA's role would be to facilitate evaluation of technologies and techniques that, if successful, might be applied in multiple producing areas Statewide. Components of such evaluations could include comprehensive, state-wide evaluation of specific well production practices; area-wide or field-wide evaluations of potential by-passed pay horizons, demonstration projects of new technologies that have not yet been applied in New York or technology that may be under-represented in the State.

Two areas that might be particularly fruitful for NYSERDA to investigate include evaluation of current fluid-lifting technology and the potential costs and benefits of new technology, and evaluation of past and

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[5] Improved production efficiency could result from increased well production, lower operating costs, or a combination of both.

current formation and well stimulation practices. The focus of the former evaluation would be on technologies and practices to reduce operating costs and potentially improve production, whereas the primary focus of the latter evaluation would be technologies specifically designed to improve production. The Well Characterization Tool developed for this project could be used to define study areas based on initial screening of producing formations, well production, well depth, and water production, etc.

DEVELOP A COMPREHENSIVE WELL PLUGGING AND ABANDONMENT STRATEGY

This final recommendation is closely related to the first and second recommendations. Programs and strategies to manage long-term inactive wells and sub-economic active wells will likely result in a growing inventory of wells with high priority for plugging and abandonment (P&A). This could potentially represent a huge financial burden to the oil and gas industry and potentially to the State. The recommended inactive well and field evaluation programs are likely to be more effective, if at the same time, New York can develop a comprehensive strategy to reduce P&A costs and make the process more efficient. Following are potential components of a comprehensive well plugging and abandonment strategy that might be considered.

Comprehensive Well P&A Strategy – Potential Components

- *Streamline Well Plugging and Abandonment Process.* The permitting and approval process for well plugging and abandonment should be evaluated and streamlined as much as possible, especially for operators with multiple plugging operations in a single field.
- *Evaluate New P&A Techniques and Technologies.* Consider new techniques that may reduce P&A costs, as well as be applicable to New York. Conduct field demonstrations and pilot programs to test promising techniques, which if found to be successful and cost-effective, could be promoted to operators as appropriate. Examples might include bentonite plugging or other alternative P&A designs.
- *Identify P&A Cost Reduction Measures.* Some states have evaluated and approved novel technical approaches for well plugging and abandonment. Alternative funding approaches include grants to landowners to P&A wells on their property; cost sharing arrangements between states and operators; and agreements to plug wells in place of other fines and requirements. Other measures include scrutiny of all physical aspects of the plugging and abandonment process including well site access, well preparation and site restoration issues to identify ways to streamline the process and reduce costs.
- *Identify Priority Fields for P&A.* A list of priority fields and wells for P&A would be an outcome of a comprehensive performance analysis of all oil and gas fields. The Well

Characterization Tool could be used to screen wells and fields and aid in the compilation of a State list of 'high risk' wells and fields that would be ineligible for a long-term inactive well program. Such fields might include the numerous fields that contain multiple inactive wells and report no production from active wells. Other priority P&A fields would include fields with a high contamination risk determined based on environmental ranking criteria as it becomes available, or prior knowledge of site conditions at the field.

EXPAND THE WELL CHARACTERIZATION TOOL CAPABILITY TO CHARACTERIZE ENVIRONMENTAL RISK

The Well Characterization Tool can be used to rank wells according to the potential risk of surface and aquifer contamination from the well, as well as the potential risk of the well becoming a financial liability to the State or local communities. At present, the ranking logic in the Well Characterization Tool uses the age of the well, the number of years with no reported production, and whether any data is available on the well construction to imply a level of potential contamination risk. Ideally, characterization and ranking of wells according to potential environmental risk of contamination should be based upon criteria that are directly related to the potential of the well to become a source of contamination. Such criteria might include: depth of aquifers penetrated by the well, protection of these aquifers by casing and cement, depth of the producing zone, location and type of well plugs, fluid level and casing pressure tests, other mechanical integrity surveys, site surveys, and proximity of the well to surface water and sensitive environments. Much of this information continues to be collected for New York wells, but has not been converted to the RBDMS database and is not available to be used with the Well Characterization Tool.

It is recommended that New York expand the environmental management capabilities of the Well Characterization Tool to characterize and rank wells according to criteria that accurately represent potential contamination risk. Implementing this recommendation will require that New York transfer environmental and well data currently on paper forms into RBDMS. The Well Characterization Tool has already been designed to accommodate an 'Environmental Rank ID', a five or six-element code assigned to individual wells which describe the well according to various indicators of potential contamination risk. Suggested code elements for 'Environmental Rank ID' include well type, years inactive, casing and levels of USDW protection, fluid level, mechanical integrity tests, age of the well (if age triggers other compliance requirements), and other environmental flags such as site inspections, proximity to surface water and sensitive environments, and proximity to known drinking water supplies.

CHARACTERIZATION OF NEW YORK STATE WELLS

This section provides an overview of the population of New York wells and a starting point from which to evaluate the various options to limit the future financial and environmental risk from long-term inactive wells. This section characterizes New York State wells according to well type and well status; well type and owner; well type and financial security requirements; well type and age; and well type and years out of production (from base year of 1999).

WELL CHARACTERIZATION TOOL

New York's oil and gas wells were characterized according to a variety of criteria using the Well Characterization Tool, which is a Microsoft Access Visual Basic Module developed by ICF Consulting to perform quick and efficient queries of New York's current oil and gas database. The Well Characterization Tool is intended to serve as tool to categorize and rank wells for the objectives of this project:

- To identify marginal, inactive and orphan wells that may present a financial liability to the State and local governments.
- To identify candidate wells for new technologies to improve production, reduce environmental risk, or reduce the costs of plugging and abandonment.
- To evaluate the potential implications of recommended regulatory or policy changes and initiatives. For example, the Well Characterization Tool can be used to estimate the locations and numbers of wells that could be impacted by a proposed regulatory or policy initiative.

New York is in the process of fully implementing RBDMS to manage all production and well data pertaining to oil and gas wells, storage, injection, brine and other miscellaneous wells. The current RBDMS contains more than 33,000 well records, so working with the database for the purpose of efficiently searching and categorizing wells is a daunting undertaking. The Well Characterization Tool was developed to efficiently accomplish the characterization of New York wells. The Well Characterization Tool consists of three components:

- Master well database comprised of selected data tables extracted from New York's SQL Server RBDMS
- Graphical user interface to construct database queries, and
- Customized query results table.

The RBDMS data tables that are incorporated into the Well Characterization Tool master database are shown in Table 1.

Table 1. Data Elements in Well Characterization Tool Master Table

RBDMS Data Table	Description
tblWellMaster	Well location, API number, spud date, completion date, well status, well type
tblPrdWells	Producing oil wells
tblGeoFmtn	Geologic formations, producing formations, field names
tblGeoFmtnTops	
tblGeoFields	
tblRefCompany	Well ownership; financial security compliance
tblWellCement	Casing and cement intervals
tblWellCementCls	Cement type and cement volumes
tblNYAnnualWell	Current reported oil, gas, and water production
tblPrdGasVolume	Annual gas production
tblPrdOilVolume	Annual oil production

Figure 1 shows an example of the graphical user interface and Figure 2 provides an example of the customized results table. A detailed discussion of the design and function of the Well Characterization Tool is provided in Appendix A. New York's RBDMS database platform is Microsoft SQL Server, which is updated daily. The Well Characterization Tool was originally designed as a stand-alone desktop analysis tool to be updated periodically with a current version of RBDMS. The New York Department of Environmental Conservation Minerals Division has since fully implemented the Well Characterization Tool into New York's SQL Server RBDMS. A stand-alone desktop version of the Well Characterization Tool is available from NYSERDA. The master tables for the Well Characterization Tool must be extracted into Microsoft Access from a current version of the New York Risk Based Data Management System (RBDMS). The version of the RBDMS master well tables used for this project contained the most current well data and production data available during March 2002. The data include gas production data complete through 2000; complete oil production data through 1999, as well as incomplete oil and gas well data and production data for 2000 and 2001. Since the oil production data was complete through 1999, the base year selected for the well characterization analysis was 1999. Because the 1999 base year does not match the current year, the well characterization analysis presented in this section should be considered a general overview of New York State wells rather than a precise count of current wells in the various categories. This report section provides an "order of magnitude" characterization of New York oil and gas wells that illustrates the challenges presented by New York's current oil and gas infrastructure. This section also illustrates how the Well Characterization Tool might be used in the future to implement study recommendations or similar policy initiatives, using up-to-date well and production data.

Figure 1. Well Characterization Tool Graphical User Interface

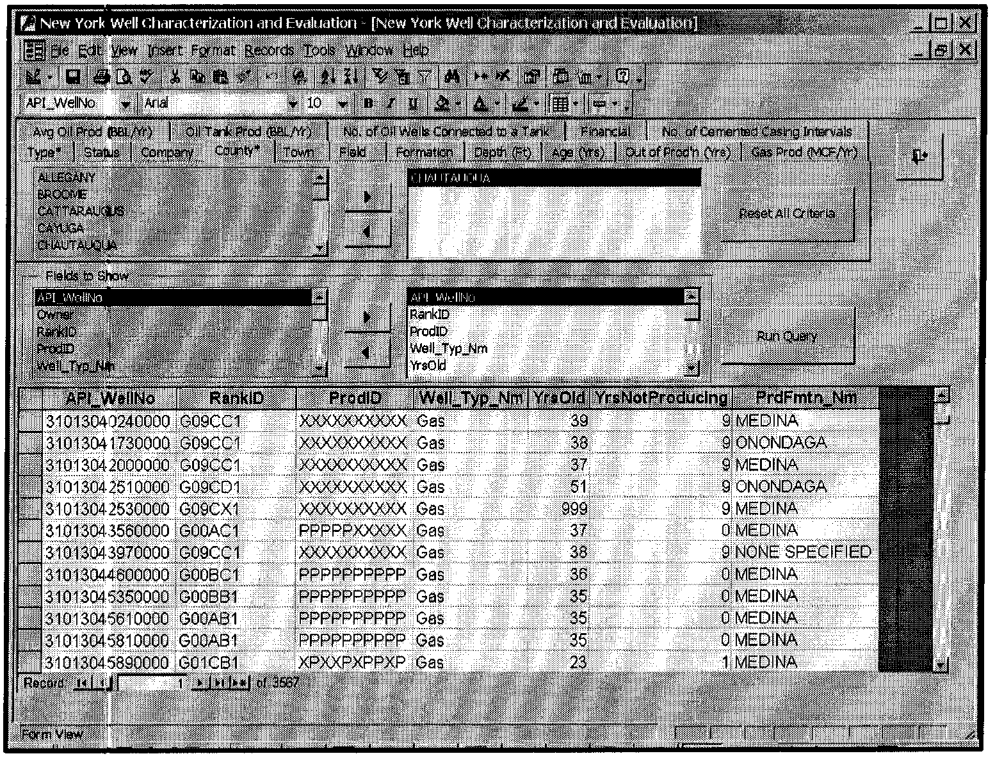


Figure 2. Well Characterization Tool – Query Results Table Example

Well API No	Rank ID	Production ID	Age	Years Not Producing	Formation
31013225350000	G02AA1	XXPPPX----	5	2	MEDINA
31013225360000	G02AA1	XXPPPX----	5	2	WHIRLPOOL
31013225190000	G02AA1	XXPPPP----	5	2	MEDINA
31013225470000	G02AA1	XXPPP-----	4	2	MEDINA
31013225830000	G02AA1	XXPP------	3	2	MEDINA
31013223210000	G02AA0	XXPPPPPX--	7	2	MEDINA
31013170530000	G01DB1	XPXXXXPXPP	18	1	MEDINA
31013045890000	G01CB1	XPXXPXPPXP	23	1	MEDINA
31013121930000	G01CB1	XPPPPPXPPP	22	1	MEDINA
31013187450000	G01CB0	XPPPPPPPPP	16	1	MEDINA
31013121600000	G01BB1	XPXXXPXPPP	22	1	MEDINA
31013109730000	G01BB1	XPXXXPPPPX	25	1	MEDINA

Special Features of the Well Characterization Tool

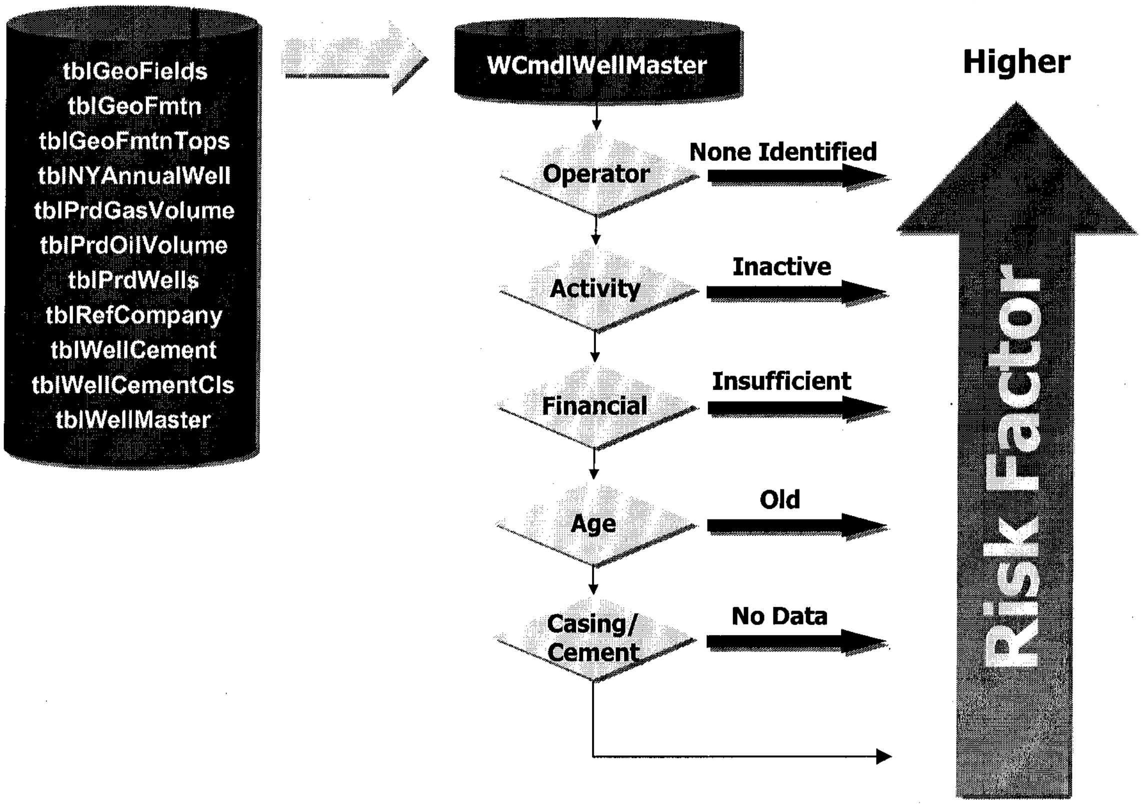
A detailed description of the Well Characterization Tool is provided in Appendix A, however several features of the tool require some discussion here. The Well Characterization Tool database is pre-screened to filter out all wells in the RBDMS Master Well table with status of plugged and abandoned (PA). The Well Characterization Tool developed for this project applies only to wells with active, inactive, or unknown status, and does not evaluate plugged and abandoned wells. The version of the Master Well Database extracted for this project contains 17,935 wells (excluding plugged and abandoned wells), most of which are commercial oil and gas wells. To the extent that domestic or home use gas wells are identified in the RBDMS data, they are excluded from the master database queries.

The Well Characterization Tool database contains the data fields named 'Prd_*year,*' such as 'Prd_1999', 'Prd_1998', etc. For most gas wells, this data field represents the total well production reported for an individual well for the year. For most oil wells, annual oil production is reported by tank, not by individual wells. The annual production value reported for individual oil wells in the data field 'Prd_*year*' is calculated by the Well Characterization Tool and represents an average annual production for the well based on the total tank production for the year divided by the number of oil wells assigned to the tank ID. The oil well production data are not intended to represent actual oil production from individual wells. However, the average per well oil production is a useful parameter for ranking and comparing wells, as discussed later in this report.

The field 'RankID' was created in the Well Characterization Tool database to score and rank each individual well according to various criteria such as age of the well, estimated production, years inactive. The 'RankID' scoring system is described in Appendix A. The 'RankID' is designed so that after a database query result is returned, the wells can be sorted in descending order by 'RankID'. The wells that present the greatest potential risk of environmental and financial liability are returned at the top of the data table. For example, age and years without reported production are two key risk factors. When a query result is sorted, the oldest wells with the most years out of production are returned near the top of the list, the highest priority wells being those with no identified owner/operator.

When the Well Characterization Tool was first developed, the ranking methodology was originally intended to score and rank wells according to various direct environmental risk factors such as proximity to drinking water aquifers, type of well completion and levels of USDW protection, surface contamination, etc. The Well Characterization Tool currently contains a data field called 'RankEnv', which is not currently populated. Although New York captures data on various well site characteristics and well features that could be used to identify direct environmental risk factors, the data are only available on paper forms, not in electronic format in the RBDMS master tables. Due to the lack of electronic data, ranking of wells according to environmental risk could not be accomplished except in the most general way. Although the 'RankEnv' data field is not currently populated, it is available for the future when the detailed environmental data are eventually transferred to New York's RBDMS. Figure 3 illustrates the Well Characterization Tool 'Rank ID' concept.

Figure 3. Overview of the Well Characterization Tool 'RankID' Concept



CHARACTERIZATION OF NEW YORK STATE WELLS

Introduction

This section provides a general characterization of New York State wells using the Well Characterization Tool. The objectives of the Well Characterization task were the following:

- Ensure that the large population of marginal and shut-in wells does not become an environmental or financial liability to the State or local governments.
- Ensure that marginal and inactive wells are not prematurely abandoned before the wells can be evaluated for by-passed production and alternative uses.
- Identify cost-effective technologies that could reduce the cost to evaluate, rework, or plug and abandon marginal wells.

The information available to address these objectives included well type, well status, the age of the wells, production data, years out of production, the owner of the well and compliance with financial security requirements, the depth of the well, producing formation, and cased and cemented intervals in the well. This section provides a series of tables that group New York wells by well type and status according to various categories representing potential risk factors such as the age; years out of production; owner compliance with financial security requirements; availability of data on well construction; and average well depth. Factors such as the age of a well, years with no reported production, insufficient bonding, and lack of basic well data are assumed to indicate the potential for a well to become a financial or environmental liability.

An example of a high risk well might be seventy-year-old oil well that has no reported production for the past ten years. No information about the well construction is available such as depth and type of surface casing, production casing or cement. The well owner may be exempt from bonding requirements, so no financial security has been provided for the eventual plugging of the well. While none of these factors provides a direct indication of the financial or environmental risk posed by the well, they indicate potential areas for concern or further investigation. A seventy-year old oil well with no production reported for ten years suggests that the well may receive little attention and maintenance. Nothing is known about the mechanical integrity of the well or the reason for the lack of production. It is unknown whether the well could be a workover candidate.

The tables included in this section provide a general characterization of oil and gas wells in New York, which indicate areas of concern and the potential magnitude of effort needed to adequately address the challenges and opportunities provided by New York's aging, marginal wells. Although it was beyond the scope of this project to provide detailed analyses of specific regions, this section nevertheless provides examples of how the Well Characterization Tool can be used to obtain a more detailed profile of idle and marginal wells and potential future risk within the boundaries of a specific oil and gas field or municipality.

Overview of Well Types and Well Status

The master database generated by the Well Characterization Tool contains 17,935 wells. Table 2 provides a crosswalk between the well types and well status codes in the New York RBDMS data. Table 2 shows for example, that gas wells are coded as one of six well types such as 'Gas', 'GD' (gas development well), 'GE' (gas exploratory well), etc. Oil wells are similarly coded as one of seven well types. Storage wells have four well type categories, and injection wells and dry holes each have two well type categories. 'Other' well types include stratigraphic tests, unknown wells, geothermal wells, dummy records, and coalbed methane. The Well Characterization Tool groups all of the well types shown in Table 2 into seven well types: 'Gas', 'Oil', 'Dry Hole', 'Storage', 'Injection, 'Unknown', and 'Other'. For example, the seven RBDMS well types that designate oil wells are included under the single category of 'Oil' in the Well Characterization Tool.

Table 2 shows that there are eighteen RBDMS well status designations. Although some of the well status designations are lightly populated with wells, all of the well status categories are incorporated into the Well Characterization Tool. Six of the well status designations are relevant to the objectives of the well characterization task and are the focus of the analysis described in this section: 'AC' (active), 'PR' (producing), 'IN' (inactive), 'SI' (shut in), 'TA' (temporarily abandoned), and 'UN' (unknown). Of the 17,935 wells in the database, approximately 6,162 wells are oil wells and 7,939 wells are gas wells. Approximately 56 percent of the oil wells are active (3,465 wells), 28 percent are inactive (1,728 wells), and 16 percent are unknown (958 wells). Approximately 75 percent of gas wells have active or producing status (5,992 wells), 8 percent are inactive, shut-in, or temporarily abandoned (621 wells), and approximately 16 percent have unknown status (1,268 wells). Ninety-six percent of the approximately 856 storage wells are active (819 wells). Of the 1,174 injection wells, approximately 52 percent are inactive (610 wells); 22 percent are active (260 wells) and 26 percent (303 wells) are unknown. Ninety-four percent of the 699 dry holes and dry wildcats have unknown status (660 wells).

Table 2. Overview of New York Wells by Well Type and Well Status

Well Type		Well Status																		Total
		AC	PR	IN	SI	TA	UN	AB	C	CA	DC	DG	DR	HU	I	PW	SP	VP	WC	
Gas	Gas	1	16		2	2	3		2	1	2	8			7	9	1		1	**55**
	GD	5649	1	531	8	2	1155	4						4				3		**7357**
	GE	152		23	4		7													**186**
	GEL								1											**1**
	GW	172		37	12		98	15												**334**
	GWL	1					5													**6**
Oil	Oil		4	3											10					**17**
	OD	3333		1701			942											1		**5977**
	ODM	2		2																**4**
	OE	4		1			1													**6**
	OW	53		18			11													**82**
	OB	68		3			4													**75**
	OBL	1																		**1**
Storage	ST	807			6	3	14	1							4					**835**
	STL	10								1										**11**
	SO														1	3				**4**
	SE	2					4													**6**
Injection	IG			1			1											1		**3**
	IW	260		609			302													**1171**
Dry Hole	DH	3		11	4	2	169	2										1		**192**
	DW	2		3	3	3	491	5												**507**
Brine	BR	72	1	38	7		51	3												**172**
	BRL	5		2			1													**8**
Other	UN	25	1	130		8	343											329		**836**
	CM												1							**1**
	DMY															1				**1**
	DS	4		2			1													**7**
	DSL			4																**4**
	SG	20		4	1		29													**54**
	TH	5		12			5													**22**
Totals		**10651**	**23**	**3135**	**47**	**20**	**3637**	**30**	**3**	**2**	**2**	**8**	**1**	**4**	**22**	**13**	**1**	**335**	**1**	**17935**

Well Type Codes: AC = Active; PR = Producing; IN = Inactive; S I= Shut-in; TA = Temp Aband.; UN= Unknown; AB = Abandoned; C = Completed; CA = Cancelled; DC = Drilling Complete; DG = Drilling; HU = Home Use; I = Issued Permit; PW = Permitted Well; SP= Spudded; VP = Void Permit; WC = Waiting on Completion

Oil Wells

This section contains summary tables, which were constructed from queries using the Well Characterization Tool. The purpose of these summary tables is to provide an overview characterization of New York wells, based on the master well and production data that were available in RBDMS at the start of this project. Because New York's master well database is updated daily, the same query run during different months on different versions of the database may return different results. The purpose of the tables in this section is to provide an "order of magnitude" characterization of New York wells to identify the most important areas for concern and further investigation. For example, if a particular query returns a result of 106 wells, the significance of the query is determined by the relative magnitude of the result not the specific number. This allows public and private resources to be focused on issues and solutions that could potentially impact many wells rather than only a few wells or a single well.

The summary tables presented here represent the results of multiple queries plus additional filtering applied to the results table returned by the Well Characterization Tool. The results table returned by each query can be renamed and saved in the Well Characterization Tool Access module. From there, the query results can be further sorted, filtered and additional operations applied.

Inactive Oil Wells. For the 1999 base year, a query of inactive oil wells that reported no annual production for at least one year returns 1495 wells. Further filtering of the query results found that some current year production data (2000 and 2001 production) were reported for 58 wells, which suggests that the wells were recently returned to active status, were misclassified, or were new wells. Table 3 summarizes the results of a database query on inactive oil wells, which excludes the wells with inactive status that report some current year oil production. Table 3 shows that approximately 1437 inactive New York oil wells have no reported production for at least one year. Fifty-seven percent of inactive oil wells have been out of production for at least nine or more years and are clearly long-term inactive wells. Nearly 64 percent of inactive oil wells (915 wells) are of unknown age or were completed before the year 1924. More than half of inactive oil wells (approximately 731 wells) are exempt from financial security requirements. For 30 percent of inactive oil wells, the well owner appears to be out of compliance with the well bonding requirements for his operations. As a result, Table 3 suggests that as many as 80 percent of inactive oil wells may have little or no financial security for the eventual plugging and abandonment of the well.

Which inactive oil wells present the greatest potential financial or environmental liability for the State or local communities? If age and years of non-production are assumed to imply a greater potential for damage, leaks, or neglect, then Table 3 indicates that a large number of inactive oil wells could be investigated further through a combination of well owner contacts, review of well records, and site inspections. Table 3 can be used to estimate the potential impact and costs of such initiatives and other proposed inactive well policies. For example, if new permit requirements were proposed for long-term inactive wells, the potential number of impacted wells would be determined by the definition of 'long-term inactive' status. Table 3 shows that if long-term inactive status was defined as ten years of non-production, then at least 800 inactive oil wells could be impacted; if the cut-off definition was five years of non-production, then more than 1050 inactive oil wells could be impacted.

Table 3. Inactive Oil Wells

Years w/ No Production	Age (Years)					Total Wells	Bonding Status			Well Data	
	Unknown	>75	>35 - 75	10 -35	<10		No Identified Owner/ Operator	Wells w/ No Bond Required	Operator Bond Less Than Required	Well Data Available (Casing, Cement)	Average Well Depth
≥ 9	511	33	130	145	-	819	-	496	203	4	1187
8	-	-	-	-	-	-	-	-	-	-	-
7	9	1	3	26	-	39	-	10	19	-	1415
6	7	3	-	3	1	14	-	10	1	-	1160
5	144	-	10	25	1	180	-	11	164	-	1517
4	23	-	1	13	1	38	-	22	9	1	1401
3	37	-	29	32	4	102	-	59	1	-	941
2	67	2	4	29	4	106	-	53	31	1	1157
1	77	1	-	49	12	139	-	70	2	2	784
Totals:	**875**	**40**	**177**	**322**	**23**	**1437**		**731**	**430**	**8**	**1195**

Table 3 and the following summary tables in this section can also be used to estimate the potential cost of proposed inactive well policies. For example, if all of the inactive oil wells in Table 3 were required to be plugged and abandoned at an average cost of $10,000 to $20,000 per well, a conservative estimate of the total cost to plug these wells could be in the range of $14 million to $29 million. However, the cost burden for the eventual plugging of all the inactive wells in Table 3 could be reduced, deferred, and otherwise managed through selectively applied long-term inactive well policies involving a combination of inactive well fees, individual well testing, and schedules for deferred well plugging.

Table 3 and the other summary tables in this section do not analyze specific wells to determine locations of individual high-risk wells or clusters of wells. The Well Characterization Tool can be used for more refined and location-specific analyses. Well Characterization Tool can be used to quickly determine potentially high-risk localities where a large number of non-productive unknown inactive oil wells might be found. For example, of the 511 unknown inactive oil wells in Table 3 with no production since 1990, more than 127 wells are located in Richburg Field in the town of Bolivar, 51 wells are located in Richburg Field in the town of Scio, 22 wells are located in three producing fields in the town of Allegany.

Unknown Oil Wells. For the 1999 base year, there were 954 oil wells with 'unknown' status. Of these, 260 wells reported current year production and 29 wells were new, recently completed wells. Table 4 shows the remaining 665 oil wells with unknown status that have no reported production for at least a year. Eighty-six percent of unknown oil wells have no reported production for nine years or more. No well data (casing or cemented intervals) is available for any of the unknown oil wells. The age of more than 55 percent of the unknown status wells is also unknown. An additional eight percent of wells are more than 75 years old. Fourteen of the wells appear to be orphan wells with no identified owner or operator. Nearly two-thirds of unknown oil wells are exempt from well bonds. As with the inactive oil wells shown in Table 3, more than 85 percent of unknown oil wells may have little or no financial security for the eventual plugging and abandonment of the well. If age and years of non-production are assumed to imply a greater potential for damage, leaks or neglect, then Table 4 indicates that 355 unknown oil wells are in a high potential risk category (non-productive since 1990 and age unknown or greater than 75 years.)

Table 4. Oil Wells; Unknown Status

Years w/ No Production	Age (Years)					Total Wells	Bonding Status			Well Data	
	Unknown	>75	>35 - 75	10 -35	<10		No Identified Owner/ Operator	Wells w/ No Bond Required	Operator Bond Less Than Required	Well Data Available (Casing, Cement)	Average Well Depth
≥ 9	301	54	105	109	-	569	14	354	120	-	1221
8	-	-	-	-	-	-	-	-	-	-	-
7	11	-	-	2	-	13	-	4	8	-	1223
6	40	1	1	3	-	45	-	42	3	-	1103
5	18	-	11	-	-	29	-	25	3	-	905
4	2	-	1	2	-	5	-	1	4	-	1223
3	-	-	2	1	-	3	-	2	-	-	631
2	-	-	-	-	-	-	-	-	-	-	-
1	-	-	1	-	-	1	-	-	-	-	1505
Totals:	**372**	**55**	**121**	**117**	**-**	**665**	**14**	**428**	**138**	**-**	**1116**

Active Oil Wells. For the 1999 base year, approximately 3400 oil wells had 'active' or 'producing' status. Of these, 429 wells were associated with tanks that had no production reported for at least one year. Production from oil wells in New York is generally reported by tank, not by individual well. For the purpose of well characterization and comparison of wells, it is useful to have an estimate of individual well production. The Well Characterization Tool computes estimated annual production for individual oil wells by dividing annual tank production by the number of active wells connected to the tank. Table 5 summarizes the oil wells with active status, which can be readily identified in the Well Characterization Tool database as non-producing because the tanks to which the individual wells are connected have no reported production.

Table 5 shows that the operators of approximately 55 percent of non-productive 'active' wells are either exempt from bonding requirements or have not provided all of the required financial security for the eventual plugging and abandonment of the wells. Most of the oil wells are exempt from bonding. As with the inactive and unknown oil wells, well data is available for very few wells. More than half the non-producing active wells in Table 5 (229 wells) were non-producing for only one year, which suggests a response to the low oil prices of late 1998 and 1999. More than 50 percent of non-productive active oil wells were completed before 1924 or are of unknown age (218 wells total). An additional 20 percent of non-productive active oil wells were completed between 1925 and 1966.

Table 5. Active Oil Wells; Non-Productive

Years w/ No Production	Age (Years)					Total Wells	Bonding Status			Well Data	
	Unknown	>75	>35 - 75	10 -35	<10		No Identified Owner/ Operator	No Bond Required	Operator Bond Less Than Required	Well Data Available (Casing, Cement)	Average Well Depth
≥ 9	42	8	18	18	2	**88**	-	58	5	4	2072
8	-	-	-	-	-	-	-	-	-	-	-
7	-	-	1	3	-	**4**	-	1	-	-	609
6	1	-	-	-	-	**1**	-	1	-	-	-
5	2	-	1	2	1	**6**	-	1	2	-	1454
4	12	-	1	-	2	**15**	-	8	-	-	1719
3	13	-	-	7	-	**20**	-	14	-	-	1373
2	49	5	11	1	-	**66**	-	51	15	-	1187
1	67	19	64	49	30	**229**	-	77	6	2	1235
Totals:	**186**	**32**	**96**	**80**	**35**	**429**	**-**	**211**	**28**	**6**	**1378**

The actual number of non-producing active oil wells may be substantially greater than the total wells shown in Table 5. Many oil production tanks have dozens of wells connected to a single tank battery. If oil production is reported for a tank, all of the wells connected to the tank are generally reported as 'active'. The Well Characterization Tool allows rapid identification and classification of tanks that have marginal and sub-economic production and the active wells associated with these tanks. In many cases, the completion dates of the wells connected to a single tank may span fifty years or more. If tank production is marginal, it appears unlikely that every oil well connected to the tank is actively producing. Only a single well or a few recent wells may contribute all of the tank production. The remaining wells are in effect, non-producing wells and may be potential contamination risks and plugging liabilities. For example, individual wells may have been non-productive for many years and the condition of the well and well site is unknown. If the wells are already exempt from bonding requirements and the owner has no means to plug the well or perform the remedial work necessary to return the well to production, the well may be allowed to languish.

Table 6 shows the age and bonding status of active oil wells for which current production is reported, and summarizes the estimated annual well production for individual wells. (Recent wells completed in 2000 and 2001 are excluded.) Individual well production is estimated by dividing total tank production by the number of active wells connected to the tank. Table 6 shows that on an individual well basis, estimated average annual oil production is extremely low. Of more than 2900 active, producing oil wells in Table 6, less than 9 percent of oil wells (255 wells) have average annual production of more than 100 barrels. Twenty-seven percent of active producing oil wells have average production of more than 50 barrels per year. Of these, more than 78 percent (612 wells) were completed after 1964. Table 6 shows that more than 1000 wells have estimated individual production of ten barrels of oil or less per year. As discussed above, it is possible that many of the very low performing oil wells represent a large number of non-performing wells connected to a tank reporting marginal production.

Table 6. Active Oil Wells; Estimated Average Production for Individual Wells

Estimated Average Annual Production Per Well (barrels/ year)	Age (Years)					Total Wells	Bonding Status			Well Data	
	Unknown	>75	>35 - 75	10 -35	<10		No Identified Owner/ Operator	No Bond Required	Operator Bond Less Than Required	Well Data Available (Casing, Cement)	Average Well Depth
<1	38	7	42	21	2	**110**	-	67	-	-	*1304*
1 – 10	380	10	187	322	5	**904**	-	289	32	17	*1291*
> 10 - 50	328	41	106	616	37	**1128**	-	214	234	11	*1280*
> 50 - 100	58	25	25	313	103	**524**	-	42	81	2	*1225*
> 100	49	2	8	69	127	**255**	-	31	44	3	*1395*
Totals:	**853**	**85**	**368**	**1341**	**274**	**2921**	-	**643**	**391**	**33**	

Tables 5 and 6 demonstrate that so-called 'active' oil wells have similar potential to become environmental and financial liabilities as inactive and unknown oil wells. The Well Characterization Tool can be used to refine the data summarized in the Tables 5 and 6 to identify specific wells, operators, and oil and gas fields for further investigation and follow up. The estimated total number of active oil wells that might be of concern as long-term idle wells depends upon what potential risk factors, age, years out of production or bonding status, are emphasized.

Figure 4 provides an example of how the Well Characterization Tool can be used to screen active, marginal oil wells for *de facto* long-term shut-in wells, potential financial and environmental liabilities, and potential candidate wells for remedial action. Operators A, B, C in Figure 4 represent a total of 153 active wells and approximately 966 barrels of oil production. Most of this oil production may be coming from only two wells, the recent wells operated by Operators A and B. The 92 wells of unknown age operated by 'A' and 'B', and all the wells operated by 'C' which are more than 68 years to 100 years old could be investigated further to determine that actual production status and condition of the wells. The remaining 42 wells operated by 'A' and 'B' could be investigated further for potential technology applications to improve well performance. The lease held by Operator 'C' might be a candidate for further evaluation of reservoir performance in the context of a larger field evaluation of the potential for by-passed pay zones or potential undrained reservoir compartments.

Figure 4. Query Example for Potential High Risk Non-Producing Active Oil Wells

Well Characterization Tool Query:
1. Select Criteria: ***Well Type*** = Oil; ***Avg Oil Prod (Bbl/Yr)*** = "1" and "1 – 10" **2. Run User Query** **3. Query Results Table:** Sort "Descending" on *OilTanknWell_1999.* This groups all the oil wells connected to a single tank and brings the tanks with the largest number of wells to the top of the list. **4. Analyze Query Results Table:** For each tank look at the number of wells connected to the tank, the age of the wells, and the total annual tank production, financial security compliance.
Examples:
Operator A: 91 Wells Connected to Production Tank Total Annual Tank Production = 606 barrels Estimated Average Annual Production = 6 – 7 barrels/well 83 Wells: Age Unknown 7 Wells: Completed 1970 – 1982 1 Well: Completed 1998
Operator B: 45 Wells Connected to Production Tank Total Annual Tank Production = 350 barrels Estimated Average Annual Production = 7 – 8 barrels/well 9 Wells: Age Unknown 35 Wells: Completed 1967 – 1974 1 Well: Completed 1999
Operator C: 17 Wells Connected to Production Tank Total Annual Tank Production = 10 barrels Estimated Average Annual Production = 0.6 barrels/well 1 Well: Completed 1900 16 Wells: Completed 1934 - 1936

Gas Wells

Inactive Gas Wells. For the 1999 base year, 591 wells have the well status of 'Inactive'; an additional twenty gas wells are 'shut in' or 'temporarily abandoned'. However, 141 wells with inactive status have production reported for the current year (2000) and 37 wells report gas production for both 1999 and 2000. It appears that approximately 141 wells may be misclassified as inactive, or represent formerly inactive wells that were returned to active status. Table 7 summarizes the results of a database query on inactive gas wells excluding wells with inactive status that report gas production during 1999 and 2000. As Table 7 shows, New York has approximately 457 inactive gas wells that have had no production reported for at least a year. Forty-three percent of inactive gas wells have been out of production for at least nine or more years. Seventy-five percent of inactive gas wells are between ten and thirty-five years old. The operators of 351 of inactive gas wells comply with current bonding requirements. Only six wells have no identified owner or operator. No financial security is required for fifty-four wells. For the remaining forty-six inactive gas wells, the operator either has not provided the required bonding, or has provided less bonding than the required amount for his total operations.

Table 7. Inactive Gas Wells Summary

Years w/ No Production	Age (Years)					Total Wells	Bonding Status			Well Data	
	Unknown	>75	>35 - 75	10 -35	<10		No Identified Owner/ Operator	No Bond Required	Operator Bond Less Than Required	Well Data Available (Casing, Cement)	Average Well Depth
≥ 9	27	8	35	123	2	**195**	6	38	34	46	*2586*
8	1	-	-	6	2	**9**	-	1	-	2	*2627*
7	-	-	-	9	2	**11**	-	1	1	8	*2781*
6	-	-	-	15	6	**21**	-	2	1	11	*3318*
5	2	-	1	16	4	**23**	-	2	2	5	*2987*
4	-	-	1	29	5	**35**	-	-	1	13	*2785*
3	-	-	2	35	2	**39**	-	2	2	12	*3053*
2	-	-	4	62	3	**69**	-	6	2	23	*3298*
1	1	-	-	48	6	**55**	-	2	3	27	*3146*
Totals:	**31**	**8**	**43**	**343**	**32**	**457**	**6**	**54**	**46**	**147**	

How many inactive gas wells present the greatest potential financial or environmental liability for the State or local communities? If age and years of non-production are assumed to imply a greater potential for damage, leaks, or neglect, then Table 7 indicates that fewer inactive gas wells, compared to the inactive oil wells in Table 3, are in the highest potential risk category due to a combination of age and years inactive. Only 16 percent of inactive gas wells are more than thirty-five years old or of unknown age and have reported no production for more than five years. Approximately 75 percent of inactive gas wells (343 wells) were completed between 1964 and 1989, and half of these wells (169 wells) have not produced for at least five years. This is a sizeable number of relatively recent inactive gas wells, which may be worthwhile to evaluate for potential to resume production from these wells.

The Well Characterization Tool could be used to refine additional investigations of the post-1964 inactive gas wells. For example, Well Characterization Tool queries can be structured to identify significant clusters of inactive gas wells according to such criteria as producing formation, operator, producing field, geographic location etc. These more refined queries might point to potential opportunities for returning this age category of inactive wells to production. For example, different actions could be needed for clusters of gas wells that may be inactive due to unfavorable gas market conditions and clusters of gas wells that are inactive due to reservoir performance and engineering/operational factors.

Unknown Gas Wells. For the 1999 base year, approximately 1,268 gas wells have 'unknown' well status. Some of the unknown wells are recent wells for which no updated production data has been provided. The database query was constructed to screen out such wells, including wells with a start date of 1999, 2000, or 2001, and wells with current gas production reported for 2000. The remaining unknown gas wells in Table 8 have no production reported since 1998, and represent the population of wells with potential to become future financial or environmental liabilities.

Almost 98 percent of unknown gas wells (1,153 wells) have no reported production for nine years or more, and 16 percent of these wells (186 wells) appear to be orphan wells with no identified owner. Nearly all of the unknown gas wells have no financial security for the eventual plugging of the well. Apart from the apparent orphan wells, 76 percent of the unknown gas wells (908 wells) are exempt from well bonding and 3 percent of wells may have insufficient bonding. The age of more than 30 percent of the unknown status wells is also unknown. An additional 30 percent of wells are more than seventy-five years old. Well data (casing or cemented intervals) are available for only two percent of the unknown gas wells. If age and years of non-production are assumed to imply a greater potential for damage, leaks, or neglect, then Table 8 indicates that 708 unknown oil wells are in a high potential risk category (non-productive since 1990; age unknown or greater than seventy-five years; no identified owner/operator).

Table 8. Gas Wells with Unknown Status

Years w/ No Production	Age (Years)					Total Wells	Bonding Status			Well Data	
	Unknown	>75	>35 - 75	10 -35	<10		No Identified Owner/ Operator	No Bond Required	Operator Bond Less Than Required	Well Data Available (Casing, Cement)	Average Well Depth
≥ 9	357	351	391	54	-	1153	186	908	37	14	1866
8	-	-	2	1	-	3	-	-	1	1	1615
7	-	-	-	7	1	8	-	-	5	4	3585
6	-	-	-	1	-	1	-	-	-	-	2017
5	-	-	-	4	-	4	-	-	2	2	3665
4	-	-	-	2	-	2	-	-	1	2	2947
3	-	-	-	6	4	11	-	-	-	3	3303
2	1	-	-	-	-	0	-	-	-	-	-
1	-	-	-	-	-	0	-	-	-	-	-
Totals:	358	351	393	75	5	1182	186	908	46	26	2714

Active Gas Wells. For base year 1999, approximately 218 active gas wells had no production reported for at least one year. Nearly 70 percent of the wells have no reported production for at least five years and 45 percent have no reported production since 1990. Only thirty-eight non-producing active wells were completed before 1964. As with inactive gas wells, the majority of the non-producing active gas wells (172 wells) were completed between 1964 and 1989. Well data are available in the master well file for at least a third of the wells. Depending upon the reasons for lack of production, many of the post-1964 non-producing active gas wells may be amenable to technology or economic policy actions designed to return the wells to production. The Well Characterization Tool can be used for additional investigation of the non-producing active gas wells to further classify these wells according to criteria such as producing formation, operator, producing field, geographic location, etc. More refined queries might point to potential opportunities for returning this age category of inactive wells to production. For example, more refined queries might identify clusters of gas wells that are inactive for different reasons such as unfavorable gas market conditions, reservoir performance factors, or engineering/operational factors, which would suggest different actions for returning the wells to production.

Table 9. Active Gas Wells

Years w/ No Production	Age (Years)					Total Wells	Bonding Status			Well Data	
	Unknown	>75	>35 - 75	10 -35	<10		No Identified Owner/ Operator	No Bond Required	Operator Bond Less Than Required	Well Data Available (Casing, Cement,)	Average Well Depth
≥ 9	7	8	15	69	-	99	-	27	9	35	2631
8	-	-	2	9	-	11	-	2	-	3	2681
7	-	-	-	11	-	11	-	-	-	5	2719
6	-	-	-	9	1	10	-	-	1	5	2516
5	-	-	-	18	2	20	-	1	-	9	2781
4	-	-	1	10	-	11	-	1	-	7	2503
3	1	-	-	11	-	12	-	1	1	4	3243
2	1	-	1	11	3	16	-	2	1	9	3534
1	-	1	1	24	2	28	-	4	3	11	2913
Totals:	**9**	**9**	**20**	**172**	**8**	**218**	**-**	**38**	**15**	**88**	**2836**

For active gas wells with current production reported, Table 10 categorizes wells according to annual production for individual wells, and summarizes the age and bonding status of wells in each production category (recently completed gas wells with a completion date of 1999 to 2001 are excluded). Of more than 5,600 active, producing gas wells in Table 10, fewer than two percent are of unknown age or were completed before 1924. Nearly all of the active gas wells are marginal producers, with fewer than three percent of gas wells producing more than 10,000 Mcf per year or 27.4 Mcf per day.

Table 10. Active Gas Wells; Current Production Reported

Estimated Average Annual Production Per Well (Mcf/ year)	Age (Years)					Total Wells	Bonding Status			Well Data	
	Unknown	>75	>35 - 75	10 -35	<10		No Identified Owner/ Operator	No Bond Required	Operator Bond Less Than Required	Well Data Available (Casing, Cement)	Average Well Depth
<100	13	7	22	213	19	**274**	-	6	5	115	2779
100 – <1,000	26	14	47	1662	114	**1863**	-	60	41	1010	2910
1,000 - <10,000	23	26	63	2799	400	**3311**	-	40	59	1922	3019
10,000 - <100,000	-	1	5	75	68	**149**	-	8	3	72	3541
≥ 100,000	-	-	-	-	13	**13**	-	-	-	12	6854
Totals:	**62**	**48**	**137**	**4749**	**614**	**5,610**	**-**	**114**	**108**	**3,131**	**2993**

Table 10 indicates that 274 active gas wells produced less than 100 Mcf in 1999. This group of wells could be evaluated further for potential financial and environmental liability, as well as the likelihood of well shut-in. Annual production from the majority of active producing gas wells in Table 10 ranges between 1000 Mcf and 10,0000 Mcf (3311 wells). An additional one third of the active gas wells in Table 10 produce between 100 Mcf and 1000 Mcf per year, or approximately 0.3 Mcfd to 3 Mcfd. Nearly all of the active gas wells in Table 10 (85 percent) were completed be between 1965 and 1989 and would be worthwhile to evaluate for potential production improvement through technology applications, recompletions, and improved operating practices.

Injection Wells and Storage Wells

Table 11 and 12 summarize the results of Well Characterization Tool queries for injection and storage wells by well status and age. For the 1999 base year, Table 11 shows that almost 78 percent of injection wells are inactive (610 wells) or have unknown status (303 wells). Although 22 percent of injection wells have active status, it is difficult to determine from the Well Characterization Tool data whether active injection operations are actually occurring. Approximately 38 percent of injection wells are of unknown age (448 wells) and 39 percent were completed before 1965 (454 wells). No well data are available in the master well database for injection wells. More than half of injection wells are not required to have well bonds and or bonding is less than required.

Table 11. Injection Wells

Well Status	Age (Years)					Total Wells	Bonding Status			Well Data	
	Unknown	>75	>35 - 75	10 -35	<10		No Identified Owner/ Operator	Wells w/ No Bond Required	Operator Bond Less Than Required	Well Data Available (Casing, Cement)	Average Well Depth
Inactive	340	9	234	27	-	**610**	-	408	128	-	1257
Unknown	58	-	170	73	2	**303**	-	63	11	-	1341
Active	50	-	41	156	13	**260**	-	35	17	-	1533
Totals:	**448**	**9**	**445**	**256**	**15**	**1173**	**-**	**506**	**156**	**-**	**1340**

Nearly all of the storage wells in Table 12 are active wells; none have inactive status and only one percent of storage wells are shut in. Less than three percent of storage wells have unknown status, of which two wells appear to be orphan wells.

Table 12. Storage Wells

Well Status	Age (Years)					Total Wells	Bonding Status			Well Data	
	Unknown	>75	>35 - 75	10 -35	<10		No Identified Owner/ Operator	Wells w/ No Bond Required	Operator Bond Less Than Required	Well Data Available (Casing, Cement)	Average Well Depth
Inactive	No Storage Wells with Inactive Status										
Shut In	-	-	-	-	8	**8**	-	-	1	4	3236
Unknown	6	2	4	-	2	**14**	2	10	-	2	2532
Active	8	15	612	143	37	**815**	-	1	3	157	2837
Totals:	**14**	**17**	**616**	**143**	**47**	**837**	**2**	**11**	**4**	**163**	**2836**

Dry Holes

For the 1999 base year, Well Characterization Tool queries identified approximately 699 wells classified as dry holes. The status for 94 percent of dry holes, approximately 660 wells, is unknown. The Well Characterization Tool was queried to determine the number of dry holes in each oil and gas field. Most dry holes, 498 wells, are characterized in the New York master well database as 'Dry Wildcat' with field name unspecified, target producing horizon unspecified and status unknown. Sixteen additional dry holes (not specified as dry wildcats) are located in unnamed fields. Table 13 shows the estimated number and status of dry holes in named oil and gas fields. Most of the 185 dry holes in current, named oil and gas fields have unknown status. Thirteen of these wells appear to be orphan wells, with no owner identified; nearly all the dry holes are exempt from bond requirements. Two dry holes with active status show gas production for the current year and appear to be producing wells that may be misclassified. The unknown dry holes shown in Table 13 should at least be verified to determine if the dry holes were plugged and abandoned or if they exist as temporarily abandoned well bores.

Table 13. Dry Holes in Named Fields

Well Status	Age (Years)					Total Wells	Bonding Status			Well Data	
	Unknown	>75	>35 - 75	10 -35	<10		No Identified Owner/ Operator	No Bond Required	Operator Bond Less Than Required	Well Data Available (Casing, Cement)	Average Well Depth
Inactive	-	-	1	7	1	9	-	-	1	2	3337
Unknown	42	28	95	7	-	172	13	158	1	2	2230
Active	2	1	1	-	-	4	-	3	1	-	2055
Totals:	**44**	**29**	**97**	**14**	**1**	**185**	**13**	**161**	**3**	**4**	**2280**

Table 14 summarizes the number of dry wildcats and dry holes in unnamed, unspecified fields in each county. Most of the dry holes in Table 14 were completed before 1964 and as a result, nearly 80 percent of these dry wells and wildcats are exempt from bonding requirements. Nineteen percent appear to have no identified owner/operator. Twenty percent are of unknown age (100 dry holes). The average depth of these dry hole ranges from less than 400 feet to almost 4000 feet.

Table 14. Dry Wildcats and Dry Holes in Unnamed Fields, by County

County	Age (Years)					Total Wells	Bonding Status			Well Data	
	Unknown	>75	>35 - 75	10 -35	<10		No Identified Owner/ Operator	Wells w/ No Bond Required	Operator Bond Less Than Required	Well Data Available (Casing, Cement)	Average Well Depth
Allegany				1		**1**	-	1	-	-	*600*
Broome	3	1	2	1	-	**7**	3	4	-	-	*3352*
Cattaraugus	3	-	-	1	-	**4**	3	-	1	-	*587*
Cayuga	3	1	9	1	-	**14**	2	12	-	-	*2232*
Chemung	1	2	21	-	-	**24**	-	24	-	-	*3018*
Cortland	-	1	3	-	-	**4**	-	4	-	-	*2426*
Chenango	1	-	-	1	-	**2**	-	1	1	-	*2218*
Genesee	5	5	2	4	-	**16**	5	7	4	-	*1444*
Herkimer	-	2	2	-	-	**4**	1	3	-	-	*2004*
Jefferson	5	-	1	-	-	**6**	1	5	-	-	*855*
Lewis	-	1	1	-	-	**2**	1	1	-	-	*1000*
Livingston	1	7	14	1	-	**23**	2	21	-	-	*1983*
Madison	4	-	8	-	-	**12**	4	8	-	-	*2506*
Monroe	3	2	2	-	-	**7**	4	3	-	-	*2399*
Niagara	-	-	1	-	-	**1**	-	1	-	-	*381*
Oneida	11	-	12	-	-	**23**	9	14	-	-	*1407*
Onondaga	3	-	3	-	-	**6**	-	6	-	-	*3946*
Ontario	10	10	24	1	-	**45**	10	35	-	-	*1722*
Orleans	-	2	3	3	-	**8**	2	6	-	-	*2547*
Oswego	7	1	8	-	-	**16**	9	7	-	-	*1852*
Schuyler	4	1	25	-	-	**30**	4	26	-	-	*2582*
Seneca	-	-	11	-	1	**12**	1	10	-	-	*3053*
Steuben	19	2	134	5	4	**164**	21	136	2	-	*3512*
Tioga	2	-	5	-	-	**7**	3	4	-	-	*2802*
Tompkins	7	-	22	-	-	**29**	-	29	-	-	*2445*
Wayne	3	-	1	1	-	**5**	3	2	-	-	*2871*
Wyoming	-	-	1	-	-	**1**	1	-	-	-	*3437*
Yates	5	2	23	1	-	**31**	5	26	-	-	*1773*
Totals:	**100**	**40**	**338**	**21**	**5**	**504**	**94**	**396**	**8**	**-**	

Potential Environmental and Financial Risk From New York State Wells

At present, the ranking logic in the Well Characterization Tool uses the age of the well, the number of years with no reported production, and whether any data are available on the well construction to imply a level of potential contamination risk. This assumes that the older the well and the longer it is non-producing, the more likely the well is to deteriorate and leak fluids to the surface or underground sources of drinking water. While age and number of years inactive can be poor proxies for potential environmental risk, these data are currently the only electronic data available to characterize and compare New York wells for contamination potential.

The 'Rank ID' field in the Well Characterization Tool is a six-character code which is applied to each well to rank order the wells according to various criteria that could indicate the well's potential to become an environmental or financial liability. The Rank ID concept is discussed in detail in Appendix A. The first character of the Rank ID code indicates well type. The second character indicates whether an owner/ operator is identified for the well. The third character indicates the number of years that the well has had no reported production. The fourth character indicates compliance of the corresponding operator/owner with current financial security requirements (no data, not enough, not required, etc.) The fifth character indicates the general age of the well, and the sixth character is a yes/no indicator if data are available indicating cased and cemented intervals. The Rank ID code is designed so that a descending sort on Rank ID of Well Characterization Tool query results will bring the wells with the greatest potential risk to the top of the list.

What is the magnitude of New York's potentially high risk, long-term inactive well inventory? Table 15 and Table 16 apply the assumptions in the 'Rank ID' concept to the Well Characterization Tool query results summarized in the preceding summary tables to estimate the size of New York's potentially high risk, long-term inactive wells inventory. All of the wells in Table 15 have no reported oil and gas production, or injection or storage operations, since 1994. All the wells were completed before 1965, or the completion dates (i.e., the ages of the well) are unknown. Approximately 4,140 long-term inactive wells comprise New York's potential high environmental risk inventory based on a combination of the age of the well and number of years inactive. The only way to assess the actual environmental risk presented by the wells is to evaluate each well individually using all of the well data, including paper records and electronic data, plus field information and site investigations available for each well.

Table 15. New York Long-Term Inactive Wells by Well Type and Years Inactive

Estimated Number of Long-term Inactive Wells (No reported production or other operations since 1994)				
Well Type	**Wells With Unknown Date of Completion**	**Wells Completed Before 1924**	**Wells Completed From 1924 to 1964**	**Total Wells By Well Type**
Oil	1086	100	281	**1467**
Gas	394	367	446	**1207**
Injection	398	9	404	**811**
Storage	6	2	4	**12**
Dry Hole (Known Fields)	42	28	95	**165**
Dry Hole (Unknown Fields& Wildcat Wells)	100	40	338	**478**
Total Wells By Completion Date	**2026**	**546**	**1568**	**4140**

Table 16 estimates the inventory of long-term inactive New York wells that have potential to become financial liabilities to the State or to local communities for plugging, environmental clean up and site restoration. All the wells were completed before 1965 or the age of the wells are unknown. Approximately 4,116 long-term inactive wells comprise New York's potential high financial risk inventory based on the number of years inactive, the amount of bonding provided by operators to cover the future cost of well plugging, and whether a well has an identified owner. Table 16 shows that most of the wells are in the high potential financial risk inventory because the wells are exempt from well bonding requirements. The only way to assess the actual financial risk presented by the wells is to evaluate potential plugging and site restoration cost for each well individually using all relevant well data and operator information, including paper records and electronic data, plus any field information and site investigations that suggest unusual P&A costs.

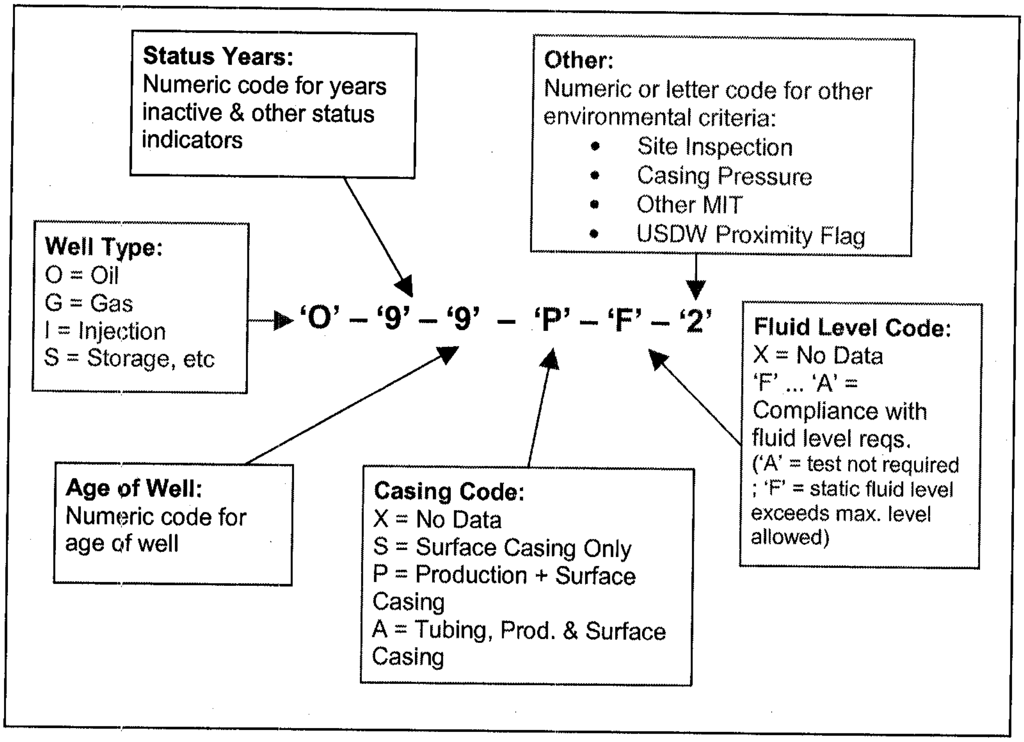
Table 16. New York Long Term Inactive Wells by Well Type and Financial Security

Estimated Number of Long-term Inactive Wells (No reported production of other operations since 1994)				
Well Type	**No Identified Owner/Operator**	**No Well Bond Required**	**Bond Less Than Required**	**Total Wells by Well Type**
Oil	14	1013	528	**1555**
Gas	192	982	93	**1267**
Injection	0	471	139	**610**
Storage	2	10	1	**13**
Dry Hole (Known Fields)	13	158	2	**173**
Dry Hole (Unknown Fields & Wildcat Wells)	94	396	8	**498**
Total Wells By Financial Security	**315**	**3030**	**771**	**4116**

Environmental Rank ID. Ideally, characterization and ranking of wells according to potential environmental risk of contamination should be based upon criteria that are directly related to the potential of the well to become a source of contamination. Such criteria include depth of the aquifers penetrated by the well; protection of aquifers by casing and cement; location and type of well plugs; depth of the producing zone; fluid level; debris or sand level in the well; casing pressure tests and other well bore integrity tests; site surveys and evidence of surface contamination; and proximity of the well to surface water and sensitive environments. Much of this information is collected for New York wells, but has not been converted to the RBDMS database. It is recommended that the capability of the Well Characterization Tool be expanded to characterize, rank, and manage individual wells according to the direct potential for aquifer and surface contamination. Such a capability would require that the environmental data currently residing on paper well reports be transferred to the RBDMS system. In addition, the logic and criteria for an 'Environmental Rank ID' code would need to be developed and implemented in the Well Characterization Tool. The Well Characterization Tool module already includes an 'Environmental Rank ID' data field for future use.

Figure 5 illustrates how 'Environmental Rank ID' logic might be developed to reflect New York's environmental priorities and available data. The 'Environmental Rank ID' code would be based on five or six criteria representing potential environmental risk. Meaningful categories within each environmental criterion would be indicated by a character in the 'Environmental Rank ID'. The criteria codes would be ordered in the 'Environmental Rank ID' with a single character for each criterion representing the well's direct environmental risk factor. The order of the characters from left to right in the 'Environmental Rank ID' code represents the relative importance of each environmental risk factor in defining the overall environmental risk potential of the well.

Figure 5. Illustration of Environmental Rank ID Logic to Illustrate Potential Environmental Risk



REGULATORY OVERVIEW

The objective of this task was to review New York State regulations pertaining to idle or inactive well status and compare with other relevant state and Federal requirements for financial security and eventual well plugging and abandonment. This topic is the subject of the 2000 Interstate Oil and Gas Compact Commission (IOGCC) report, *Produce or Plug?,* which reports the results of an IOGCC survey sent to oil and gas producing states and the Bureau of Land Management (BLM) requesting information on a range of topics pertaining to identification and management of the inactive oil and gas wells. The information compiled by the IOGCC includes the states' statutory authority, financial security requirements, and technical requirements and approval procedures for managing idle wells. Rather than duplicate the IOGCC's very comprehensive overview and analysis of current state requirements, this section excerpts and summarizes the regulatory requirements of selected states to illustrate the range in the state of development and implementation of inactive well programs and requirements in oil and gas producing states. This section also compares New York's current regulations with selected other oil and gas producing states. Table 17 at the end of this section provides an overview of inactive/idle well regulations for New York and a comparison with other states. Table 18 provides an overview of financial security requirements for New York and a comparison with selected other states. The tables also provide the URL link to online state regulations. For a comprehensive overview of all states, the reader is referred to the 2000 IOGCC report, *Produce or Plug?*

NEW YORK'S INACTIVE WELL REQUIREMENTS

Findings

Security for Single Wells and Blanket Bonds. New York's security requirements for single wells and blanket bonds appear to be in the approximate middle range of what other states require. However, two important aspects of New York's financial security provisions have the practical effect of diluting the State's bonding requirements. First, the majority of oil and gas producing states allow a regulatory agency to change the financial security/bonding amounts by regulation. New York is one of eight states where bond amounts are set by the legislature.[6] New York regulators do not have the flexibility to set bonding requirements accordingly, as the costs of plugging and abandonment increase due to inflation, future environmental and land restoration stipulations, or unforeseen increases in labor or material costs. As actual costs of plugging and restoration outstrip the financial security required for older wells, such wells are at an increased risk of becoming financial liabilities to the State and local communities.

A second concern with New York's well bonding requirements is that wells completed before 1963 are exempt from financial security requirements. Because of this exemption, operators with large numbers of "grandfathered" wells

[6] The other states are California, Indiana, Kansas, Kentucky, Texas, Virginia, West Virginia. (See IOGCC, 2000, *Produce or Plug?*)

may have provided little or no financial security for the eventual plugging of their wells. New York currently has more than 2000 oil wells, 1000 gas wells and 500 injection and storage wells for which no financial security is required. In addition, approximately 100 gas wells and 575 oil wells have operators who do not meet current bonding requirements. Even when an operator complies with current bonding requirements, the statutory requirement is likely to fall far short of the operator's eventual plugging liability, if the operator has many grandfathered wells. For oil wells especially, it is common to find operators with twenty-five to more than one hundred wells whose total statutory bonding requirements are less than $10,000. As large numbers of aging, grandfathered wells become increasingly concentrated under the responsibility of fewer and fewer operators, the practical effect of the exemption from financial security requirements is to increase the vulnerability of the State and local communities to a huge plugging liability if such operators abandon their oil fields or become insolvent.

Inactive/ Idle Well Status. Like most states, New York allows wells to remain inactive or idle for a short period (ninety days to one year) without State approval. Nearly all states allow the shut in period to be extended beyond the first year. New York allows additional extensions for up to one year, renewable for additional successive periods, if the operator demonstrates cause. Some states allow wells to be long-term inactive or shut-in wells, meaning five years or more, either by setting the initial allowable shut-in period at five years or more,[7] by allowing lengthy shut-in extensions,[8] or by allowing unlimited shut-in extensions.[9] Compared to other oil and gas producing states, New York's regulation is one of the more stringent because wells can be shut-in for only one year after which approval must be obtained for additional one-year extensions. The practical effect is that New York's idle well regulations cannot be adequately enforced due to constraints on manpower and other agency resources, and as a result, New York has a *defacto* long-term inactive well program. For example, New York has approximately 1,379 gas wells and 1,440 oil wells with either inactive or unknown status that have no reported production since 1992. In addition, more than 120 gas wells and more than 90 oil wells with 'active' status have no reported production since 1992.

Inactive Well Fees and Tests. Most states that currently allow long-term inactive wells also have specific requirements for testing shut-in or temporarily abandoned wells to monitor the condition of the well. Usually, proof of compliance with testing and monitoring requirements is required to receive approval to extend the shut-in status of the well. Sixteen states have requirements for testing of inactive wells. Most states require some combination of an annual pressure test or fluid level test, as well as a mechanical integrity test every two to five years, or as requested by the regulatory agency. In some states, the frequency and type of the mechanical integrity test is determined by the age and construction of the well and the proximity of the production zone to the lowermost

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[7] In seven states the initial period approved for inactive or shut-in well status is five years: California, Florida, Illinois, Indiana, New Mexico, Pennsylvania, West Virginia (see IOGCC, 2000). Alaska allow indefinite suspension of operations (shut-in) due to lack of production and market infrastructure, or need for field delineation.

[8] States allowing initial extension of shut-in period for 4 years or more: Florida, Indiana, Kansas, Michigan, New Mexico, Texas, Utah

[9] States with some provision for unlimited extensions of shut-in well status: Alabama, Arkansas, Colorado, Illinois, New Mexico, North Dakota, Ohio, Oklahoma, Pennsylvania, South Dakota, Tennessee, Texas, West Virginia, Wyoming

USDW.[10] In addition, many states require an annual fee for each unbonded well that remains inactive, a one-time fee to register an inactive well, or fees to apply for and renew inactive well status. New York currently has no requirements for tests or annual fees for inactive wells.

Recommendations

The overview of other state inactive well regulations suggests the following recommendations for New York to consider for reducing the potential future financial liability. The foremost recommendation is to enforce compliance with New York's current bonding requirements and increase the financial security requirements or levy additional idle well fees. Increased fees and updated bonding requirements will lessen the gap between anticipated costs of well plugging and abandonment and current bonding requirements for older shallow wells. New York should consider granting the Division of Mineral Resources the authority to adjust well bonding requirements as needed to reflect changing costs for well plugging and abandonment and site restoration.

Recognizing that New York already has large and growing population of long-term inactive oil and gas wells, it is recommended that New York adjust its regulations to effectively monitor and manage these long-term inactive wells. Recommended elements to be considered for long term inactive well regulations include the following:

- Provide for inactive well status up to twenty-five years depending on the type and condition of the well,
- Require a nominal fee to register long-term inactive wells,
- Set a schedule for required fluid-level monitoring and mechanical integrity testing and
- Require operators to develop long-term inactive well plans.

[10] Underground source of drinking water. Usually an aquifer with total dissolved solids content less than 10,000 mg/l.

Table 17. Overview and Comparison of NY Inactive Well Regulations with Selected Other States

Overview of Selected Inactive Well Regulations				
State	**Well Status Definitions**	**Inactive Well Permits**	**Required Tests & Fees for Inactive Wells**	**Regulation Link**
New York	**Shut-in Well (SI)** 1. Capable of production but closed in temporarily for repairs, testing or lack of market. 2. Shut in awaiting abandonment 3. Lawful Shut in period = 1 year. Extension up to 1 year	1. SI well for more than one-year requires permission from NY DEC. 2. SI extensions granted for up to one year. 3. Additional SI extensions require a petitions from the owner/ operator and demonstration of continued good cause 4. Upon termination of the lawful SI period, well must be produced or permanently plugged and abandoned.	None	http://www.dec.state.ny.us ***State of New York 6 NYCRR Part 555.2***
	Temporary Abandonment (TA) 1. Wells may be temporarily abandoned for up to 90 days	1. Operations are discontinued. Well is shut in without P&A. TA extension can be granted for a reasonable time period if operator demonstrates good cause 2. Upon termination of the lawful TA period, operator must resume operations or permanently P&A the well	None	http://www.dec.state.ny.us ***State of New York 6 NYCRR Part 555.3***
Pennsylvania	**Inactive Well** No operations or production for more than 12 months.	1. The Department will grant inactive status for 5 years. 2. The operator shall satisfy a set of criteria for approval of inactive status pertaining to (78.102,) well condition, cement, and casing information. 3. Annual monitoring/ testing required to maintain inactive status. 4. After 5 years, return well to active status or plug. 5. 1-year extension by application	1. Annual monitoring and reporting for inactive production wells 2. If no production report for 12 months, monitoring report is required. 3. Annual mechanical integrity test injection well per UIC Program requirements	***http://www.pacode.com/secure/data/025/chapter78/subchapDtoc.html*** Chapter 78. Oil and Gas Wells: Subchapter D: Inactive Wells Subsection 101 -105
Ohio	**Inactive Well** Well is incapable of production, or injection operations cease.	With regulatory agency approval. TA well = permission granted to delay permanent plugging.	None	

Table 17, continued. Overview of Selected Inactive Well Regulations				
State	**Well Status Definitions**	**Inactive Well Permits**	**Required Tests & Fees for Inactive Wells**	**Regulation Link**
Indiana	**TA or Deferred Plugging Status**. 1. Well is completed as a nonproductive well, ceases oil or natural gas production, or is no longer operated for the purpose for which the well is permitted 2. If operator fails to file an annual report, wells are considered temporarily abandoned.	1. Eight technical requirements described in the rule for TA status 2. TA status for up to one year. 3. TA status may be renewed for up to 5 consecutive years. 4. Upon termination of the period of lawful temporary abandonment, operator must either resume operations or permanently plug the well.	1. MIT for inactive wells older than two years 2. Monitor the fluid level by acoustical or wire line methods on an annual basis and report the results 3. If fluid level is less than 100 feet from base of lowest underground source of drinking water (USDW) operators must notify sate within 24 hours and comply with one of five alternative procedures.	***http://www.state.in.us/dnroil/ogrules.htm*** 312 IAC 16-5-20 Temporary abandonment of wells
Illinois	**Inactive Well.** Well has ceased operation for a period of up to 24 consecutive months.	1. Criteria for approved TA status pertain to bonding, well condition, and fluid level information (240.1130), 2. TA status shall be granted for a 5-year period. Annual extensions possible after the 5-year period. 3. If TA status denied, well must be plugged or TA status must be secured within 90 days 4. MIT for Class II injection wells	1. Annual fluid level test during period of TA status, unless the operator elects to a. Set a cast iron plug or b. Install tubing & packer and conduct a mechanical integrity test. 2. Mechanical Integrity Test for Class II injection wells every 5 years.	http://www.isgs.uiuc.edu/isgsroot/oilgas/oilgasreg/oilreg.html Subpart K - Plugging of Wells Subpart L - Requirements for Test Wells
Colorado	Inactive Well. Any shut in well with no production to sales for 12 consecutive months; Any well temporarily abandoned for 6 consecutive months	1. A well may be SI or TA with approval for a period not to exceed 6 months 2. Operators shall identify and list any SI or TA wells on their monthly production report. 3. Extension of SI or TA status with application containing future plans for utilization.	1. All SI/TA wells shall pass a MIT within 2 years of SI/TA status 2. MIT on 5-year intervals from the initial MIT date 3. If MIT test fails operator must repair well or P&A	http://oil-gas.state.co.us *Drilling, Development, Producing and Abandonment (300 Series)*

Table 17, continued. Overview of Selected Inactive Well Regulations

State	Well Status Definitions	Inactive Well Permits	Required Tests & Fees for Inactive Wells	Regulation Link
Oklahoma	**Inactive Well** defined as follows: - A well which after 7/1/197 experiences mechanical failure or loss of mechanical integrity -A well on which work to reestablish production started on or after 7/1/97 and on or before 6/30/03, that has not produced oil or gas for a period of not less than 1 year -A well on which work to reestablish production started on or after 7/1/94, and on or before 6/30/ 97, that has not produced oil or gas for a period of not less than 2 years Temporary Abandonment: Idle well is in an environmentally safe condition that ensures that well bore fluid level remains below the base of the lowest USDW.	Time period for plugging wells after drilling, testing is completed or production operations cease: - Plug well within 24 hours if it presents an imminent hazard to USDW. - Dry hole without casing: plug within 72 hours - Inactive/ Dry wells with only surface casing and cement: plug within 90 days - Wells with production casing: plug within 90 days OR TA for up to 5 years with permit. 30 days before the permit expires, the operator shall return the well to beneficial use, permanently P&A, or apply for a new TA permit -Fine for failing to commence timely plugging operations = up to $1,000/well. - Shut-in gas wells waiting on connection to sales line have active production operations status & are exempt from TA requirements.	Inactive Wells with TA Permit: -Annual Fluid Level or MIT ~~- Fluid level must be 150 below~~ base of lowest USDW -MIT at least once every 5 years - Wells failing an MIT must be plugged in 30 days or repaired and retested. - Fine for failure to comply = $500/ well	http://www.occ.state.ok.us/ ***Chapter 10 - Oil and Gas Conservation Rules*** *(Effective 07-01-2002)*
Texas	**Inactive Well.** No reported production, 12 consecutive mos. **Delinquent Inactive Well.** Inactive well with no plugging extension permit. **Active Well Status.** Three consecutive months exceeding minimum production standard: **Oil wells** must produce at least 10 barrels of oil for each of three consecutive months; **Gas wells,** must produce 100 MCF for each of three consecutive months. **Injection well** must show newest effective date of injection or volumes injected for the year.	1. Inactive wells must file a plugging extension form for up to one year. 2. Annual testing requirements determined case by case depending on whether the operator is bonded, and whether the well is inactive for more than 36 months. 3. No plugging extensions granted for more than 36 consecutive months. 4. Delinquent inactive wells shall be plugged immediately, unless the well is restored to active operations.	1. Conduct Fluid level test within 90 days prior to plugging extension application. 2. Fluid level must be at least 250 feet below the base of the lowest USDW 3. Hydraulic Pressure test conducted during the inactive period demonstrating mechanical integrity of the well 4. Inactive wells more than 25 year old well must have fluid level test & demonstrate mechanical integrity 5. State may plug an inactive well and seek compensation from the operator.	http://www.rrc.state.tx.us/rules/index.html Texas Administrative Code Title 16 Part 1Chapter 3 Rule 3.14 Changes in Rule 14 (B)(2) Extension Permit Requirements (Form W-1X): Individual Well Bonds; H-15 Testing; Restoring a Well to Active Status

Table 17, continued. Overview of Selected Inactive Well Regulations				
State	**Well Status Definitions**	**Inactive Well Permits**	**Required Tests & Fees for Inactive Wells**	**Regulation Link**
California	**Idle or Inactive well.** No produced or no injection operations for a continuous 6-month period during any consecutive 5 year period.	1. File a written notice of intention to abandon the well. 2. A well is permitted to remain idle for 5 years.	1. Fluid level or other approved test every 5 years. 2. Fluid level test every 2 years if fluid level adjacent to freshwater or potential USDW 3. Wells greater than 15 years old need clean-out depth and fluid test annually. 4. Casing pressure test if well fluid level is adjacent to fresh water zones. Engineering evaluation also required. 5. 5- year Idle Well Permit Fee	http://www.consrv.ca.gov/dog/idle_well/idle_well.htm ftp://ftp.consrv.ca.gov/pub/oil/laws/PRC01.pdf **California Laws for Conservation of Petroleum and Gas**
Bureau of Land Management	**Shut in Well.** Well is physically and mechanically capable of producing oil and/or gas in paying quantities, but no production or injection operations for one month. **Temporarily Abandoned.** Well is physically or mechanically incapable of producing oil and/or gas of sufficient value to exceed direct operating costs but may have value for a future oil/gas completion for EOR or water disposal. **Idle Well** A well has been SI or TA for 12 consecutive months or longer.	1. No well may be TA for more than 30 days without the prior approval. 2. Wells may not be inactive for more than 30 days without a permit. 3. A delay in the permanent abandonment of a well may be authorized for a period of up to 12 months. 4. Operator may obtain approval from the bureau to extend idle well status for additional periods, none of which may exceed an additional 12 months .	1. To request SI well status after a positive well test demonstrates that the well is physically and mechanically capable of production in paying quantities, operator must provide very strong justification why the well is not producing. 2. To request TA well status, operator must provide sufficient justification for future use of the well. (TA well status generally requires periodic mechanical integrity tests. BLM must be judicious approving TA well status)	*http://www.blm.gov/nhp/efoia/wo/fy01/im2001-147a.pdf* *http://www.hanfordreach.net/fedgasregs.htm* ***43 CFR 3160: Federal Oil and Gas Regulations***

Table 18. Overview and Comparison of NY Financial Security Requirements with Selected Other States

Overview of Selected Financial Security Requirements					
State	**Security for Single Wells**	**Blanket Bonds/ Fees**	**Exclusions**	**Financial Security Regulation Link**	**Inactive Wells Fee**
New York	Based on depth of well Amount Depth (ft) $2,500 < 2,500 $5,000 2,500-6,000 Case by case > 6,000	Varies by depth and number of wells Amount Depth (ft) $25,000-$100,000 < 2,500 $40,000-$150,000 > 2,500	Wells drilled before 1963.	Cash, surety, CD, letter of credit http://www.dec.state.ny.us/website/regs/551.htm ***Part 551 Reports and Financial Security***	None
Pennsylvania	$2,500 per well An operator with < 200 wells who cannot obtain a bond for a well drilled prior to 4/18/85 must pay a yearly non-refundable fee of $50/well.	$25,000 for any number of wells. An operator with < 200 wells who cannot obtain a bond for wells drilled prior to 4/18/85 can pay a yearly non refundable blanket fee: Amount # of wells $500 10 - 20 $1,000 >20 Or the operator could make phased annual deposits of collateral to fully collateralize the bond in the following schedule: # of Wells Deposit Additional Wells 1-10 $50/well N.A. 11-25 $1,150 $150 26-50 $1,300 $400 21-100 $1,500 $400 101-200 $1,600 $1,000	Wells drilled before 4/18/85 no bonding required but must pay a yearly non-refundable fee.	Cash, surety, CD, Phase deposit bond *http://www.dep.state.pa.us/dep/deputate/minres/OILGAS/act223.htm* Sec. 601.215. Bonding	None Campaign to register all oil & gas wells. Required for wells that are not plugged, permitted, or designated as orphan wells. The registration fee is $15 per well, or a blanket fee of $250 for all wells registered at the same time.
Ohio	$5000 $10,000 for financial statement	$15,000 > 3 wells $30,000 for financial statement		Surety Bonds, Certificates of Deposit, Irrevocable Letters of Credit, Cash Bonds Ohio Revised Code §1509.07; Ohio Administrative Code Rule 1501:9-1-03.	$50

Table 18, continued. Overview of Selected Financial Security Requirements					
State	**Security for Single Wells**	**Blanket Bonds/ Fees**	**Exclusions**	**Financial Security Regulation Link**	**Inactive Wells Fee**
Indiana	$1,000 for individual test holes $2,000 for individual oil, gas or Class II wells	$5,000 blanket bond for any number of test holes. $30,000 blanket bond for any number of oil, gas or Class II wells	None	Surety Bond, Cash Bond, Certificate of Deposit. Written proof of financial responsibility; applies only to individuals utilizing wells for private use. *http://www.state.in.us/dnroil/ogrules.htm#Bond%20required* ***Rule 4 Bonding***	None
Illinois	Bond Amount — Depth (ft) $1,500/well — < 2,000 $3,000/well — > 2,000	Blanket Bond: Amount — # of wells $25,000 — 1-25 $50,000 — 26-50 $100,000 — > 50	None	Certificate of Deposit, Surety Bond, Irrevocable Letter of Credit *http://dnr.state.il.us/mines/dog/Rules/SUBPARTO.pdf* Subpart O - Bonds	None
Oklahoma	Based on cost of plugging, closure and removal operations for each well. Operators file current financial statement every year.	1. Surety bond in amount greater than $25,000 but less than $100,000. 2. Operator may file a surety bond of a lesser amount but that is sufficient to cover the total estimated cost of properly plugging and abandoning each well. 3. Operators file a current financial statement every year	None	Financial Statement as surety Bonds, Corporate Surety Bond Certificates of Deposit, Irrevocable Commercial Letters of Credit, Cashier's check, Certificate of Deposit, or other negotiable. *http://www.occ.state.ok.us/* ***Chapter 10 - Oil and Gas Conservation Rules*, Part 3.**	If a blanket bond covers an inactive well, an individual plugging bond may be required on the SI or TA well.
Colorado	***Surface Protection***: $2,000/well for non-irrigated land $5,000/well for irrigated land. ***Soil Protection and Plugging and Abandonment*** $5,000/well	***Surface Protection:*** State wide blanket financial assurance for $25,000. ***Soil Protection and Plugging and Abandonment*** Amount — # of wells $30,000 — <100 $100,000 — >100	None	*Surety bonds* http://oil-gas.state.co.us/RR%20Asps/700-ser.htm ***Financial Assurance and Environmental Response Fund***	For an excess inactive well*, an operator's shall increase the financial assurance by $5,000/well. *See definition in rule

Table 18 continued. Overview of Selected Financial Security Requirements					
State	**Security for Single Wells**	**Blanket Bonds/ Fees**	**Exclusions**	**Financial Security Regulation Link**	**Inactive Wells Fee**
Texas	Option 1: for well operators only (no other activity) The amount is calculated by multiplying the depth of all wells by $2.00 per foot.	Option 2: Blanket bond Amount # of wells $25,000 0 - 10 $50,000 11 - 99 $250,000 >100	Unbonded operators: Cash Options: Option 3: $1,000 Option 4: 12.5% of the bond that would be required under Option 1 or 2	Surety Bonds, Certificates of Deposit, Irrevocable Letters of Credit, Cash Bonds Changes In Fees, Financial Assurance Requirements, and Well Transfers Pursuant to Statutory Amendments Approved in Senate Bill 310	$ 300 Plugging extension permit fee. Texas require immediate bonding of inactive wells
California	Bond per well based on depth of well. Amount Depth (ft) $15,000 < 5,000' $20,000 5,000 - 10,000' $30,000 > 10,000 '	Blanket bond not including bond or fee for idle wells Amount # of wells $100,000 < 50 $250,000 > 50 Blanket bond for all wells including idle wells = $1,000,000		Surety, Cash, CD http://www.consrv.ca.gov/dog/index.htm ftp://ftp.consrv.ca.gov/pub/oil/laws/PRC01.pdf ***California Laws for Conservation of Petroleum and Gas***	Annual fee/idle well Amount Years Idle $100/well < 10 $250/well 10-15 $500/well > 15 Or escrow account $5,000/well or Indemnity Bond $5,000/well
Bureau of Land Management	Minimum amount of $10,000 in lieu of a $10,000 lease bond.	$25,000 for statewide operations $150,000 for nationwide operations	None	Surety Bonds, Certificates of Deposit, Irrevocable Letters of Credit, Cash Bonds, Cashier's Check, US Negotiable Treasury Securities *http://www.blm.gov/nhp/news/regulatory/3800_AC40-Final/3104.1.html* ***Title 43--Public Lands: Interior/ Chapter II--BLM Part 3100--Oil And Gas Leasing- Subpart 3104--Bonds***	None

OVERVIEW OF OTHER IDLE/ INACTIVE WELL PROGRAMS

INACTIVE WELL PROGRAMS – CONCEPTS AND METHODOLOGY

The American Petroleum Institute (API) developed the concepts and methodology for a risk-based inactive well program, which is described in the 1993 environmental guidance bulletin, *Well Abandonment and Inactive Well Practices for U.S. Exploration and Production Operations*, API Bulletin E3. The goal of API's recommended inactive well program is to focus monitoring and plugging and abandonment efforts on inactive wells that threaten fresh water aquifers, surface soil and surface waters. Briefly summarized, API's recommended inactive well program includes the following elements:

- Classify inactive wells as shut-in or temporarily abandoned. Develop a system to score or rank wells according to the potential for the well's fluids to migrate to a USDW or to the surface.
- Identify the pressurized formations penetrated by the well bore.
- Identify the fresh water aquifers penetrated by the well bore.
- Identify mechanical barriers to fluid migration provided by well construction components including surface casing, production casing, tubing and packers, wellbore plugs, and score the well accordingly.
- Assign a fluid migration potential category such as minimal, low, moderate, and significant.
- Monitor the well as needed.
- Perform appropriate follow up action such as repairing the well or plugging and abandoning the well.

While no state implements all of the elements of the API guidelines, some of the concepts are expressed in individual state's regulations pertaining to inactive wells. California's Long-Term Idle Well Management Program comes the closest to implementing the American Petroleum Institute methodology (Hesson and Glinzak, 2000). Many oil and gas producing states that do not have inactive well management programs *per se,* nevertheless offer various incentives to operators to voluntarily return long-term inactive wells to production. Highlighted below are some of the aspects of various state inactive well programs. The intent here is to provide an overview of the scope and flavor of the new inactive well requirements, rather than an exhaustive regulatory review, to illustrate the range of measures that New York might consider implementing in a long-term inactive well program.

State Inactive Well Programs

California Idle Well Management Program. Operators file an Idle Well Management Plan for wells that have been idle for ten years or longer. The plans require operators to annually reduce a portion of their long-term idle wells by returning the wells to production or injection over a continuous six-month period, or by plugging and abandoning the well. Operators prioritize the idle wells for elimination based on criteria such as the immediate hazard presented by the well (leaking to surface or ground water), years out of production, location relative to fresh water aquifers, and mechanical integrity of the well. The schedule for idle well elimination ranges from one well every two years, for operators with ten or fewer inactive wells, to four percent of wells per year, for operators with more than 250 inactive wells. In addition, all idle wells must be covered by an appropriate individual bond or idle well fee. For wells that are idle more than fifteen years, a determination of clean-out depth and a fluid-level test are required. Wells penetrating fresh water aquifers must be pressure-tested. If the operator cannot demonstrate that the well can be returned to production, the well must be repaired or plugged. Wells that have been idle five or more years, but less than fifteen years, are required to have mechanical integrity tests and fluid level tests on schedules ranging from once every five years to annually, depending upon specific circumstances.

California also has an orphan well program under which operators have ninety days to attempt to bring an idle orphan well back into production without incurring any liability for plugging the well. Additionally, the oil and gas assessment is waived for any well inactive for five years or longer that is returned to production.

Texas, Oklahoma, and New Mexico. In November 2000, Texas adopted a new inactive well program that focuses on three factors to prioritize inactive wells for further action:

- Depth of surface casing with respect to the base of the lowermost USDW
- Well bore conditions, fluid level, and casing pressure
- Well location and level of hazard with respect to surface water, water wells, populated and environmentally sensitive areas

Wells that have been out of production for more than three years have twelve months in which to be plugged, returned to production, or issued a new inactive well extension permit. All wells inactive wells must be permitted, a fluid level and mechanical integrity is required, as well as a plugging bond equal to about $3.00 per foot of depth for a land well. All wells returned to active status must meet minimum annual production or injection requirements. Oil wells must produce ten barrels a month for three consecutive months and gas wells must produce 100 Mcf a month for three consecutive months. Injection wells must report the new effective date of injection operations, as well as the volumes injected.

Oklahoma's new inactive well program became effective July 2002. All inactive wells with no production casing must be plugged within ninety days. Inactive wells with production casing must have a temporary abandonment permit, which requires either annual fluid level monitoring or a mechanical integrity test.

New Mexico operators must submit an annual plan for inactive wells to either return the wells to active operations or plug. Operators out of compliance with current inactive well regulations have two years to bring all wells into compliance with current regulations.

Bureau of Land Management. Review of all shut-in and temporarily abandoned wells on public lands is a high priority in the current BLM Five-Year Strategic Plan. There are an estimated 11,100 inactive wells on BLM-supervised public lands. Field inspections are required for all wells that currently report no production and operators must justify the current well status. Wells may be shut-in or temporarily abandoned with BLM approval. Operators must submit annual plans for inactive wells that justify the well status or specify the time in which operators will take the following actions: return the well to production; recomplete the well in a different horizon; convert the well to other use; or plug and abandon the well. The BLM has long implemented economic incentives in the form of royalty reductions and temporary suspension of producing obligations to encourage operators to work over marginal wells to increase production or to implement enhanced recovery projects.

Alberta. In 1997, the Alberta Energy and Utilities Board initiated a Long-Term Inactive Well Program. Operators have five years to eliminate all wells that have been inactive for more than ten years, which represents about one third the inventory of inactive wells in Alberta. Other program elements include financial security requirements for previously unbonded wells and a salvage program. Within three years, the industry plugged more than 1,200 long-term inactive wells and was returning as many as 100 wells per year to active status.

Incentives for Orphan, Inactive, and Marginal Wells. The most common incentive offered by nearly all states is some form of severance tax and/or royalty relief for taking over orphan wells, returning inactive wells to production, or boosting marginal well production. Beyond severance tax or royalty relief, few of the other incentives offered by states seem very compelling. A few states offer grants to landowners to plug wells on their property; one state waives the permit application fee for orphan wells. Arizona offers a substantial reduction on property tax for returning wells to production. Texas offered a program between 1996 and 2000 under which operators could transfer marginally producing, non-economic wells into a state-sponsored experimental research program. Operators would transfer the wells to the program and pay 75 percent of the state's expected plugging costs for the well. In return, the operator would be released from future plugging liability for the well and the well would be available for research on enhanced oil recovery techniques and other new technologies. California offers a "take an orphan well for a test drive" program under which operators attempt to restore orphan wells. If the operator is successful, the operator gains the well and the oil and gas assessment is waived. If unsuccessful, the operator assumes no plugging liability for the well.

New York cannot offer severance tax reduction as an incentive to operators to participate in an inactive well program. Perhaps more promising for New York is California's concept of orphan well "test drives". Another possibility for New York might be a variation on Landowner Plugging Grants, in which the State might provide local communities with grants that could be used to provide property tax incentives for operators to return long-term inactive wells to production.

TECHNOLOGY OVERVIEW

TECHNOLOGIES REVIEWED

The objective of this task was to review various innovative and new or emerging technologies that might have potential application in New York to extend the productive life of marginal wells, return inactive wells to production, or reduce the costs of plugging and abandonment of uneconomic wells. Four categories of technologies were reviewed:

- Reservoir and field evaluation; well performance optimization
- Alternative lift systems for marginal wells
- Miscellaneous technologies to enhance/ extend production in marginal wells
- Well plugging and abandonment technologies

The specific technologies reviewed in each category are summarized in four tables at the end of this section. Each table provides a brief description of the technology and the potential benefits of applying the technology, a summary of the state of development or application of the technology, relevant implementation requirements and cost information, and contacts for further information.

Reservoir and Engineering/Operations Analyses to Optimize Field Performance

This category includes integrated techniques and approaches, as well as specific technologies to evaluate marginal fields and reservoirs to optimize performance, or to evaluate sub-economic fields prior to plugging to avoid pre-mature abandonment. The specific technologies include both commercial and government-funded modeling software and analytical tools and approaches. Because these approaches are aimed at marginal and sub-economic fields, they stress low cost techniques and solutions. Some of the techniques stress engineering analysis of individual well performance, stimulation effectiveness, and statistical analysis of production data. Other approaches stress reservoir evaluation to locate potential by-passed pay and to identify previously unrecognized reservoir compartmentalization.

NYSERDA has previously supported projects aimed at evaluating specific fields or reservoirs for performance optimization including, for example, an evaluation of a Medina field for infill drilling potential (Martin, 1998 and Pekot, Wozniak, and Martin, 1998). NYSERDA should consider funding systematic and comprehensive evaluation of New York oil and gas fields prior to abandonment for the purpose of reviving and extending the economic life of these fields. Table 19 provides a case study where such an approach resulted in extending the economic life of a soon-to-be abandoned oil field by twelve years and more than 380,000 barrels of incremental production. Elements of an integrated approach for evaluating New York's sub-economic fields could include the following:

- Estimate original hydrocarbon place and total recovery. Are there remaining hydrocarbons-in-place to justify field revitalization efforts?
- Are there by-passed zones, or zones with poor hydrocarbon recovery due to previously unrecognized reservoir compartments or past completion practices?
- Was well stimulation and/or secondary recovery ineffective?
- Are there pervasive technical problems affecting individual well and field performance?
- What diagnostic surveys are needed?

Diagnostic tools and new survey technologies that should be considered for these field evaluations include:

- Field-wide downhole tag surveys and fluid level tests to evaluate well condition
- Downhole video imaging
- Through-casing formation tester
- Cased hole and through-tubing nuclear logging tools
- Cased hole resistivity and through-tubing resistivity surveys

Artificial Lift Systems

Artificial fluid lift systems include plunger lifts, automatic casing swabs, balanced oil recovery systems and air pulse artificial lift. Many of these fluid lift technologies are not altogether new and have been applied in New York wells. However, fluid lift systems must be tailored to specific field characteristics. The optimal fluid lift system for a field may change during the lifetime of a field, as the production characteristics of the field change. A comprehensive state-wide evaluation of fluid lift systems currently applied in New York fields could be undertaken in the context of field performance optimization. Such an evaluation might include demonstration pilots, as well as an evaluation of the economics of various artificial lift systems tailored to specific fields. An example is included in the technology evaluation tables of a field in which replacement of beam pumps with automatic casing swabs extended the productive life of Clinton wells in Ohio. Similarly, automatic casing swabs might be considered for gas wells in New York, where reservoir pressures have declined and can no longer support plunger lifts. Air pulse artificial lift is a relatively new lifting technology applicable to very shallow oil and gas wells (less than 2000 feet), which should be evaluated further for its applicability to New York wells.

Miscellaneous Technologies to Enhance/Extend Marginal Well Production

This category includes a variety of technologies that are applied to individual wells to enhance or extend well production. Most of the new and emerging technologies reviewed in this category are well stimulation technologies. Solid propellant fracturing, CO2/sand stimulations, and various seismic stimulation technologies are designed for lower pressure, low permeability reservoirs. Low cost hydraulic fracturing technologies are designed for application in marginal fields and low cost recompletions. Other technologies summarized in Table 21 include new enhanced dilute surfactant for improved oil recovery and paraffin prevention, and new, potentially lower cost technologies for casing repair and downhole water shut-off including microfine cements for casing repair in older wells, and pressure activated casing sealants.

Well Plugging and Abandonment

The final category reviewed includes technologies for well plugging and abandonment. The current literature suggests that most of the technology development in this area appears to be focused on development of specialty cements and cementing techniques designed for special applications such as horizontal wells, ultra-deep wells, and deep water offshore cementing operations. Compressed bentonite and bentonite and gravel plugging is a relatively new well plugging technology that is being applied in California's inactive well management program and is becoming available in other regions in the U.S. Other potentially applicable plugging technologies summarized in Table 22 include coiled tubing cementing and description of a comprehensive process to streamline large scale, multiple well plugging and abandonment operations.

Bentonite well plugging is available in the northeastern U.S. and being applied to plugging of oil and gas and injection wells. New York has tested bentonite plugs in a few orphan well plugging operations with mixed results.[11] As this technology evolves and matures, it may provide a low cost and effective alternative method for plugging and abandoning shallow wells in New York. However, anecdotal observations from compressed bentonite vendors and well pluggers in New York and Pennsylvania indicate that access to the well site is one of the biggest obstacles to lowering the cost of well plugging and abandonment operations, followed by removal of downhole obstructions.[12] Saving a few thousand dollars in a well plugging operation by using alternative plugging materials may be insignificant compared to the cost of site access and well preparation. Issues and practices pertaining to well site access and preparation might be a fruitful area for NYSERDA to evaluate for streamlining and cost reduction in well plugging and abandonment operations.

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[11] Jack Dahl, New York Department of Environmental Conservation, Minerals Division, personal communication August 2002.

[12] Jim Collins, Venterra, Inc., personal communication, September 2002.

Technology Recommendations

NYSERDA is already an active supporter of and participant in various projects to develop, demonstrate, and apply new technologies to extend the economic life of the oil and gas industry in New York. Many recent technologies and methodologies have been applied in New York, and it is challenging to find a technology that has not been considered. The tables at the end of this section summarize various new and emerging technologies in each of the categories discussed above. Some of the technologies listed are already applied in New York, but it is possible that these technologies are not fully implemented in the State, or may not implemented as effectively as possible.

Integrated Reservoir Performance and Engineering Analyses of Marginal Oil and Gas Fields to Develop 'Best Practices' Guidelines. The primary recommendation arising from the technology overview task is for NYSERDA to sponsor comprehensive evaluations of New York's marginal oil and gas fields, including wells and fields where operators have been previously unable to identify and implement opportunities to increase production. One of NYSERDA's goals is to develop a system to prevent the premature abandonment of New York's poorest performing and non-performing wells. A crucial element of such a system is assessing the remaining productive potential of New York's poorest performing areas to develop 'best practices' or technology guidelines for these fields. Such an effort would result in a portfolio of oil and gas producing fields, which would be ranked according to the potential for performance improvement and additional economic oil or gas production.

For potentially productive fields, the resulting 'best practices' guidelines could include recommendations for minimum production criteria for active oil and gas wells (i.e., an economic production "cut off"), as well as recommendations for field-specific strategies to improve overall performance such as technology demonstration projects for field diagnostic surveys, well workovers, and recompletions. For other fields with little or no remaining productive potential, the resulting guidelines could include recommendations for large-scale plugging and abandonment operations, or potential alternative uses such as gas storage, research, or carbon sequestration. The Well Characterization Tool could be used for initial screening and prioritizing of study areas. For example, the Well Characterization Tool can be used to locate and rank the oil fields, townships, and or producing formations as having the best to the poorest current oil production. Various production queries can be structured to quickly pinpoint wells that may have an anomalous production history compared to neighboring wells.

Comprehensive Technical and Economic Evaluation of Fluid Lifting and Stimulation Technology in Producing Fields. While related in part to the previous recommendation, the focus of this recommendation is to improve production efficiency and lower the operating cost of current producing wells (but not necessarily uneconomic wells), thereby improving their economics and extending the producing horizon of individual wells and fields. Components of such a study could include demonstration projects of new technologies that have not been applied in New York, as well as demonstration projects intended to expand the application of successful artificial lift and well stimulation technologies to other producing areas in the State.

Cost Saving Strategies for Well Plugging and Abandonment. Despite the best efforts of industry and government the extend the productive life of New York's oil and gas industry and to provide for effective management of long-term inactive wells, the fact remains that New York faces a huge financial burden to eventually plug and abandon the current population of inactive oil and gas wells. New York has more than 3,700 oil and gas with unknown or inactive status and no reported production. If this total is assumed to represent a likely portion of the current New York well population that could be required to be plugged and abandoned, and if the anticipated average plugging and abandonment cost is assumed to be $10,000 per well, 3700 non-producing wells represent an estimated financial liability of at least $37 million. It is easy to imagine future scenarios in which the potential costs to plug and abandon wells exceed the New York oil and gas industry's annual revenues. Consequently, it is recommended that NYSERDA support the development of processes and technologies to reduce well plugging and abandonment costs and put inactive wells to alternative uses, as well as identify innovative ways to finance the New York oil and gas industry's future P&A liabilities.

Table 19. Reservoir Evaluation and Performance Optimization

Technology Overview – Reservoir Evaluation; Optimization of Field Performance						
New Technology	**Description**	**Potential Benefits**	**State of Development/ Application**	**Requirements to Implement**	**Cost Information**	**Operator/ User/ Other Contact**
Integrated Reservoir Evaluation of Fields Prior to Abandonment	Integrated, whole-field approach to reservoir evaluation of oil field prior to abandonment. Reserves evaluation, geological interpretation, production, reservoir properties, and production economics. Computer modeling to validate scenarios to optimize oil recovery & cash flow.	23- well field cumulative production of 279,000 barrels. Field production had declined to less than 5 bopd. Ready to abandon. Design waterflood for field & implement in March 1999. Current field production is 12-14 barrels per day. Total secondary recovery estimated to be 384,000 barrels over 12 years.	Company will implement comprehensive field and reservoir evaluation to other sub-economic fields to identify other acquisition prospects.			Farrar Oil Company
Reference: Aman, B.A., Nichols, T.W., Snyder, R.L., Payne, M.E., 1999, Integrated Reservoir Evaluation Revives Nearly Abandoned Illinois Basin Field, SPE 57437.						
Identify Unstimulated Zones or Ineffective Stimulations from Previous Multiple Zone Hydraulic Fracture & Nitrogen Fracture Treatments	Determine effectiveness of past well stimulation. Use existing data. Collect new downhole diagnostic data: spinner surveys, injection/fall off test, tracer logs, production data analysis, hydraulic fracture data analysis	Candidate reservoirs for restimulation may be widespread in the Appalachian Basin. Multi-stage fracture treatments are common & may result in unstimulated or poorly stimulated zones. Potential economic restimulation candidates. Target benefit is 10 Mcfd to 20 Mcfd incremental production increase from restimulation.	Pilot test. Comprehensive evaluation of three "study groups" of wells for restimulation potential. Funding by Stripper Well Consortium.	Mechanical condition of well must be adequate for restimulation. Invest in appropriate diagnostic surveys	Varies depending upon diagnostic surveys & well condition	Schlumberger Holditch Reservoir Technologies; Equitable Production
Reference: Stripper Well Consortium, current funded project descriptions						
Miscellaneous Engineering/ Analytical Tools Identify & Evaluate Under-performing Wells and Optimize Well Performance - I	SWARM -"Stripper Well Analysis for Remediation Methodology" PC-based software uses cumulative production data to rapidly compare performance of individual wells with performance of adjacent wells. Identify under-performing wells & screen to identify problem wells or well clusters.	Quickly identify wells with abnormal production declines for further review	Commercial software available approx. April 15. User manual & data import interface are in development	Personal Computer, well location in x-y coordinates, radial distance to adjacent wells, cumulative production data	None provided.	Schlumberger Holditch Reservoir Technologies
Reference: Petroleum Technology Transfer Center (PTTC), 2001, "DOE Stripper Gas Well Projects Explore Different Approaches for Identifying Under-Performing Wells " from PTTC Technology Connections excerpted from PTTC Network News, Quarter 2, 2001.						

Table 19, continued. Reservoir Evaluation; Optimization of Field Performance						
New Technology	**Description**	**Potential Benefits**	**State of Development/ Application**	**Requirements to Implement**	**Cost Information**	**Operator/ User/ Other Contact**
Miscellaneous Engineering/ Analytical Tools Identify & Evaluate Under-performing Wells and Optimize Well Performance - II	Methodologies for statistical analysis of type curves and cumulative production data within a field. Identify wells w/ abnormal production decline rates. Analyze production type curves to identify and predict reservoir problems, such as poor fracture half-length, abnormal reservoir skin damage, etc., Incorporate advanced decline curve analysis for low permeability and multiple completion gas wells into a fast, easy-to-use PC based software	Rapid identification of problem wells and under-performing wells in stripper gas fields with large numbers of wells. Focus remediation efforts on "stand out" problem well.	Methodologies under development and pilot testing, funded by DOE National Energy Technology Laboratory and Stripper Well Consortium. Contact DOE NETL.	Personal Computer. Understand reservoir engineering fundamentals.	Not provided.	James Engineering, Incorporated; Advanced Resources International; Equitable Production; Belden & Blake
Reference: PTTC, 2001, "DOE Stripper Gas Well Projects Explore Different Approaches for Identifying Underperforming Wells," PTTC Network News, Qrtr.2, 2001.						
Appalachian Basin-Production Data Analysis Applications	Analytical Models & Solutions for Advanced Decline Curve Analysis: Combines pressure transient solutions & conventional decline curve analysis. Specific solutions to represent a variety of boundary conditions & reservoir types. Moving Domain Analysis: Broad, statistical approach to production & completion data analysis. Low cost, Rapid, Good for large areas, large data sets. Compute "Production Indicator" for each well & use to compare new & old wells.	Analytical Solutions for Advanced Decline Curve Analysis: Various applications: estimate future production/reserves; infill well potential & optimal well spacing; evaluate artificial lift & compressor installations to reduce bottom hole pressure, etc. Moving Domain Analysis: identify interference between wells; evaluate completion practices on well performance; identify infill drilling locations; screen large fields to high-grade areas for in-depth engineering analysis	Moving Domain Analysis and Advanced Decline Curve Analysis successfully conducted on Appalachian Basin fields.	Standard database and spreadsheet software. Data Mapping software. Production data, well completion data, stimulation reports, any pressure data.	Variable. Depends upon size of study, amount of data, & study objectives.	S.A. Holditch Reservoir Technologies, Pittsburgh PA
Reference: Frantz, J.H., Spivey, J.P., and others, 1996, Practical Production Data Analysis for the Appalachian Basin, Society of Petroleum Engineers, SPE 37347 *Frantz, J.H., and Fairchild, N.R., 1998, Applying Moving Domain Analysis in the Appalachian Basin, American Association of Petroleum Geologists Abstracts.,* *PTTC, 2000, Mapping, Locating, and Recovering By-Passed Hydrocarbons, Petroleum Technology Transfer Council West Coast Region Workshop, May 22-23, 2000.*						

Table 19, continued. Reservoir Evaluation; Optimization of Field Performance

New Technology	Description	Potential Benefits	State of Development/ Application	Requirements to Implement	Cost Information	Operator/ User/ Other Contact
Through-Casing Formation Tester for Formation Pressure and Fluid Content	Cased Hole Dynamics Tester (CHDT) Modular wireline tool. Drills holes (0.28 in. diameter) through casing, cement, & formation. Measure formation pressure & pressure transient. Take fluid samples and measure resistivity of fluid. Mechanical plug seals the hole. Pressure tests the mechanical plug.	Real-time pressure and flow rate measurements. Pressure profile of formation, determines reservoir fluid gradient. Use to locate potential bypassed hydrocarbons pay zones in cased wells prior to well abandonment. Formation testing when open hole testing is not possible. Supplements cased hole log suite. Best for comprehensive, field-scale evaluation of bypassed hydrocarbon potential.	Commercial version of tool available through vendor.	Prior casing & cement inspection. Select pressure test points from wireline well logs. Pressure drawdown test of casing seal. Operate in casing 5.5 - 9.4 in. dia. Drills hole up to 6 inches long. Fluid sample from 1 to 6 gals.	None provided.	Developed jointly by Gas Research Institute and Schlumberger
Reference: Burgess, K.A., MacDougall, T.D., Siegfried, R.W., Fields, T.G., 2001, Wireline Conveyed Through-Casing Formation Tester Preserves Casing Integrity, SPE 72371.						
Thru-Tubing Nuclear Logging Tools	Pulsed Neutron Capture (PCN) and Carbon Oxygen (CO) logs. Use in combination to distinguish hydrocarbons from water. Porosity & lithology indicator.	Lower cost cased hole logging. No longer necessary to kill a well & pull tubing. Combination tools designed to run in casing.	Thru-tubing combination tools available from service company vendors.	Nuclear logging tools best for moderate to high porosity. PCN requires saline formation water. Use in combination with CO log to distinguish freshwater and HC.	Not Provided	Baker Atlas, Computalog, Halliburton, Schlumberger
Reference: Lang, K., 2000, Locating Bypassed Oil in Existing Wells, Petroleum Technology Transfer Center State-of-the-Art Technology Summary, volume 6, no 3.						
Cased Hole Resistivity Log	Schlumberger Cased Hole Formation Resistivity Tool;	Saturation and formation fluid evaluation in low porosity/low salinity formations. Deep depth of investigation (7 - 32 ft.). Distinguish hydrocarbon-bearing zones from water-bearing zones	Available from service company vendor since 2000.	Cased hole only. Tool is too large for tubing. Very slow logging speed required. Tool effectively makes stationary measurements. Longer measurement time extends range of measurable resistivity. Requires very good electrode contact with casing. May require scale removal.	Not Provided	Schlumberger
Reference: Lang, K., 2000, Locating Bypassed Oil in Existing Wells, Petroleum Technology Transfer Center State-of-the-Art Technology Summary, volume 6, no 3						
Case Hole Resistivity	Baker Hughes Through Casing Resistivity Tool (TCRT)	slim tool with centralizing & orientation arms	Can be deployed in tubing, horizontal & deviated wells. Slim hole tool has been field tested		Not Provided	Baker Hughes, Inc.
Reference: Fanini, O.N., Hunziker, J., Maurer, H.M., et al., 2001, Field Test Results of a Slim Through-Casing Resistivity Array Instrument Prototype, Society Petroleum Engineers, SPE 69470.						

Table 20. Alternative Lift Systems for Marginal Wells

Technology Overview – Alternative Lift Systems for Marginal Wells						
New Technology	**Description**	**Potential Benefits**	**State of Development/ Application**	**Requirements to Implement**	**Cost Information**	**Operator/ User/ Other Contact**
Guidelines to Determine the Most Cost-Effective Lifting/ Fluid Removal Technology for Stripper Wells	Decision Tree/ Procedure Guide to diagnose production problems and implement cost-effective fluid removal technology	Increase production and ultimate recovery. Avoid premature well abandonment.	In Development with DOE and Stripper Well Consortium Funding. Guidelines will be publicly available.			James Engineering, Marietta OH
Reference: Stripper Well Consortium Funded Project Descriptions						
Air Pulse Artificial Lift	For Shallow, Low Volume Wells. Downhole pump chamber with one-way ball valve on bottom for fluid entry. Air/gas inlet line and small return line attached to produce liquid slugs to surface. Computer operated. Sensor determines when downhole pump chamber is filled. Air pulse from compressor at surface, displaces fluid from downhole chamber up the return line to surface. Compressor supplies air pulse to multiple wells.	Reduce lifting & maintenance costs. May improve production in marginal gas wells. Will greatly reduce field operating costs if applied field wide.	Successful demonstration test on oil wells at Rocky Mountain Oilfield Testing Center. Successful remote monitoring & internet-based control of the wells using satellite link and proprietary software.	Depth < 2000 ft. Liquid production <100 bpd. Apply in oil wells to lift oil or in marginal gas wells to lift water.	$7500 for single well installation on a typical 1000 ft. well includes remote automation and communication system. Leasing option.	Petroleum Asset Management Co. (PAMCO), Madison, TN;
Reference: Corlew, E., and Rochelle, J., 2000, Air pulse system for artificial lift reduces costs, World Oil, Supplement Case Study, September 2000.						
Automatic Casing Swab	Cyclic/ intermittent liquids removal from well casing. Cycle times typically 4 hours to 7 days. Recovers 1 - 3 barrels of fluid with each lift.	Can operate at lower pressures than plunger lift. Production tubing not required. May be best for installation on new wells. Can replace beam pumps, which become oversized as well production declines. Lower operating cost; greater operational flexibility than wireline swab.	Recent R&D to improve mechanical reliability of earlier automatic casing swab systems.	Good production casing integrity. Uniform casing weight. No scale, paraffin, salt buildup. 3 to 5 Mcf per barrel fluid lifted. GOR >5000 scf/bbl BHP < 1000 psig Low water to oil ratio Low solids/fines production	Not Provided	Sandia National Laboratories, Albuquerque, NM; Belden & Blake Corp.
Reference: Petroleum Technology Transfer Council, 1997, Technology Improves Marginal Gas Well Production, PTTC Technology Summary 1997. Haynes, C.D. and Miller, T.C., 1991, Field Experiments with Automatic Casing Swabs, Society of Petroleum Engineers, SPE 21695.						

Table 20, continued. Alternative Lift Systems for Marginal Wells						
New Technology	**Description**	**Potential Benefits**	**State of Development/ Application**	**Requirements to Implement**	**Cost Information**	**Operator/ User/ Other Contact**
Balanced Oil Recovery System (BORS Lift)	Mathematical formula calculates "balance point" in oil column. Flexible tube attached to nylon strap lowered to the balance point in the oil column. Oil enters tube under reservoir energy and fills tube. Water is left downhole. Tube lifted to surface by attached nylon strap, which is wound/ unwound on a reel at the surface. Oil is automatically dumped to a small holding tank and the process is repeated. When holding tank is full, oil is transferred to sales line. Computer controls depth for tube fill and # cycles per hour.	Oil migrates into wellbore at natural rate. Prevents water encroachment from water column. Lower costs for well servicing and lower electrical power costs. Reduce operating cost & improve well profitability. In pilot tests, conventional pump wells average 2 bopd. BORS lift wells average 3.5 - 5 bopd.	BORS units commercially available since Jan 1999 for sale or lease. In 1998, successful pilot test by Renco in 5 marginal/ uneconomic stripper wells in Oklahoma. Regent Energy Corp. applied to 10 wells in Horseshoe Gallup Unit, NM during 2000 - 2001.	Gas-drive or solution gas-drive reservoir. Well depth < 3200 ft.; Adequate permeability/ oil entry into well bore; Oil/water contact; balance calculations for well. Electric power source.	Purchase cost = $19,500/ unit. Lease multiple units for approx. $2000 - $2100/ month.	Regent Energy, Corp, Tulsa, OK; BORS International
Reference: Fox, B. and Allen, G., 2000, Alternative artificial lift system improves well profitability, World Oil Supplement, Case Study, May 2000; Journal of Petroleum Technology, 2001, Technology Applications: Producing Shallow Low Volume Wells, August 2001, volume 53, No. 8.; Petroleum Technology Transfer Council, 2001, BORS Lift Units Profitable in Horseshoe-Gallup Unit, New Mexico, PTTC Technology Summary, 4th Quarter, 2001.						
Plunger Lift	Cyclic/ intermittent liquids removal from well. Tubing extends from surface to perforations. Gas pressure builds beneath plunger seal, eventually lifting plunger and produced fluids to surface. Plunger drops to bottom of tubing to repeat process.	Eliminates periodic swabbing, soaping, and blowdown to remove accumulated fluids.	Common lifting technology for low volume gas wells. Various algorithms, software available & in development to optimize plunger lift operations according to reservoir characteristics and field performance.	Approx. 400 scf per barrel fluid per 1000 ft. of lift. Production tubing with good mechanical integrity, free of scale & paraffin buildup & other obstructions. Power source: solar or field electrical power	Installation cost $1,500 to $10,000 per well. Annual O&M costs $500 to $1000.	Various commercial vendors. Government and academic research for Plunger Lift Optimization. Stripper Well Consortium
References: Various Sources. Vendors, reservoir and operations engineering literature, SPE. Example: Phillips, D. and Listiak, S., 1998, How to optimize production from plunger lift systems, World Oil, May 1998. Also, current Stripper Well Consortium project description, "Optimization of Plunger Lift Performance in Stripper Gas Wells" and Christian, J., Lea, J.F., Bishop, B., 1995, Plunger Lift Comes of Age, World Oil, November 1995.						

Table 21. Miscellaneous Technologies for Marginal and Older Wells

Technology Overview – Miscellaneous Technologies to Enhance or Extend Production from Marginal/ Older Wells						
New Technology	**Description**	**Potential Benefits**	**State of Development/ Application**	**Requirements to Implement**	**Cost Information**	**Operator/ User/ Other Contact**
Microfine Cements for Casing Repair	Microfine cement consists of very finely ground Portland cement (fines are 3 -5 microns compared to 20-25 microns for fines in conventional oilfield cements . Can easily penetrate voids such as cracks, channels, & casing leaks that cannot be repaired with traditional cements. Good compressive strength and low permeability.	Casing leak repair in older wells that might not withstand a cement squeeze & exposure of the well to acids. Water shutoff in older wells due to channeling behind pipe. May reduce or eliminate premature abandonment of marginal producing wells due to casing leaks & unwanted water production that may be too costly or inaccessible to repair with conventional cements & cementing techniques.	Commercially available through service company vendor.		None Provided.	Halliburton Services.
Reference: Heathman, J.F., East, L.E., 1992, Case Histories Regarding the Application of Microfine Cements, SPE 23926.						
Pressure-Activated Sealant for Casing Repair	Pressure-activated polymer sealant fluid. Pressure drop across a leak site causes fluid to polymerize into a flexible seal. Best for long narrow leaks & cracks, not circular holes or wide spread corrosion.	Low cost remedial casing repair. Alternative to remedial workovers. Avoid premature well abandonment	Commercially available. Successful field applications reported.	Not for severe leaks, high leak rates > 1 barrel per minute	May reduce the cost of casing-leak workovers by 50 percent. In field test, average repair cost = $22,500 per well for sealant repair vs. $45,000/well for conventional casing repair using workover rig. Sealant cost is approx. 85% of treatment cost. Cost estimate based on volume of sealant required.	CamWest, Casper, WY; Seal-Tite, Mandeville, LA
Reference: Torr, D., Rusch, D., 2001, Pressure-activated sealant repairs casing leaks, World Oil, Petroleum Technology Special Report, March 2001.						

Table 21, continued. Miscellaneous Technologies for Marginal and Older Wells						
New Technology	**Description**	**Potential Benefits**	**State of Development**	**Requirements to Implement**	**Cost Information**	**Operator/ User/ Other Contact**
Enhanced Dilute Surfactant	New chemical treatment initially developed for cleaning oil-contaminated soils. Application under development for oil wells to clean perforations, promote oil flow from reservoir & reduce paraffin formation in the well. Product does not emulsify oil in water. Oil moves as free product slug with produced water & can be separated at the surface with standard oil/ water separation techniques.	Spent product solution in produced water can be disposed with the produced water. Appears to remove paraffin in some wells & may prevent paraffin formation. Can be used for on-site clean up of oil contaminated soils as alternative to dig & haul site remediation.	Chemical commercially available in NY for pilot tests. Product currently marketed under the name "BE-D-1". Pilot testing currently underway in 400 Texas stripper wells.	Solution must be heated to 190 deg F & pumped in hot. Cap well for 24 hr & pump back. Formation water salinity must be less than 30,000 ppm.	Approx. $20 - $25/ gallon. Dilute to 1 – 1.5% solution.	T.M. Cook Co. 108 Ball St. East Syracuse, NY 10305 315-437-3285
Reference: Glenn Davies, T.M. Cook, Co., personal communication.						
Low Cost Hydraulic Re-Fracturing (Low Pressure, Low Volume, With Proppant)	Low cost method for hydraulic fracturing of new or existing oil wells for well cleanup. Single pump truck & two persons. Requires a water storage tank or water truck for support. 1,000 gallons of fracturing fluid (borate cross-linked guar polymer) and 1,200 # of proppant pumped at rates of 3-4 bbls/minute & pressure up to 5,000 psi. Enzyme gel breakers.	Best for old, shallow oil wells that may indicate near well bore formation damage, or were never effectively fractured.	Field test of 8 fracture treatments on shallow wells in the US NPR-3. Results were mixed. Most demonstrated that an effective fracture treatment was obtained.	If well has high static fluid level, it must pump off quickly. Fracture fluid must cleanly break under reservoir conditions.	None Provided.	Rock Creek Enterprises, Buffalo, Wyoming
Reference: Rocky Mountain Oilfield Testing Center, 1998, Low Cost Refracturing, RMOTC Test Report, 96PT14.						
Low Cost Hydraulic Fracturing (Water Only, No Proppant)	Hydraulic fracturing using water only, no proppant. Frac size approx. 5000 bbls. for oil wells & 3000 - 4000 bbls for gas wells. Pump up to 50 bbls/minute. Pump down casing. Water is flowed back approx. 24 hours & the well put on pump.	Lower cost. Good for shallow reservoirs.	Mature technology. Successfully used in the Appalachian Basin. Recent test in Ohio demonstrated a successful uphole recompletion of depleted Clinton/Medina wells in the Berea sandstone.	Casing Integrity. Cased hole neutron log or other surveys to locate uphole potential.	Reported incremental cost is $0.50/MCF or approx. $35,000/well. Pay out in 2 to 3 years.	Oxford Oil Co., Zanesville, OH and MB Operating Company, Canton, OH.
Reference: Petroleum Technology Transfer Council, 1999, Appalachian Basin Region Technology Transfer Workshop, March, 1999, "Optimizing Well Production and Operating Efficiencies" PTTC Technology Connections.						

Table 21, continued. Miscellaneous Technologies for Marginal and Older Wells						
New Technology	**Description**	**Potential Benefits**	**State of Development/ Application**	**Requirements to Implement**	**Cost Information**	**Operator/ User/ Other Contact**
Solid Propellant Fracturing	Progressively burning, solid propellant fracturing tool. Conveyed on wireline in a pressure-tight canister under a fluid column of 300 - 1800 ft. Fluid must be compatible w/ formation (water, brine, oil, acid, etc.) Tool available for open hole or cased hole operations. Propellant generates high-pressure gases that fracture formation. Radial fractures 10 to 100 ft., extend 2-5 ft above and below zone.	Can be used in open & cased hole. Fracture breakout to aquifers & other zones is minimal.	Commercially available as of July 1998. 350 fracture stimulations performed to date in Appalachian & Illinois Basins, KY, & KS. Most at depths< 3000 ft. Promising in naturally fractured reservoirs like New Albany Shale. Effective in injection wells to lower injection pressures.	Cased hole applications must have at least 4 perforations per foot & casing in good condition. Must have good cement bond & casing integrity. Run gauge rings beforehand, gamma-ray and cement bond logs. Temperature logs usually run after treatment to determine effectiveness.	5 Trenton Limestone oil wells stimulated in Illinois basin. Typical open hole completion at 2350'. Average cost for solid-propellant fracture stimulation = $3000/well. Individual treatments paid out in 2 weeks.	Commercial tool available from J Integral Engineering. Successful field application by Ashley Oil, Casey, IL. Also, Geotec Thermal Generators, Inc., Boca Raton, FL
Reference: Schmidt, R.A., Ashley, W.M., 2001, Solid propellants provide cost-effective stimulation in marginal wells, World Oil Supplement, Case Study, September 2001. Also, Petroleum Technology Transfer Council (PTTC), 2000, "Developments in Well Stimulation and Slim Hole Technology"						
Liquid-Free CO2/Sand Stimulation	CO2 is pumped as liquid & vaporizes under reservoir conditions. Contain some liquid breakdown acid. 120 tons liquid CO2 30,000 to 46,000 lb 20/40 sand.	Eliminate formation damage in water sensitive formations. Applicable to low pressure, dry-gas reservoirs. Test results in demonstration wells compare favorably with nitrogen gas fracture treatment. Improvement over nitrogen-foam treatments.	Widespread commercial application in Canada. Recently reported 5-year field demonstration in Devonian shales in eastern KY.			
Reference: Mazza, R.L. , 2001, Liquid-Free CO2/Sand Stimulations: An Overlooked Technology-Production Update, Society of Petroleum Engineers, SPE 72383.						
Seismic Stimulation	Downhole vibration tool under development and testing with US Federal research funding. Acoustic Stimulation Tools are commercially available.	Potential low cost procedure to enhance oil production in depleted fields with very high water production & high immobile oil saturation.	On-going DOE - sponsored research. Field tests have mixed or inconclusive results to date. Commercial tools available from vendors.	Best in fields with high water cut and large amount of immobile oil saturation. Best results reported in fields with heavy, high viscosity oil (<20 - 22 API). Larger casing sizes. Depths < 5000 ft.	Not Provided. Contact vendors.	Applied Seismic Research, Plano, TX; PerfClean, Midland, TX; Prism Production Technologies, Edmonton, Alberta; Sonic Production Systems, Ames, IA.
Reference: Jackson, S., Roberts, P., Majer, E., 2001, Advances in Seismic Stimulation Technologies, PTTC Network News, Qrtr 2, 2001.						

Table 22. Well Plugging and Abandonment

Technology Overview - Well Plugging and Abandonment						
New Technology	**Description**	**Potential Benefits**	**State of Development/ Application**	**Requirements to Implement**	**Cost Information**	**Operator/ User/ Other Contact**
Compressed Sodium Bentonite Nodules as Alternative Plugging Material to Cement.	Emplacement of gravel followed by bentonite nodules, by pouring dry in well bore. Followed with hot water to initiate hydration of bentonite. Other technique, wet emplacement of bentonite in well bore loaded with cold water.	Hydration of bentonite forms impermeable barrier. Resistant to chemical alteration. Withstands well temperatures to 170° C, salinity to 189,000 mg/L, and pressure differential across plug to 1500 psi. Hydrates in an oily environment as long as there is access to water.	Field pilot test in 19 oil and gas wells and injection wells in California oil field.	Modify abandonment designs for successful emplacement of bentonite and plug verification; regulatory approval	Historical abandonment costs in pilot field = $7000 - $14,000. Estimated cost savings with bentonite are 20% - 40%.	Chevron Environmental Management Co., Bakersfield, CA
Reference: Englehardt, J, Wilson, M.J., Woody, F., 2001, New Abandonment Technology, New Materials and Placement Techniques, SPE 66498.						
Petro-Plug Bentonite Plugging	Petro-Plug process uses bentonite and gravel to plug and abandon cased oil and gas wells.	Potential effective & lower cost method to plug and abandon oil and gas wells. Unlike cement, bentonite will not crack or break. Bentonite will seal casing leaks. Bentonite retains hydration capacity & will expand to fill breaches in the plug. Bentonite continues to seal if movement of well bore occurs due to ground motion. Bentonite & gravel plug can be removed by circulation.	Field test in two inactive water injection wells in Naval Petroleum Reserve 3, Natrona Co., Wyoming. Well depth 3476' & 3540'. Pressure test to meet WY requirements.	Modify well abandonment design. State regulatory approval.	Costs not evaluated	Rocky Mountain Oilfield Testing Center. Field test of Technology Developed by Petro-Plug, USA, LLC, Casper, WY
Reference: Rocky Mountain Oilfield Testing Center Project Test Results, 1998, Petro-Plug Bentonite Plugging, Report No. RMOTC/97PT22.						
One-trip, Coiled Tubing Hydraulic Cementing System	Hydraulic cement setting tool sets cement by hydraulic pressure, no required rotation. Cement is contained in the setting tool.	Eliminates need to pump cement on site. Coiled tubing conveyance eliminates need for wireline & rig services. Reduces abandonment cost.	Commercial application available through vendor.			
Reference: Smith, M.V. and Pitura, J.M., 1994, Cost-effective Solutions to Well Plugging and Abandonment, SPE 27864.						

Table 22, continued. Well Plugging and Abandonment						
New Technology	**Description**	**Potential Benefits**	**State of Development/ Application**	**Requirements to Implement**	**Cost Information**	**Operator/ User/ Other Contact**
Streamline Large Scale Well Abandonments by Integrating Abandonment Design, Permitting, & Field Implementation	1. Set up database for well review & tracking using commercial desktop software 2. Review wells, populate database: TD, perforations, casing description, fresh water zones, top cement 3. Propose generic abandonment designs to State regulators for pre-approval 4. Inventory saleable equipment/ assets 5. Submit batch permits 6. Streamline scheduling, contracting, tracking & verification	Significant savings in cost & time. Avoid redundancies & duplication of effort. Reduce legal & regulatory liability through better tracking and program management. Reduces overall well abandonment costs by streamlining the well identification, permitting, well tracking & supervision of well abandonment contractors.	Developed database. Received State approval for general well abandonment design for pilot field test. System poised for large-scale implementation on operator's properties in California.	Best for large number of wells requiring abandonment. Personal computer & commercial database software. Pre-approval from State for general well abandonment designs.	Total abandonment liability = $7,000 to $20,000 per well. Abandonment costs for wells with gas migration = $15,000 to $150,00 per well. Estimated cost savings through integrated streamlining program = 30%	Chevron Environmental Management Co., Bakersfield, CA
Resource: Woody, F, 2001, Streamlining Abandonments for Cost Reduction, SPE 66497.						

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Pekot, L.J., Wozniak, D.A., and Martin, J.P., 1999, Tight Sand Evaluation Applied to the Medina Group of Chautauqua County, NY, Society of Petroleum Engineers, SPE 57440.

APPENDIX A. WELL CHARACTERIZATION TOOL

WELL CHARACTERIZATION TOOL MAIN FORM

This Appendix explains the organization of the New York Well Characterization Tool, which was developed as a screening and analysis tool to identify and evaluate well populations that could be affected by proposed policy changes or regulatory actions. The Well Characterization Tool user interface provides a quick way to design and organize database queries to identify well populations that satisfy various criteria such as well status, age, current production, years out of production, financial security, etc. These criteria can be combined in a query to select wells that present an implied level of potential financial or environmental risk. The Well Characterization Tool consists of a Microsoft Access Visual Basic module, which generates two forms designed to serve as a user interface to query selected tables in the Division of Mineral Resources Risk-Based Data Management System (RBDMS) database. A current version of the RBDMS database must first be extracted from Microsoft SQL Server into Access. The Well Characterization Tool was originally designed as a stand-alone desktop system that must be periodically updated with a current version of the RBDMS master well and production data. A version of the Well Characterization Tool has also been implemented in the Minerals Division SQL Server RBDMS.

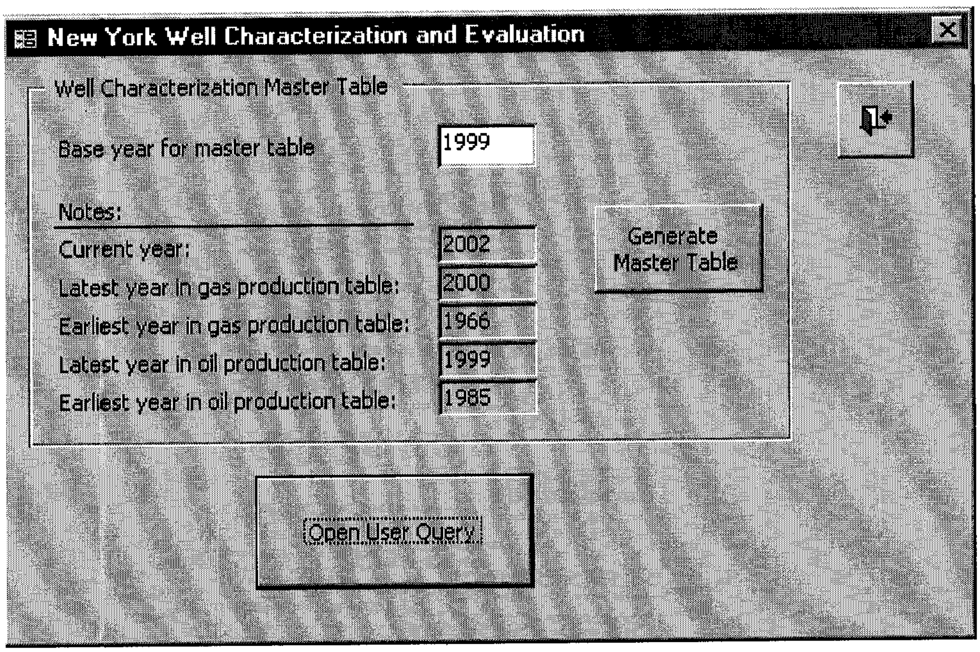
Table A-1 provides a list of the database tables and forms in the Well Characterization Tool. Tables and forms created by the Visual Basic module are identified by "WC" at the beginning of the table name. The names of tables extracted from the RBDMS database begin with 'tbl'.

Table A-1. Forms and Tables in the Well Characterization Tool Module

Form Name	Description
WCfrmUsrQry	User Query Form
WCfrmMain	Well Characterization Main Form
Table Name	**Description**
WCmdlUserQueryResult	Table created every time that a new user query is run
WCtblTabCriteria	Table with description of Tabs and Criteria
WCmdlWellMaster	Created each time that the base year is changed
WCmdlqryTable	Table capturing field, formation, county, and town.
WCmdlOilWell2Tank	Maps oil wells to a tank, tank production, number of wells per tank and average oil production per well
WCmdlOilTankTable	Oil Tank production, number of wells per tank
WCtblCountyName	County name
WCtblBaseYear	Base year
tblPrdWells	RBDMS table
tblGeoFmtn	RBDMS table
tblGeoFmtnTops	RBDMS table
tblRefCompany	RBDMS table
tblGeoFields	RBDMS table
tblWellCement	RBDMS table
tblWellCementCls	RBDMS table
tblNYAnnualWell	RBDMS table
tblPrdGasVolume	RBDMS table
tblWellMaster	RBDMS table
tblPrdOilVolume	RBDMS table

The first window to appear when the tool is open is shown in Figure A-1. This window corresponds to the form 'WcfrmMain' located in the module form view. The form 'WcfrmMain' in Figure A-1 indicates that the *'Base Year for the Master Table'* is 1999, which for this example means that the most recent oil and gas production data captured in the Master Table (WcmdlWellMaster) is from 1999. The user can change the base year by typing in a different year in the white box located next to the label *'Base Year for Master Table'*. To generate a new Master Table (with a new base year) the user must click on the *'Generate Master Table'* button. Once the Master Table is generated, the user then selects and clicks the *'Open User Query'* button. The *'Notes'* section indicates the current year and the range of dates for oil and gas production data in the database. The user can close the window view by clicking the upper right hand icon represented as an open door.

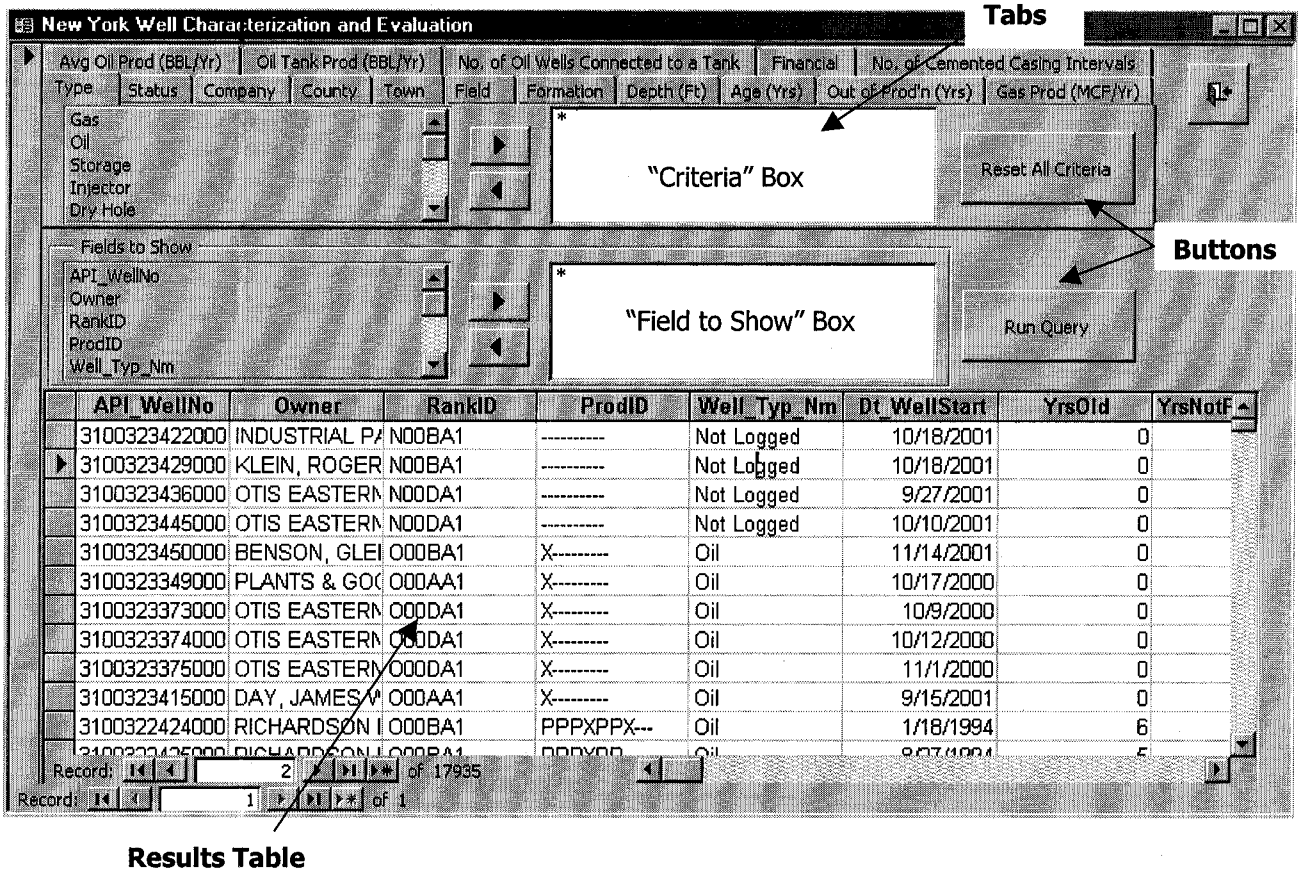
Figure A-1. Well Characterization Tool Main Form



WELL CHARACTERIZATION TOOL USER QUERY FORM

Figure A-2 shows the view of the User Query Form that appears after clicking the *'Open User Query'* button. This form corresponds to the 'WcfrmUsrQry', located in the Form View. The tabs and buttons on the User Query are used to set up the various queries of the Well Characterization Tool database. The "User Query Form" has the following elements: two rows of tabs at the top of the form; two boxes named *'Criteria'* and *'Fields to Show'*; two buttons located in the right hand side named *'Reset All Criteria'* and *'Run Query'*; and a *'Results Table'* which is located at the bottom. The User Query Form has sixteen tabs, which represent the criteria that can be used to select wells from the database. The sixteen tabs are the basis for the queries. Selecting one or more criteria on a single tab filters the criteria available to view in the other tabs. For example, if 'oil' is selected on the *'Well Type'* tab, when the *'County'* tab is opened only the counties with oil wells will appear under the *'County'* tab.

Figure A-2. Well Characterization Tool User Query Form



Features of the User Query Form

Following are descriptions of the features of the User Query Form.

Tabs

Each tab provides a selection of criteria that can be used to filter or select records from the well characterization database. The sixteen tabs represent the criteria that can be used to select wells from the database. In the VB module, the table "WCtblTabCriteria" lists and describes these criteria.

- *Type* - refers to well type: gas, oil, storage, injection, dry hole, not logged, other
- *Status* - refers to well status codes such as AC (active), IN (inactive), SI (shut in), etc.
- *Company* – refers to owner or operator of the well
- *County*

- *Town*
- *Field* – refers to the name of the producing field
- *Formation* – producing formation
- *Depth* – total well depth in feet
- *Age* – age of the well. Wells are selected according to pre-defined age categories. The age of the well is calculated from the base year. Selecting an age category on the 'Age' tab will select all of the wells with in the database that are within the age category. The age category '999' means that the well is more than 75 years old.
- *Out of Prod'n (Yrs)* – years out of production. 'Years out of production' is calculated from the base year. A '0' value means production was reported for the well in the base year. The criterion of '≥ 9 years' means that no production was reported for the well for the ten years prior to the base year. 'No data' means there is a null value for production in the master RBDMS database.
- *Gas Prod (MCF/Yr)* – annual gas production. Various production categories are defined ranging from '*1 Mcf – 100 Mcf*' to '*>10,000 Mcf*', in addition to '0' and 'no data' categories. Selecting a production category will select all the wells in the database with annual gas production within the production range of the category.
- *Avg Oil Prod (BBL/Yr)* – an estimated average oil production per well, which is calculated by dividing the tank production by the number of wells associated with the tank. This oil production value is not the actual oil production from individual wells, but it can be used as a flag or identifier for older, marginal oil wells.
- *Oil Tank Prod (BBL/Yr)* – reported production for the oil tank connected to an individual well. The criteria on this tab allow the tank production to be filtered according to various production categories.
- *No. of Oil Wells Connected to Tank* - the number of individual wells connected to a tank. Currently this tab only allows filtering on a single criterion to select the wells with '*No Data*'.
- *Financial* – general criteria that indicate whether the owner/operators of individual wells meet New York's current requirements to provide financial security for oil and gas operations. The criteria range includes '*No Data*', '*Not Required*', '*Not Enough*' (current bonds/financial security do not meet statutory requirements), '*Enough*' (meets current requirements), '*More than Enough*' (operator's bonds and securities exceed current requirements).
- *No. of Cemented Casing Intervals* – number of intervals ranging from '1' to '6'. The criteria under this tab select wells with data pertaining to cased and cemented zones within the well. Although many of the wells in the master database currently have no data, this tab can be used to screen wells according to the well data that is available. For example, selecting a producing formation on the '*Formation*' tab

and then selecting criteria from the '*No. of Cemented Cased Intervals*' tab, will quickly indicate if well completion data is available for the producing formation of interest.

Criteria Box.

The criteria selected under each tab are displayed in this box. The user selects criteria from the required tab by clicking in the arrow or double clicking the selected criteria. The selected criteria will appear in the criteria box. To select multiple criteria from each tab, press the "Ctrl" key and select the desired criteria one by one. Click in the arrow and all of the selected criteria will be displayed in the criteria box. To select a group of adjacent criteria, press the "Ctrl" "Shift" keys and click in the arrow.

When criteria are selected from a tab, an asterisk (*) will appear on the upper right hand corner of the tab indicating that tab is active in the query. This feature allows the user to keep track of the tabs have been selected for a query.

The 'Reset All Criteria' button followed by the 'Run Query' button will reset all previously selected criteria and return the user to the Master Table.

Fields-to-Show Box and Run Query

The 'Fields- to- Show Box' indicates what data fields have been selected for display in the 'Results Table.' The data fields are displayed in the Results Table in the order in which they are selected in the 'Fields to Show Box.' If no data fields are selected, the Results Table will show all data fields. After all criteria and data fields are selected, click the 'Run Query' button to generate the query.

Results Table

The entire Master Table (WcmdlWellMaster) appears as the Result Table when the User Query Form is first opened. Table A-2 contains a list of data fields in the Master Table and a description of the fields. Each time that a user runs a new query, the 'WcmdlUserQueryResult' table in the table view will change, which generates a new Results Table. To save a Results Table for future reference or for use with other applications in Microsoft Access, the user must go to table view in Access and rename the 'WcmdlUserQueryResult' table.

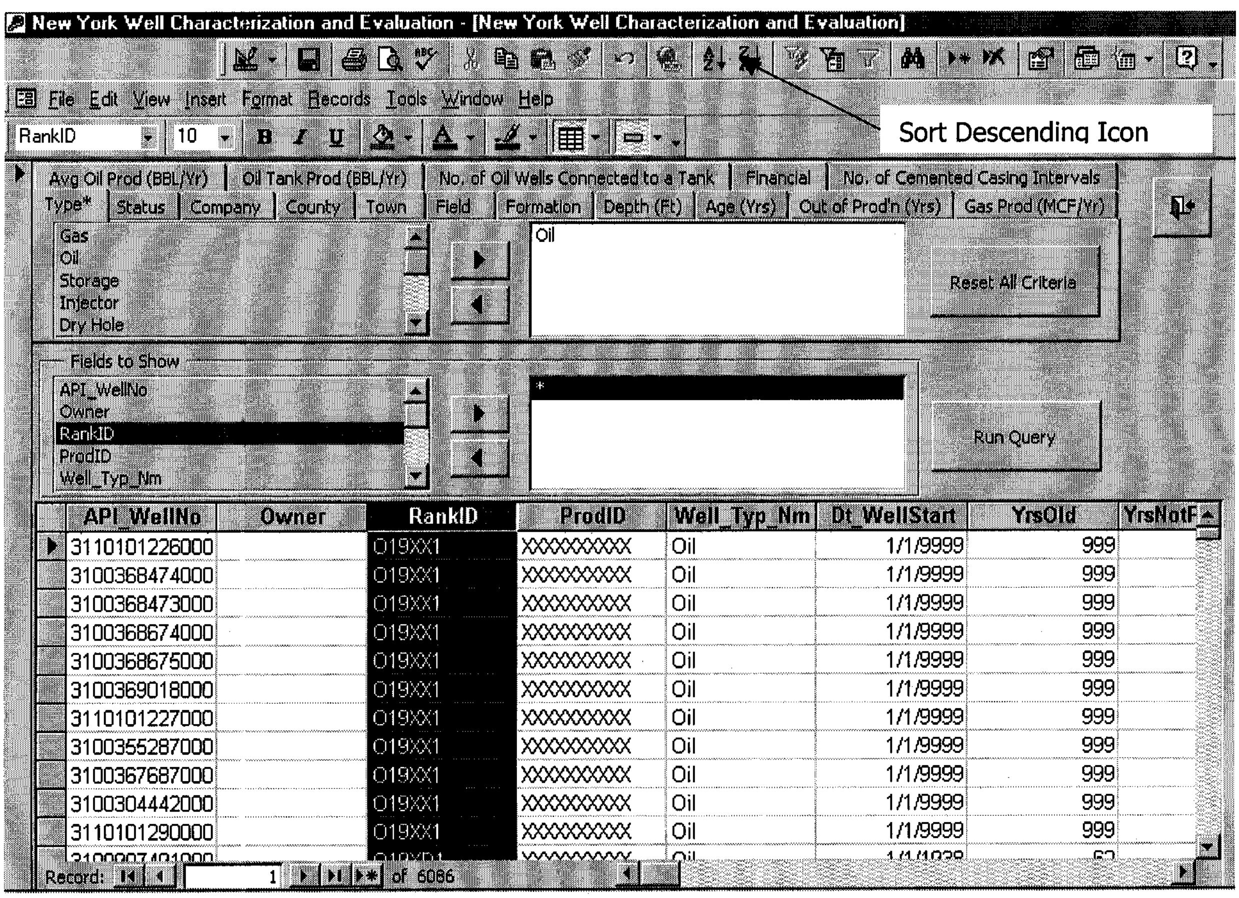
Table A-2. Master Table Field Names and Description

Master Table Field Names	Description
API_WellNo	API Number
Owner	Company
RankID	Rank ID
ProdID	Production ID
Well_Typ_Nm	Well Type Name
Dt_WellStart	Drilling Date
YrsOld	Well Age
YrsNotProducing	Year Not Producing
Cnty_Nm	County Name
Town	Town
Well_Nm	Well Name
Field_Nm	Field Name
PrdFmtn_Nm	Producing Formation Name
Depth	Well Depth
Prd_1999 … Prd_1990	Annual Well Production from 1990-99 Gas Wells: Actual Individual Well Production Oil wells: Calculated Average Individual Well Production
OilTankID_1999 … OilTankID_1990	Oil Tank ID Associated to with an Oil well for each year from 1990-99
OilTankPrd_1999 … OilTankPrd_1990	Total Annual Oil Tank Production from 1990-1999
OilTanknWell_1999 … OilTanknWell_1990	Yearly Number of well associated to the tank ID
CurGasProd	Annual Gas Production reported for Current Year
CurWaterProd	Annual Water Production reported for Current Year
CurOilProd	Annual Oil Production reported for Current Year
YNDataCmtCsg	Yes/No Flag if Data is available on casing or cemented intervals
NumOfCmtData	Number of Cemented Intervals
Csg_String	Type of Casing
Bot	Bottom of Cased Interval
BoC	Bottom of Cement
ToC	Top of Cement
Class_Cmt	Type of Cement
Sacks	Number of Sacks
Opfsneed	Financial Security Need
Opfshave	Financial Security Have
RankProd	Production Rank
RankEnv	Environmental Rank
RankTech	Technology Rank
PB_Depth	Plug Back Depth
Well_Typ	Well Type Code
Wl_Status	Well Status
OpNo	Operator Number
Cnty	County Number
Field_No	Field Number
fDepth	Internal
fAge	Internal
fYrsNotProducing	Internal
fGProduction	Internal
fOProduction	Internal
fOil_Tank_Production	Internal
fN_Oil_Wells_Tank	Internal
fFinancial	Internal
fCement	Internal

Rank ID

'Rank ID' is a six-digit code assigned to each well by the Well Characterization Tool, which describes the well according to a variety of criteria such as age of the well or years out of production. The 'Rank ID' is designed to so that wells can be ordered according to the potential for financial or environmental risk implied by the selection criteria - from highest potential risk to lowest risk. Each character or digit represents a single criterion or risk factor. The first character indicates well type: oil, gas, storage, or injector. The remaining characters indicate: operator/owner (whether known or unknown); number of years out of production (from 0 to >9); compliance of the corresponding operator/owner with current financial security requirements (no data, not enough, not required, etc.); age of the well, (<10 years to >75 years); data available for casing and cemented intervals (yes/no). The 'RankID' is flexible and the string of characters that comprise the 'RankID' code can be regrouped or modified. A descending sort by 'Rank ID' in the Results Table will bring wells with the greatest potential risk to the top rows of the table. Figure A-3 is an example of a 'Rank ID' sort.

Figure A-3. Well Characterization Tool Rank ID Example



In Figure A-3, the 'Rank ID' code, O19XX1, is deciphered as follows: 'O' means the well type is an oil well; '9' means the number of years out of production are 9 or more; the first 'X' means no financial security is available data; the second 'X' means no data is available for age of the well; '1' means no data is available for casing or cemented zones in the well. Following is a complete list of the component criteria and codes used for Rank ID:

- **1st Character: Well type**

G=Gas	I=Injector	X=Other
O=Oil	D=Dry Hole	
S=Storage	N=Unknown	

- **2nd Character: Operator**

  0=Owner identified   1=No owner identified.

- **3rd Character: Number of years out of production (since base year)**

  0=Well producing in base year
  1=Out of production 1 year prior to base year
  2=Out of production 2 years prior to base year
  ...
  8=Out of production 8 years
  9=Out of production 9 years or more

- **4th Character: Financial Security**

A=More than enough	C=Not required	X=No data
B=Enough	D=Not enough	

- **5th Character: Age of the well**

A= 10 years or younger	D= 51 to 74 years
B= 11 to 35 years	E= 75 years or more
C= 36 to 50 years	X=No data

- **6th character: Cement**

  0=Casing string is cemented at one or more depth intervals
  1=Casing string is not cemented

Production ID or ProdID

'ProdID' is a ten-digit identifier with each digit corresponding to a production year in the Master Table. Production ID provides a quick snapshot of the reported production history for the well for the ten years prior to the base year. 'P' indicates that there was production reported for the well in the corresponding year. 'X' means no production was reported in the corresponding year. For example, if the base year is 1999 and the 'ProdID' is 'XXPXXXPXXP', the first 'X' means no production was reported for the well in 1999. The last 'P' means that production was reported for the well in 1990. There was production reported for this well for only three of the last ten years. If the well is not an oil or gas production well, or if the well is not yet drilled, this status is indicated by a hyphen in the corresponding year.

APPENDIX B. WELL CHARACTERIZATION TABLES

This Appendix contains several tables that were generated using the Well Characterization Tool to estimate the number of long-term inactive wells in the various oil and gas fields, and provide an overview of the relative well productivity in different fields. The tables were created using the version of New York's RBDMS that was available in the Spring of 2002. A 1999 Base Year was assumed for production data.

The following tables illustrate the more detailed, field-specific queries that can be made using the Well Characterization Tool. In addition, the tables provide a general comparison of the various fields based on estimated individual well production and approximate numbers of long-term inactive wells.

- Table B-1. Long-term Inactive Gas Wells by Field and Well Status (1999 Base Year)
- Table B-2. Long-term Inactive Oil Wells by Field and Well Status (1999 Base Year)
- Table B-3. Approximated Number of Producing Gas Wells by Field (1999 Base Year)
- Table B-4. Approximate Number of Producing Oil Wells by Field (1999 Base Year)
- Table B-5. Approximate Number of Injection Wells by Field

Table B -1. Long-Term Inactive Gas Wells by Field and Well Status (1999 Base Year)

		No Production Reported For ≥ 9 Years (Since 1990 and earlier)			No Production Reported For 2 – 8 Years (Since 1991 –1997)			No Production For 1 Year (Since 1998)			
COUNTY	FIELD	Active Gas Wells	Inactive Gas Wells	Unknown Gas Wells	Active Gas Wells	Inactive Gas Wells	Unknown Gas Wells	Active Gas Wells	Inactive Gas Wells	Approx. Total Non-Producing Wells	No Identified Operator
Chautauqua	LAKESHORE	26	40	194	34	106	14	12	22	448	40
Erie/ Genesee	ALDEN-LANCASTER	4	12	115	6	4	1	1	1	144	9
Oswego	PULASKI	3	4	68						75	4
Onondaga	BALDWINSVILLE	1	2	54						57	4
Erie	ORCHARD PARK-HAMBURG	1	1	43	1					46	1
Erie	LAKEVIEW		5	21	2	13		2	2	45	4
Cattaraugus	RICE BROOK			42						42	18
Oswego	SANDY CREEK			41						41	
Genesee	PAVILION	1		34			1			36	1
Ontario	GENEVA			31						31	2
Ontario	WEST BLOOMFIELD	1		30						31	3
Erie	BRANT-EDEN	2	3	7	10	7			1	30	
Erie	BUFFALO	1	2	18	2	6				29	9
Erie	TONAWANDA			27						27	22
Steuben	RATHBONE		1	25						26	
Erie	NORTH COLLINS	2	1	13	1	3			1	21	
Allegany	STATE LINE		9	12						21	
Steuben	UNNAMED		3	16	1					20	10
Erie	WEST SENECA	1	2	16						19	
Livingston	DANSVILLE	5	1	12						18	
Ontario	RUSHVILLE			17						17	7
Other	UNNAMED			17						17	12
Wyoming	LEICESTER	1	8	2	2	3				16	
Oneida	ROME			16						16	8

Table B-1, continued. Long-Term Inactive Gas Wells by Field and Well Status (1999 Base Year)											
		No Production Reported For ≥ 9 Years (Since 1990 and earlier)			No Production Reported For 2 – 8 Years (Since 1991 –1997)			No Production For 1 Year (Since 1998)			
COUNTY	FIELD	Active Gas Wells	Inactive Gas Wells	Unknown Gas Wells	Active Gas Wells	Inactive Gas Wells	Unknown Gas Wells	Active Gas Wells	Inactive Gas Wells	Approx. Total Non-Producing Wells	No Identified Operator
Erie	UNNAMED		2	14						16	2
Ontario	UNNAMED		1	15						16	10
Cayuga	WEST AUBURN	5	3	1	5	1		1		16	
Livingston	UHLEY CORNERS-CALEDONIA	2	3	4			2		4	15	
Cattaraugus	UNNAMED		1	14						15	
Erie	EAST AURORA	2	3	1	3	5				14	1
Oneida	CAMDEN			13						13	1
Allegany	RICHBURG		12							12	
Allegany	UNNAMED			10		2				12	1
Yates	NORTH PENN YAN	1	1		1	2			6	11	
Allegany	BEECH HILL-INDEPENDENCE	4	5	1						10	
Erie	CENTRAL WALES			1		9				10	
Erie	COLDEN			10						10	
Wyoming	CASCADE BROOK			1		8				9	1
Wyoming	DANLEY CORNERS	1		6		1			1	9	
Erie	ELMA	3		1	1	3			1	9	
Ontario	VINCENT			9						9	
Chautauqua	GERRY-CHARLOTTE				1	7				8	
Steuben	JASPER			8						8	
Seneca	SENECA FALLS			8						8	
Chautauqua	UNNAMED			7		1				8	3
Ontario	BRISTOL			7						7	1
Erie	BUFFALO CREEK	2	2		1	2				7	
Cattaraugus	CHAFFEE-ARCADE			3	1	2			1	7	

Table B-1, continued. Long-term Inactive Gas Wells by Field and Well Status (1999 Base Year)

		No Production Reported For ≥ 9 Years (Since 1990 and earlier)			No Production Reported For 2 – 8 Years (Since 1991 –1997)			No Production For 1 Year (Since 1998)			
COUNTY	FIELD	Active Gas Wells	Inactive Gas Wells	Unknown Gas Wells	Active Gas Wells	Inactive Gas Wells	Unknown Gas Wells	Active Gas Wells	Inactive Gas Wells	Approx. Total Non-Producing Wells	No Identified Operator
Erie	COWLESVILLE	1	3	1	1			1		7	
Erie	GLENWOOD	1	1	4	1					7	
Wyoming	JAVA		1		1				5	7	
Erie	AKRON		1			3		1	1	6	
Cattaraugus	PIGEON HILL	1	2		3					6	
Cattaraugus	RED HOUSE			6						6	
Genesee	ROANOKE			6						6	
Ontario	SENECA LAKE			6						6	
Wyoming	UNNAMED		1	5						6	
Schuyler	WAYNE-DUNDEE			6						6	3
Ontario	EAST BLOOMFIELD	3	2							5	
Cattaraugus	HOTCHKISS HOLLOW		5							5	
Oswego	NORTH FULTON			5						5	4
Wyoming	SHELDON	2		2					1	5	
Wyoming	SILVER LAKE				1	2		2		5	
Oswego	SOUTH FULTON			5						5	1
Lewis	TUG HILL			5						5	
Onondaga	UNNAMED			5						5	4
Cattaraugus	ASHFORD		1		1	1			1	4	
Livingston	AVON		2	2						4	1
Wayne	CLYDE			4						4	
Chemung	ELMIRA		3	1						4	
Seneca	FAYETTE-WATERLOO	1		1	2					4	
Chenango	GENEGANTSLET		2	2						4	
Allegany	GORDON BROOK		1			3				4	

Table B-1, continued. Long-Term Inactive Gas Wells by Field and Well Status (1999 Base Year)											
		No Production Reported For ≥ 9 Years (Since 1990 and earlier)			No Production Reported For 2 – 8 Years (Since 1991 –1997)			No Production For 1 Year (Since 1998)			
COUNTY	FIELD	Active Gas Wells	Inactive Gas Wells	Unknown Gas Wells	Active Gas Wells	Inactive Gas Wells	Unknown Gas Wells	Active Gas Wells	Inactive Gas Wells	Approx. Total Non-Producing Wells	No Identified Operator
Tompkins	GROTON			4						4	
Steuben	HOWARD			4						4	
Onondaga	MEMPHIS			4						4	
Allegany	RUSHFORD		1	3						4	
Livingston	UNNAMED			4						4	
Oneida	UNNAMED		1	3						4	1
Schuyler	UNNAMED			4						4	1
Wyoming	WYOMING	1		3						4	
Allegany	ALLEN			3						3	
Cayuga	AUBURN		2		1					3	
Cayuga	BLUE TAIL ROOSTER		3							3	
Cattaraugus	BRYANT HILL CREEK	1		2						3	
Monroe	CHURCHVILLE			3						3	2
Erie	CONCORD				1	2				3	
Chautauqua	ELLERY		3							3	
Livingston	GROVELAND	1	2							3	
Ontario	HONEOYE-ORISKANY		3							3	
Livingston	HUNT HOLLOW	3								3	
Genesee	HURON CREEK			2	1					3	1
Genesee	INDIAN FALLS	1	1					1		3	
Erie	LAWTONS			3						3	
Chautauqua	NORTH HARMONY	1		1		1				3	
Steuben	NORTHWEST HARRISON	1		2						3	
Cattaraugus	SARDINIA		2						1	3	

Table B-1, continued. Long-Term Inactive Gas Wells by Field and Well Status (1999 Base Year)

		No Production Reported For ≥ 9 Years (Since 1990 and earlier)			No Production Reported For 2 – 8 Years (Since 1991 –1997)			No Production For 1 Year (Since 1998)			
COUNTY	FIELD	Active Gas Wells	Inactive Gas Wells	Unknown Gas Wells	Active Gas Wells	Inactive Gas Wells	Unknown Gas Wells	Active Gas Wells	Inactive Gas Wells	Approx. Total Non-Producing Wells	No Identified Operator
Steuben	WEST UNION			3						3	
Steuben	WYCKOFF		2			1				3	
Wyoming	ATTICA		2							2	
Ontario	BENTON RUN								2	2	
Steuben	BROOKFIELD			2						2	
Wyoming	CASTILE		1	1						2	
Allegany	CORBIN HILL		2							2	
Cattaraugus	EAST OTTO		2							2	
Genesee	ELLICOTT CREEK					2				2	
Cattaraugus	ELLICOTTVILLE	1			1					2	
Allegany	FULMER VALLEY		2							2	
Cattaraugus	HOG HOLLOW					1			1	2	
Cattaraugus	INDIAN CREEK	1		1						2	
Tompkins	LANSING			2						2	
Yates	SOUTH PENN YAN		1			1				2	
Broome	TRIANGLE		1	1						2	
Chemung	VAN ETTEN			2						2	
Allegany	ALFRED					1				1	
Cattaraugus	ALLEGANY STATE PARK			1						1	
Steuben	ANDOVER							1		1	
Cayuga	ASHLAND FARMS	1								1	
Steuben	BATH			1						1	
Genesee	BETHANY		1							1	
Chautauqua	BURR BEAR POOL								1	1	
Chautauqua	BUSTI	1								1	
Tioga	CAFFERTY HILL							1		1	

Table B-1, continued. Long-Term Inactive Gas Wells by Field and Well Status (1999 Base Year)											
		No Production Reported For ≥ 9 Years (Since 1990 and earlier)			No Production Reported For 2 – 8 Years (Since 1991 –1997)			No Production For 1 Year (Since 1998)			
COUNTY	FIELD	Active Gas Wells	Inactive Gas Wells	Unknown Gas Wells	Active Gas Wells	Inactive Gas Wells	Unknown Gas Wells	Active Gas Wells	Inactive Gas Wells	Approx. Total Non-Producing Wells	No Identified Operator
Chautauqua	CARROLL		1							1	
Allegany	CERES		1							1	
Erie	CLARENCE		1							1	
Cattaraugus	CLARKSVILLE	1								1	
Steuben	COLONEL BILLS CREEK					1				1	
Livingston	CONESUS			1						1	
Chautauqua	CONEWANGO CREEK				1					1	
Cattaraugus	CONNOISARAULEY CREEK	1								1	
Steuben	CORNING			1						1	
Steuben	CROSBY CREEK					1				1	
Onondaga	CROSS LAKE	1								1	
Cattaraugus	DAYTON	1								1	
Chemung	DOOLITTLE HILL	1								1	
Cattaraugus	DUBLIN HOLLOW	1								1	
Allegany	EAST INDEPENDENCE				1					1	
Allegany	FARMERSVILLE		1							1	
Chautauqua	FOLSOM CREEK	1								1	
Cattaraugus	GREAT VALLEY							1		1	
Madison	HAMILTON			1						1	
Monroe	HAMLIN		1							1	
Allegany	HOUGHTON			1						1	
Steuben	HUNGRY HOLLOW	1								1	
Cattaraugus	JERSEY HOLLOW	1								1	
Oswego	KASOAG		1							1	
Madison	LEBANON								1	1	

Table B-1, continued. Long-Term Inactive Gas Wells by Field and Well Status (1999 Base Year)											
		No Production Reported For ≥ 9 Years (Since 1990 and earlier)			No Production Reported For 2 – 8 Years (Since 1991 –1997)			No Production For 1 Year (Since 1998)			
COUNTY	FIELD	Active Gas Wells	Inactive Gas Wells	Unknown Gas Wells	Active Gas Wells	Inactive Gas Wells	Unknown Gas Wells	Active Gas Wells	Inactive Gas Wells	Approx. Total Non-Producing Wells	No Identified Operator
Oswego	LITTLE FRANCE				1					1	
Ontario	MELVIN HILL		1							1	
Schuyler	MONTEREY			1						1	
Cattaraugus	OLEAN		1							1	
Steuben	PAINTED POST								1	1	
Cattaraugus	PERRYSBURG			1						1	
Steuben	PURDY CREEK			1						1	
Seneca	ROSE HILL			1						1	
Madison	SANGERFIELD	1								1	
Oneida	SANGERFIELD	1								1	
Allegany	SHARON			1						1	
Allegany	SHERRY HILL					1				1	
Erie	SOUTH WALES	1								1	
Livingston	SPARTA		1							1	
Chautauqua	SPRAGUE HILL		1							1	
Tioga	STAGECOACH					1				1	
Yates	SUGAR CREEK		1							1	
Steuben	WOODHULL			1						1	

Table B -2. Long-term Inactive Oil Wells by Field and Well Status (1999 Base Year)

		No Production Reported For ≥ 9 Years (Since 1990 and earlier)			No Production Reported For 2 – 8 Years (Since 1991 –1997)			No Production For 1 Year (Since 1998)				
County	Field Name	Active Oil Wells	Inactive Oil Wells	Unknown Oil Wells	Active Oil Wells	Inactive Oil Wells	Unknown Oil Wells	Active Oil Wells	Inactive Oil Wells	Unknown Oil Wells	Approx. Total Non-Producing Wells	No Identified Operator
Allegany	RICHBURG	55	272	238	40	251	54	75	15		1000	3
Cattaraugus	CHIPMUNK		58	38	3	36	3	82	8	1	229	1
Allegany	UNNAMED		138	26							164	2
Chautauqua	BUSTI	1	4	33	7	44	1	14	46		150	
Steuben	MARSH		138	5							143	
Allegany	FORD'S BROOK		35	70		21	1	1			128	
Allegany	FULMER VALLEY	1	81	18	18		1	6	1		126	1
Cattaraugus	BRADFORD	4	4	33	9	39	7	13	5		114	
Cattaraugus	FIVE MILE		11	20	5	44		2			82	
Cattaraugus	FOUR MILE		8	5	16	7	2	21	17		76	
Allegany	BROWNING					17			47		64	
Cattaraugus	UNNAMED	5	32	14							51	
Allegany	BEECH HILL-INDEPENDENCE	5	4	7	7	7					30	1
Allegany	NILE		1	7	1	4	1	14			28	
Allegany	SCIO						24				24	
Allegany	CORBIN HILL		6	11							17	
Cattaraugus	RED HOUSE			16							16	
Allegany	CLARKSVILLE		5	3		5					13	2
Cattaraugus	FARMERSVILLE	1		11							12	
Chautauqua	GERRY-CHARLOTTE	4	5	1	1	1					12	
Chautauqua	ELLERY	4	5	1							10	
Chautauqua	NORTH HARMONY	5	2		1	1		1			10	
Allegany	ANDOVER			6	3						9	2
Cattaraugus	OLEAN	1	7								8	
Chautauqua	CARROLL		3								3	

Table B –2, continued. Long-Term Inactive Oil Wells by Field and Well Status (1999 Base Year)

		No Production Reported For ≥ 9 Years (Since 1990 and earlier)			No Production Reported For 2 – 8 Years (Since 1991 –1997)			No Production For 1 Year (Since 1998)				
County	Field Name	Active Oil Wells	Inactive Oil Wells	Unknown Oil Wells	Active Oil Wells	Inactive Oil Wells	Unknown Oil Wells	Active Oil Wells	Inactive Oil Wells	Unknown Oil Wells	Approx. Total Non-Producing Wells	No Identified Operator
Chautauqua	CLYMER HILL					1					1	
Cattaraugus	DUTCH HILL				1						1	
Erie	ELMA			1							1	1
Chautauqua	FOLSOM CREEK	1									1	
Chautauqua	HARMONY	1									1	
Cattaraugus	HOTCHKISS HOLLOW			1							1	
Cattaraugus	MUD CREEK	1									1	
Erie	NORTH COLLINS						1				1	
Cattaraugus	PORTVILLE			1							1	
Cattaraugus	RICE BROOK			1							1	
Cattaraugus	RUSHFORD			1							1	
Chatauqua	UNNAMED					1					1	
Steuben	UNNAMED			1							1	1

Table B-3. Approximate Number of Producing Gas Wells by Field (1999 Base Year)

County	Field	< 100 Mcf/Year	100 Mcf - < 1,000 Mcf/Year	1,000 Mcf – < 10,000 Mcf/Year	10,000 Mcf – < 100,000 Mcf/Year	≥ 100,000 Mcf/Year	Approximate Total Productive Gas Wells
Erie	AKRON		13	9			22
Erie/ Genesee	ALDEN-LANCASTER	11	91	147			249
Genesee	ALEXANDER		2	5			7
Allegany	ALFRED	2	1				3
Cattaraugus	ALLEGANY STATE PARK						None identified
Allegany	ALLEN			1			1
Steuben	ANDOVER						None identified
Cattaraugus	ASHFORD	2	4	5	1		12
Cayuga	ASHLAND FARMS						None identified
Wyoming	ATTICA			1			1
Cayuga	AUBURN			2			2
Steuben	AVOCA		1	1			2
Livingston	AVON	2	3	8			13
Onondaga	BALDWINSVILLE						None identified
Steuben	BATH						None identified
Allegany	BEECH HILL-INDEPENDENCE						None identified
Ontario	BENTON RUN						None identified
Genesee	BERGEN	1			2		3
Genesee	BETHANY	2	18	9			29
Steuben	BIG CREEK		1				1
Chautauqua	BIG INLET POOL			1			1
Cayuga	BLUE TAIL ROOSTER	1					1
Cattaraugus	BRADFORD				1		1
Madison	BRADLEY BROOK		3	2	4		9
Erie	BRANT-EDEN	44	129	111			284
Ontario	BRISTOL						None identified
Steuben	BROOKFIELD						None identified
Cattaraugus	BRYANT HILL CREEK						None identified
Erie	BUFFALO		9				9
Erie	BUFFALO CREEK		9	14			23
Chautauqua	BURR BEAR POOL						None identified
Chautauqua	BUSTI						None identified
Wayne	BUTLER CREEK		1				1
Tioga	CAFFERTY HILL						None identified
Oneida	CAMDEN						None identified
Chautauqua	CARROLL						None identified

Table B-3, continued. Producing Gas Wells by Field (1999 Base Year)							
County	Field	< 100 Mcf/Year	100 Mcf - < 1,000 Mcf/Year	1,000 Mcf – < 10,000 Mcf/Year	10,000 Mcf – < 100,000 Mcf/Year	≥ 100,000 Mcf/Year	Approximate Total Productive Gas Wells
Wyoming	CASCADE BROOK						None identified
Chautauqua	CASSADAGA CREEK		2	1			3
Wyoming	CASTILE						None identified
Allegany	CERES						None identified
Cattaraugus	CHAFFEE-ARCADE	2	20	31			53
Erie	CHESTNUT RIDGE		1				1
Cattaraugus	CHIPMUNK	4			4		8
Monroe	CHURCHVILLE						None identified
Erie	CLARENCE	1					1
Cattaraugus	CLARKSVILLE						None identified
Wayne	CLYDE						None identified
Chautauqua	CLYMER		1	1			2
Erie	COLDEN						None identified
Steuben	COLONEL BILLS CREEK						None identified
Erie	CONCORD	2	20	15	4		41
Livingston	CONESUS						None identified
Chautauqua	CONEWANGO CREEK						None identified
Cattaraugus	CONNOISARAULEY CREEK						None identified
Steuben	COOPERS PLAINS	1					1
Allegany	CORBIN HILL						None identified
Steuben	CORNING						None identified
Erie	COWLESVILLE		2	1			3
Steuben	CROSBY CREEK						None identified
Onondaga	CROSS LAKE						None identified
Wyoming	DANLEY CORNERS	1	34	69			104
Livingston	DANSVILLE	1					1
Cattaraugus	DAYTON	1	2	2			5
Chemung	DOOLITTLE HILL						None identified
Cattaraugus	DUBLIN HOLLOW						None identified
Wyoming	DUTCH HOLLOW		1				1
Erie	EAST AURORA	3	15	19			37
Ontario	EAST BLOOMFIELD		1	6	2		9
Allegany	EAST INDEPENDENCE						None identified
Cattaraugus	EAST OTTO						None identified
Chautauqua	ELLERY		6	2			8
Genesee	ELLICOTT CREEK						None identified

Table B-3, continued. Producing Gas Wells by Field (1999 Base Year)							
County	Field	< 100 Mcf/Year	100 Mcf - < 1,000 Mcf/Year	1,000 Mcf – < 10,000 Mcf/Year	10,000 Mcf – < 100,000 Mcf/Year	≥ 100,000 Mcf/Year	Approximate Total Productive Gas Wells
Cattaraugus	ELLICOTTVILLE	2	7	1			10
Erie	ELMA	4	20	17	4		45
Chemung	ELMIRA	1					1
Allegany	FARMERSVILLE						None identified
Seneca	FAYETTE-WATERLOO	1	9	115	9		134
Livingston	FINNEGAN HILL		2	8			10
Chautauqua	FOLSOM CREEK						None identified
Allegany	FORD'S BROOK	2					2
Allegany	FRIENDSHIP	1					1
Allegany	FULMER VALLEY						None identified
Chenango	GENEGANTSLET						None identified
Seneca	GENEVA						None identified
Chautauqua	GERRY-CHARLOTTE	1	6	8	1		16
Erie	GLENWOOD	1	4	1			6
Steuben	GLODES CORNERS ROAD				2	8	10
Allegany	GORDON BROOK			2	1		3
Cattaraugus	GREAT VALLEY						None identified
Tompkins	GROTON						None identified
Livingston	GROVELAND						None identified
Madison	HAMILTON						None identified
Monroe	HAMLIN						None identified
Ontario	HONEOYE-ORISKANY						None identified
Cattaraugus	HOG HOLLOW	2					2
Cattaraugus	HOTCHKISS HOLLOW						None identified
Allegany	HOUGHTON						None identified
Steuben	HOWARD		1				1
Steuben	HUNGRY HOLLOW						None identified
Livingston	HUNT HOLLOW			1			1
Genesee	HURON CREEK	1	73	96	2		172
Cattaraugus	INDIAN CREEK						None identified
Genesee	INDIAN FALLS	2	49	30			81
Steuben	JACKSON HILL			1			1
Steuben	JASPER		1				1
Wyoming	JAVA		17	1			18
Cattaraugus	JERSEY HOLLOW						None identified
Allegany	KARR VALLEY			1			1
Oswego	KASOAG						None identified
Chautauqua	KELLY HILL			1			1

Table B-3, continued. Producing Gas Wells by Field (1999 Base Year)							
County	Field	< 100 Mcf/Year	100 Mcf - < 1,000 Mcf/Year	1,000 Mcf – < 10,000 Mcf/Year	10,000 Mcf – < 100,000 Mcf/Year	Producing ≥ 100,000 Mcf/Year	Approximate Total Productive Gas Wells
Chautauqua	LAKESHORE	119	1027	2114	69		3329
Erie	LAKEVIEW	4	36	39	2		81
Tompkins	LANSING						None identified
Erie	LAWTONS						None identified
Madison	LEBANON			1	1		2
Wyoming	LEICESTER	5	28	28			61
Oswego	LITTLE FRANCE						None identified
Cattaraugus	LITTLE VALLEY		1				1
Ontario	MELVIN HILL						None identified
Onondaga	MEMPHIS						None identified
Steuben	MILWAUKEE CREEK			1			1
Schuyler	MONTEREY						None identified
Steuben	MUCK FARM				1	3	4
Chautauqua	MUD CREEK	1					1
Seneca	NEILSON ROAD POOL			1			1
Erie	NORTH COLLINS	4	29	18			51
Oswego	NORTH FULTON						None identified
Chautauqua	NORTH HARMONY		8	7			15
Yates	NORTH PENN YAN		1				1
Steuben	NORTHWEST HARRISON						None identified
Wyoming	NORTHWOODS				2		2
Cattaraugus	OLEAN	2					2
Erie	ORCHARD PARK-HAMBURG	2	30	23			55
Steuben	PAINTED POST						None identified
Genesee	PAVILION	3					3
Cattaraugus	PERRYSBURG						None identified
Cattaraugus	PIGEON HILL						None identified
Wyoming	PIKE CORNERS			1			1
Oswego	PULASKI						None identified
Steuben	PURDY CREEK						None identified
Steuben	RATHBONE						None identified
Cattaraugus	RED HOUSE						None identified
Seneca	REEDER CREEK			1			1
Cattaraugus	RICE BROOK						None identified
Allegany	RICHBURG	1	1	1			3
Genesee	ROANOKE		1	2			3
Oneida	ROME						None identified
Seneca	ROSE HILL		1				1

Table B-3, continued. Producing Gas Wells by Field (1999 Base Year)							
County	Field	< 100 Mcf/Year	100 Mcf - < 1,000 Mcf/Year	1,000 Mcf – < 10,000 Mcf/Year	10,000 Mcf – < 100,000 Mcf/Year	≥ 100,000 Mcf/Year	Approximate Total Productive Gas Wells
Allegany	RUSHFORD						None identified
Ontario	RUSHVILLE						None identified
Niagara	SANBORN			1			1
Oswego	SANDY CREEK						None identified
Madison	SANGERFIELD						None identified
Cattaraugus	SARDINIA	1	4	8			13
Seneca	SENECA FALLS			1			1
Ontario	SENECA LAKE						None identified
Allegany	SHARON	22	1	1			24
Wyoming	SHELDON	2	19	15			36
Allegany	SHERRY HILL						None identified
Wyoming	SILVER LAKE		4				4
Oswego	SOUTH FULTON						None identified
Yates	SOUTH PENN YAN						None identified
Erie	SOUTH WALES						None identified
Livingston	SPARTA						None identified
Chautauqua	SPRAGUE HILL			3			3
Tioga	STAGECOACH	1	1	2	5	2	11
Allegany	STATE LINE	2		1	3		6
Steuben	STONE HILL				1		1
Yates	SUGAR CREEK						None identified
Steuben	SULLIVAN PARK			1			1
Steuben	THOMAS CORNERS			1	1		2
Erie	TONAWANDA						None identified
Wyoming	TOZIER'S CORNERS			2			2
Broome	TRIANGLE						None identified
Lewis	TUG HILL						None identified
Livingston	UHLEY CORNERS-CALEDONIA	4	55	37	3		99
Cattaraugus	UTLEY BROOK			7			7
Chemung	VAN ETTEN				4		4
Ontario	VINCENT						None identified
Erie	WALES				1		1
Schuyler	WAYNE-DUNDEE						None identified
Cayuga	WELLS COLLEGE	1					1
Cayuga	WEST AUBURN	1	29	239	16		285
Ontario	WEST BLOOMFIELD		1	3			4
Erie	WEST SENECA		6	5			11
Steuben	WEST UNION						None identified
Ontario	WHETSTONE BROOK		1				1

Table B-3, continued. Producing Gas Wells by Field (1999 Base Year)							
County	Field	< 100 Mcf/Year	100 Mcf - < 1,000 Mcf/Year	1,000 Mcf – < 10,000 Mcf/Year	10,000 Mcf – < 100,000 Mcf/Year	≥ 100,000 Mcf/Yr.	Approximate Total Productive Gas Wells
Steuben	WILSON HOLLOW				1		1
Steuben	WOODHULL						None identified
Steuben	WYCKOFF				2		2
Wyoming	WYOMING			1			1

Table B-4. Approximate Number of Producing Oil Wells by Field

County	Field	Estimated Average Individual Well Production: Oil Wells Producing < 1 Barrel/Yr.	Oil Wells Producing 1-10 Barrel/Yr.	Oil Wells Producing > 10 - 50 Barrel/Yr.	Oil Wells Producing > 50 - 100 Barrel/Yr.	Oil Wells Producing > 100 Barrel/Yr.	Estimated Total Producing Oil Wells
Allegany	ANDOVER			4	7		11
Allegany/ Steuben	BEECH HILL-INDEPENDENCE	1	2	137	149	95	384
Cattaraugus	BRADFORD	24	143	312	113	33	625
Allegany	BROWNING						None Identified
Chautauqua	BUSTI	20	121	108	57		306
Chautauqua	CARROLL						None Identified
Allegany	CERES				14		14
Cattaraugus	CHIPMUNK		84	147	67	65	363
Allegany	CLARKSVILLE				9		9
Chautauqua	CLYMER HILL					1	1
Allegany	CORBIN HILL		1				1
Cattaraugus	DUTCH HILL						None Identified
Chautauqua	ELLERY		1			1	2
Erie	ELMA						None Identified
Cattaraugus	FARMERSVILLE		1	1			2
Cattaraugus	FIVE MILE		49	162	23		234
Chautauqua	FOLSOM CREEK						None Identified
Allegany	FORD'S BROOK		70				70
Cattaraugus	FOUR MILE		54	27	1	22	104
Allegany	FULMER VALLEY	3	50	38	9	23	123
Chautauqua	GERRY-CHARLOTTE					1	1
Chautauqua	HARMONY						None Identified
Cattaraugus	HOTCHKISS HOLLOW						None Identified
Steuben	MARSH						None Identified
Cattaraugus	MUD CREEK						None Identified
Allegany	NILE						None Identified
Erie	NORTH COLLINS						None Identified
Chautauqua	NORTH HARMONY					1	1
Cattaraugus	OLEAN						None Identified
Cattaraugus	PORTVILLE						None Identified
Cattaraugus	RED HOUSE						None Identified
Cattaraugus	RICE BROOK						None Identified
Allegany	RICHBURG	62	328	188	75	13	666
Cattaraugus	RUSHFORD						None Identified
Allegany	SCIO			4			4
Allegany	UNNAMED						None Identified
Cattaraugus	UNNAMED						None Identified
Chatauqua	UNNAMED						None Identified
Steuben	UNNAMED						None Identified

Table B- 5. Approximate Number of Injection Wells by Field, Age, Status

		Injection Wells Status: Unknown					Inactive Injection Wells					Active Injection Wells					
County	Field	Age: Unknown	Age: > 75 Years	Age: > 35 - 75 Years	Age: 10 - 35 Years	Age: < 10 Years	Age: Unknown	Age: > 75 Years	Age: > 35 - 75 Years	Age: 10 - 35 Years	Age: < 10 Years	Age: Unknown	Age: > 75 Years	Age: > 35 - 75 Years	Age: 10 - 35 Years	Age: < 10 Years	Approx. Total Injection Wells
Allegany	RICHBURG	33		6			106	3	146	15		18		9	9	1	346
Cattaraugus	CHIPMUNK			72	71		1		3	2		21		16	20		206
Cattaraugus	BRADFORD	2		15	2	2	4			1		2		11	116		155
Allegany	UNNAMED	1		1			148										150
Allegany	FORD'S BROOK	22		65			33										120
Steuben	MARSH			3			12	5	85	2							107
Allegany	BEECH HILL-INDEPENDENCE						3	1		2		9		5	11	12	43
Allegany	FULMER VALLEY						30										30
Allegany	SCIO			8													8
Cattaraugus	FIVE-MILE									5							5
Cattaraugus	UNNAMED						3										3