CARBON MANAGEMENT CROSS-CUT PLAN

INTRODUCTION

An inevitable consequence of economic activity and energy production and consumption is the generation of by-products, including carbon dioxide (CO_2). Carbon dioxide is recognized as a greenhouse gas that can contribute to global climate change. Even with increased efforts to improve energy efficiency, the world economy is demanding ever-increasing quantities of energy. Global and domestic demand for crude and refined products continues to expand.

The United States Government is committed to developing a portfolio of techniques and technologies for reducing carbon dioxide emissions. Central to this strategy is reducing carbon emissions per unit of production. Technologies are being developed and demonstrated for more efficiently concentrating and capturing carbon dioxide generated in energy producing processes. Global and national assessments of carbon sequestration potential show great potential storage capacity in the United States.

The U.S. Department of Energy has formed a nationwide network of regional partnerships to help determine the best approaches for capturing and permanently storing gases that can contribute to global climate change. The partnerships are a collaborative government/industry effort tasked with determining the most suitable technologies, regulations, and infrastructure needs for carbon capture, storage and sequestration (CCS) indifferent areas of the country. Under the auspices of these partnerships, characterization studies to assess CCS potential were conducted from September 2003, through June 2005. Validation phase field tests are currently underway. The seven partnerships that comprise this network include several national laboratories, more than 300 state agencies, universities, and private companies from 40 states, three Indian Nations, and four Canadian Provinces.[45]

In April 2007, DOE announced the first edition of its Carbon Sequestration Atlas of the United States and Canada. The Atlas shows the seven regional partnerships' preliminary estimates of sequestration potential, totaling 3,500 billion tons in oil and gas reservoirs, unmineable coal seams, and deep saline formations. The estimates do not include all of the formations, nationwide, in each of these categories nor other formations, such as basalt and organic rich shales. Assessment of the other areas and formations will continue. The seven carbon sequestration partnerships have estimated over 1,000 years of total sequestration potential in the United States.[46]

The U.S. Environmental Protection Agency is also assessing the potential for carbon sioxide sequestration in geologic formations and has recently issued guidance relative to the Safe Drinking Water Act regarding use of injection wells for carbon dioxide subsurface storage and sequestration.[47]

The Battelle Global Energy Technology Strategy Program (GTSP) in 2006 concluded that "assuming that other advanced energy technologies are developed and deployed along with carbon capture and storage systems, this potential storage capacity should be more than enough to address CO_2 storage needs for at least this century."[48] The GTSP report also found that storage opportunities exist throughout the United States.

Task Force Goals: The goal of the Task Force on Strategic Unconventional Fuels is to ensure the economic growth and energy security of the United States by replacing a substantial portion of the nation's increasing imports of petroleum and petroleum products with transportation fuels produced from oil shale, coal to liquids, tar sands, heavy oil, and CO_2 enhanced oil recovery.

These unconventional fuels will require more energy to produce, and therefore are expected to generate more CO_2 per unit of output than conventional oil. However, because the unconventional fuels production processes will be largely centralized in large manufacturing facilities there is a greater opportunity to capture, concentrate and beneficially utilize CO_2. Even if by-product markets cannot be found for all the CO_2 captured, the higher concentration of CO_2 generated in these processes can be expected to reduce the cost and improve the feasibility of carbon capture and sequestration (CCS) for any excess volumes produced.

The carbon management strategy outlined in this section of the Commercialization Strategy, Plan, and Recommendations focuses on carbon capture and concentration (CCC) to mitigate added emissions of CO_2 by production of industrial grade CO_2 for sale in the marketplace or for permanent sequestration. Public acceptance of unconventional fuel products will be greatly enhanced as the program succeeds in achieving these goals.

SUBPROGRAM GOALS

The goal of the Carbon Management Plan (Plan) is to encourage and facilitate the development and adoption by industry of technologies and techniques for capturing and concentrating carbon dioxide and the development of markets or sequestration opportunities for produced carbon dioxide.

The strategy for accomplishing this goal focuses on coordination of the extensive and growing activities in the nation's existing carbon capture and sequestration programs with the unconventional fuels development program, and specifically to promote the development of technologies that address the unique characteristics of unconventional fuels processes to enable capture and concentration of industrial-grade CO_2 and facilitate its beneficial use or effective storage or sequestration.

OBJECTIVES

The major objectives of the Carbon Management Plan are to:

- Achieve and exceed emissions parity with conventional petroleum by producing concentrated streams of industrial grade CO_2 and beneficially utilizing the incremental increase in CO_2 production over that of conventional petroleum.
- Enhance industry's ability to utilize the produced CO_2 byproduct for enhanced oil recovery (EOR) and other beneficial uses.
- Develop diverse markets for industrial grade CO_2 through process technology innovation and coordination of source locations with use locations.
- Facilitate the development and operations of a domestic unconventional fuels industry by integrating the goals of technology development in coal, oil shale and tar sands with the goals of capturing, and utilizing or storing produced CO_2.
- Support and collaborate with the National Energy Technology Laboratory's Carbon Sequestration Program and the Regional Sequestration Partnerships as vehicles to assist the integration of unconventional fuels carbon management technology with the broader carbon management objectives of the nation. The NETL carbon sequestration program is a

comprehensive program that includes all aspects of sequestration including identification and assessment of opportunities, technologies, and monitoring and safety. Many of the strategic actions outlined below should be understood as support for the relevant parts of the NETL program, or as recommendations of extensions to or enhancements of the NETL sequestration program specific to the goal of carbon dioxide marketing or sequestration in production of unconventional fuels.

STRATEGIES FOR MEETING GOALS AND OBJECTIVES

Objective 1 - Promote the Capture and Concentration of Industrial Grade CO_2

Strategy 1.1 – Assess Carbon Profiles: In order to assess the potential production of industrial grade CO_2 from a domestic unconventional fuels development industry, it is necessary to examine the CO_2 profile resulting from each possible industry component including the volumes and key compositional characteristics of each resulting CO_2 stream.

Strategy 1.2 – Technology Assessment, Demonstration and Advancement: To ensure that unconventional fuels production can efficiently separate and capture carbon dioxide for marketing or storage, technology currently available and being developed must be assessed. Carbon capture and concentration process technologies available for potential unconventional fuels demonstration projects must be identified.

The plan will promote the design, engineering and development of these units and assist in the integration of these units with unconventional fuels production processes. Particular attention should be given to the potential viability of using oxygen in the combustion processes so as to yield highly concentrated CO_2. The plan should also support the utilization and scale-up today's modest commercial CCS deployments, where possible.

Strategy 1.3 – Examine Novel Concepts: The plan will provide for examining the potential for novel unconventional fuel process improvements that might further reduce CO_2 production or the cost of capturing and concentrating it.

Strategy 1.4 – Develop Technology that Results in High Purity CO_2: High purity CO_2 process streams are most desirable for beneficial use or highest value use. Development of these will be promoted in the plan.

Objective 2 - Utilize CO_2 for EOR and other Beneficial Uses

Strategy 2.1 – Assess and Facilitate EOR Markets for CO_2: It is likely that the first several unconventional fuels development projects will seek to locate near markets for the high purity carbon dioxide streams. To assist industry in identifying and assessing opportunities for marketing CO_2, the plan will integrate the carbon management effort with the CO_2 EOR segment of the program plan. This will involve performing source and utilization analysis and specifying quality of CO_2 needed and inputting this information into the development program.

Strategy 2.2 Support CO_2 EOR RD&D: The plan should include continuing work with DOE in support of research and innovation in areas of CO_2 enhanced EOR, CO_2 separation technology, reservoir engineering, injection management, and monitoring systems, to increase the performance and drive down the cost of using CO_2 in this industry, thereby expanding the market opportunities.

Strategy 2.3 Reduce Delivered Cost of CO_2: The currently projected cost of concentrating CO_2 differs significantly for the various component emission streams that

would comprise a fully functional oil shale or coal-to-liquids production facility.

The cost of employing carbon capture and concentration (CCC) will be more modest for concentrated streams and more expensive for dilute CO_2 streams. Significant factors in determining the cost of employing CCC in EOR also include the distance between the CO_2 source and EOR suitable petroleum reservoirs, and the characteristics of the selected reservoir itself.

The plan will include as a first step analysis of the costs the EOR market can bear, identification of source and target locations, and determination of how an unconventional fuels industry can be integrated with these markets.

Objective 3 – Develop Diverse Markets

Strategy 3.1 – Market Characterization: The plan will include development of maps of CO_2 markets and sequestration locations and infrastructure available to reach these locations. The maps will be made available to projects for use in their siting decisions. The plan will also evaluate other key factors that might be pertinent to confirming the technical or environmental viability and acceptability of regional CO_2 storage reservoirs. A comprehensive list will be compiled showing current and possible markets, such as enhanced production of coal bed methane, inerting or moderating gases, etc., for industrial grade CO_2 and estimate their volumes.

Strategy 3.2 – Develop Siting Criteria: For industry to position facilities such that they will be better able to capture and beneficially use or store produced CO_2 the plan will determine key siting criteria for an emerging unconventional fuels production industry and will evaluate other key factors that might be pertinent to confirming the technical or environmental viability/acceptability of regional CO_2 storage reservoirs.

Strategy 3.3 – Identify CTL Siting Opportunities: Industry will seek opportunities for siting of CTL plants near their CO_2 markets because coal is more readily transported than CO_2. Because of the extent and dispersion of U.S. coal deposits, CTL plants can be built in many locations across the country -- essentially anywhere there is sufficient access to coal supplies (whether at a mine mouth or along a rail or barge line used to transport coal) to support long-term CTL operations. In fact, there are a number of plant sites currently under consideration that are located in different regions of the U.S. However, given the highly heterogeneous nature of the CO_2 markets and sequestration sites, as well as the highly variable distribution of industry and expected sources of CO_2, it is difficult to generalize potential markets or sequestration opportunities. The plan will prepare a more thorough siting assessment for a carbon capture and utilization management plan.

Strategy 3.4 – Characterize Potential Storage Locations: The Nation's candidate geologic CO_2 storage reservoirs are heterogeneously distributed across the Nation but the characteristics of these formations vary from formation to formation and even within a given formation. The plan will develop techniques and best practices for characterizing and assessing the viability of potential geologic CO_2 storage reservoirs as this may influence where unconventional fuel processing facilities are sited.

Strategy 3.5 – Support Storage Technology: Large quantities of CO_2 might be potentially stored in regional deep geologic formations. Technologies will be required to ensure the efficacy of the use of geologic storage as a means of reducing greenhouse gas emissions and will be demanded by the public to build confidence in the safety of the large scale use of geologic storage technologies. The plan will include the development and

proof of such technologies, including monitoring technology, to ensure safety.

Strategy 3.6 – Assess Infrastructure Costs for CO_2 Transport to End Use Markets or Storage: The potential scale of needed CO_2 transport and storage facilities (potentially hundreds to thousands of miles of new dedicated CO_2 pipelines and thousands to tens of thousands of CO_2 injector wells) represents a significant infrastructure investment and a potential challenge in terms of siting and permitting this infrastructure. Costs for CO_2 capture that are not offset by market sales for beneficial use will result in lower investment return, and this factor will undoubtedly impact investment decisions.

Objective 4 – Integration of Technology Development Goals

Strategy 4.1 – Support On-Going and Planned Large-Scale Demonstrations of Geologic CO_2 Storage: The public-private sector FutureGen power plant and the proposed Phase III of the Regional Carbon Sequestration Partnership program both represent critical platforms needed to lay the scientific, technical and stakeholder bases for the large scale deployment of CCC technologies needed to address the emissions from an unconventional fuels program. It is particularly important that the FutureGen power plant and the Phase III of the Regional Carbon Sequestration Partnerships will focus in large measure on CO_2 storage in deep saline formations as these are likely to be the major storage formation for the large quantities of CO_2 produced by unconventional heavy hydrocarbon production facilities.

Strategy 4.2 – Develop Effective Regional Carbon Management: Plans should take into account the regional variability of market and sequestration opportunities and other key factors.

Strategy 4.3 – Risk Assessment: The plan will develop procedures to address the need for scientific and stakeholder acceptance as well as appropriate site characterization and risk assessment.

Strategy 4.4 – Develop Post Combustion Carbon Dioxide Capture Technologies: The development and deployment of advanced CO_2 capture technologies could play a significant role in reducing the cost of using CCC technologies to further decarbonize the production of transport fuels from unconventional fuels. Of particular importance would be the development of advanced and significantly less expensive "post combustion" capture systems to deal with the more dilute CO_2 streams that may be created in either the oil shale or coal to liquids cases analyzed here.

Objective 5 – Integration of Program Goals

Strategy 5.1 – Support and Integrate With Ongoing National Energy Technology Carbon Sequestration Program[49] and the Regional Sequestration Partnership Program[50]: The Plan will support and integrate with these programs and will pay particular attention to the continued development, field testing and refinement of advanced CO_2 capture systems for dilute process streams and a robust portfolio of measurement, monitoring and verification technologies for stored CO_2.

Strategy 5.2 – RD&D Needs Assessment: Hold workshops and conferences to bring together the unconventional fuels industry, CCS research community, and DOE's CCS program to discuss the needs of the unconventional fuels industries and to ensure that they are being addressed through the larger DOE CCS R&D program.

Strategy 5.3 – Development and Deployment of Low-Carbon Emissions Base Load Electricity Generation: The continued development and deployment of advanced low-carbon base load electricity plants is a key to de-carbonizing unconventional fuel production that is power-

intensive. For the United States, the most likely candidates for delivering the large quantities of de-carbonized base load electricity are new nuclear power plants or advanced IGCC units that have been optimized to work with CCS systems. The plan will coordinate with and support this activity which is supported and funded through the DOE/FE/NETL Clean Coal Technology and Clean Coal Power program areas.

Strategy 5.4 – Integrated Analysis of the Energy, Economic and Emissions Factors of All Energy Sources: In order to prioritize where best to focus efforts on CCC and CCS, analysis will include the regional economics of electricity production including the cost competitiveness of nuclear power in different regions of the US. The impact of both the potential emissions from these unconventional hydrocarbon production facilities and the large demand for CO_2 storage on other industrial sectors will also need to be examined.

MAJOR ACTIVITIES

Based on the objective of holding emissions to petroleum-equivalent quantities and the challenges these objectives present for CCC and CCS technologies, the following is a set of recommended actions and needs focused on reducing the uncertainty that remains in successfully developing and implementing needed technologies.

- **Define critical carbon management components of potential unconventional fuels demonstration projects** as they are designed and implemented, in order to further the understanding and examine the feasibility of applying CCC and CCS to operating resource- and site-specific facilities.
- **Support the continued development, field testing and refinement of key CCC and CCS component technologies.** In particular advanced CO_2 capture systems for dilute process streams as well as the continued development of optimized IGCC+CCS facilities appear to be of particular significance. Given the large volumes of CO_2 potentially needing to be captured and utilized or stored, the nation will require a broad and robust portfolio of measurement, monitoring and verification technologies for stored CO_2. This points to the need for the continued development of a robust, widely deployable, and cost effective portfolio of measurement, monitoring and verification technologies for injected CO_2.
- **Continue research and innovation in key areas** of unconventional fuels process engineering, CO_2 separation technology, reservoir engineering, injection management, and monitoring systems, to increase the performance and drive down the cost of critical CCC components for this potential industry.
- For CTL plants and possibly from certain oil shale technologies, the vast majority of the produced CO_2 exits the plant in a concentrated and pressurized form, after leaving the gas treatment units. This means that capture of the incremental amount over the petroleum-equivalent is relatively cost-effective. It is in a form that requires little extra processing other than perhaps some extra compression for pipeline transport.[51]
- While there are regional CO_2 EOR market opportunities, as defined in the CO_2 EOR subplan, the potential large supply of pipeline quality CO_2 from these unconventional hydrocarbon industries, as well as potentially large quantities being created by other industries' adoption of CCC technologies, suggests that an imbalance could develop between CO_2 supply and CO_2 EOR market demand. Potential cost advantage of CO_2 produced

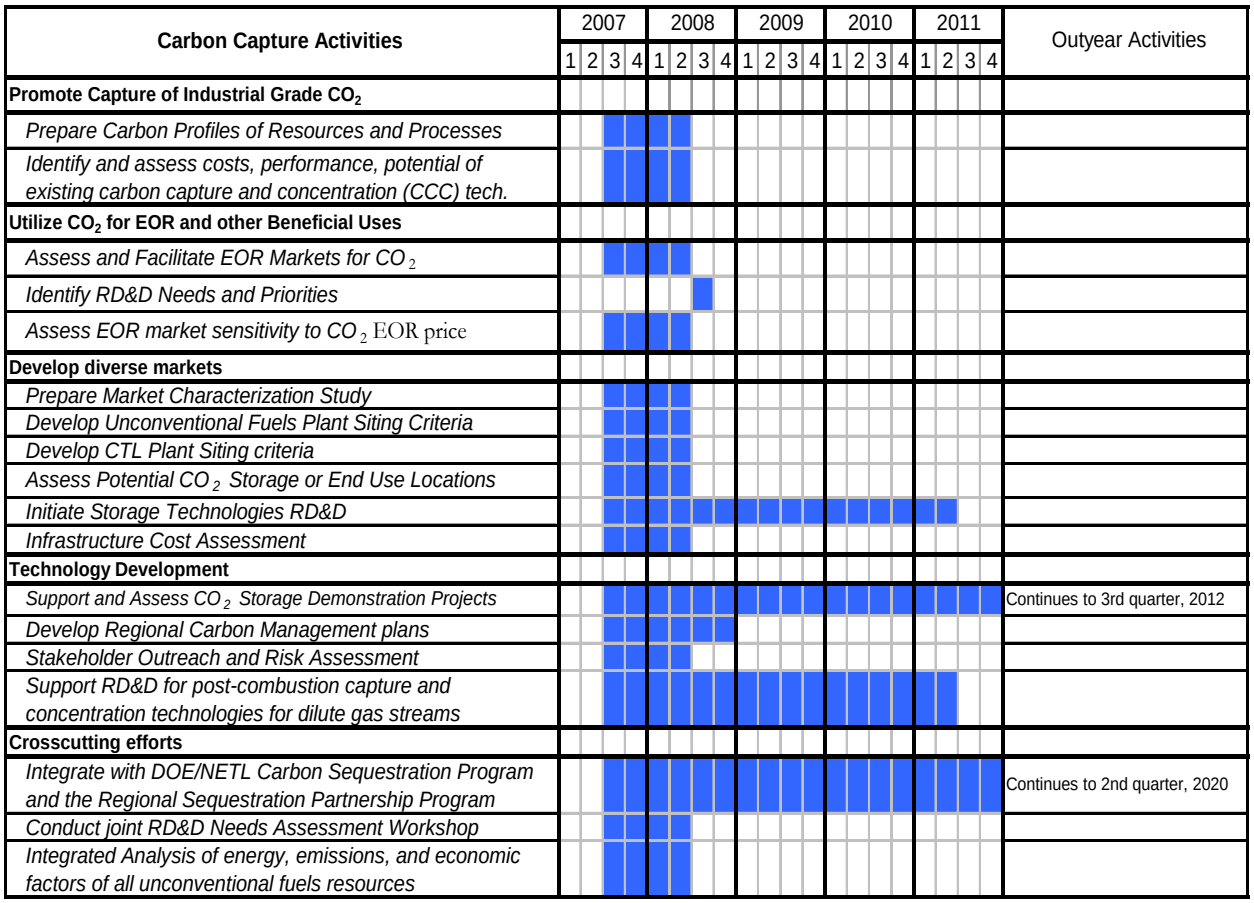
from unconventional fuels industries (compared with power generation, for example), will allow this CO_2 to better compete for available markets, and this marketing strategy will be given early attention.

CARBON MANAGEMENT PROGRAM SCHEDULE

Initial efforts to define the potential carbon emissions footprint of various unconventional fuels and assess the potential of existing capture and concentration technologies and storage approaches will be essential to development of an integrated carbon management strategy for unconventional fuels development.

Based on the findings of these analyses, RD&D needs assessments will be conducted and the priorities will be established in coordination with the managers of the resource focused subprograms and other impacted crosscutting program elements. Figure II-52 summarizes the expected schedule for development of the carbon management strategy and implementation of other subprogram activities.

Figure II- 52. Carbon Management Activities and Schedule



WATER MANAGEMENT CROSS-CUT PLAN

WATER MANAGEMENT CROSS-CUT PLAN

INTRODUCTION

The widespread full-scale exploitation of Strategic Unconventional Fuels (SUFs) represents the first major change in the oil and gas industry in several generations. In order to harvest these new resources, industry must shift to new processes and to new locations, both of which affect the amount and nature of impacts to water resources. Development of unconventional fuels will occur over a period of decades and the potential for impacts to water resources will also occur over this long schedule. Careful and thoughtful management of water issues, which occurs in a stepwise manner as industries scale up operations, will ensure protection and conservation of water. Some of the major concerns that will be addressed in the Water Management Cross-cut Plan include:

- Water impacts vary in applicability and magnitude, depending on the resource, technology applied, and location of activity.
- Current analytical tools and methodologies may be insufficient for assessing water impacts of SUF development processes and technologies, particularly in-situ processes.
- Increased demand will likely strain water supply in development areas, particularly in the west and central plains areas that are drought prone.
- Development needs to consider the needs of other water users, water rights, preservation of water quality, and other impacts of process water disposal.
- SUF development will create municipal growth and changes in community life style, leading to an increase in civil infrastructure that will increase the demand for water and generally reduce the abundance and distribution of recharge.
- Where multiple resources under development overlap, water resource and quality issues could be more complex.

The Water Management Cross-Cut Plan addresses five SUFs:

- Shale Oil
- Tar Sands
- Coal to Liquids (CTL)
- Heavy Oil
- CO_2 Enhanced Oil Recovery

CROSS-CUTTING PROGRAM GOAL

The goal of the Water Management Cross-Cut Plan (Plan) is to help industry and local communities ensure that development of unconventional fuels does not adversely affect surface or ground water quality and supply or the water rights of local water users, local governments and the affected states.

OBJECTIVES

The objectives of the Plan are as follows:

- Manage water resources to satisfy water demand and quality requirements.
- Protect rights of existing and prospective water users and meet relevant laws and regulations.
- Ensure adequacy of water infrastructure.

STRATEGIES

Each region of the United States and watersheds within regions has differences in water availability, hydrogeology, societal values, and competing uses for water. Each resource will have different water consumption requirements and re-use options. Best management practices on natural water systems will be identified and options identified for their adoption via voluntary and/or regulatory means. Current and proposed uses of water will be integrated into local/regional watershed databases and models to enable prediction of interactions of natural systems and expected water uses. A major thrust of the Plan will be the development of Regional Water Management Plans region that will include all relevant SUFs within that region.

Development of each resource type will require a set of site-specific and resource-specific activities to ensure protection of water in the area influenced by the extraction and processing operations. It is anticipated that most site-specific details will necessarily be addressed by the resource developers. However, many water management activities must be addressed at the watershed and larger scales to expedite resource development, while protecting water resources and minimizing cost. Site- and resource-specific activities will be tailored to meet the unique characteristics of each site within the framework of the regional hydrogeologic and regulatory/legal settings of the affected states. Resource Development Plans will be designed to be as water self-sufficient as possible and to limit negative impacts on water resources regionally, especially in areas where water resources are over-allocated.

The Plan will cover the development of five resource types: oil shale, coal to liquids processes, oil sands, enhanced conventional oil recovery and heavy oil. Other potential unconventional resources may be identified in the future. For each resource type, the Plan will evaluate potential practices that will help decision makers address:

- Surface water quality, rights and flows,
- Ground water quality, rights and flows,
- Water disposal, recycling and treatment,
- Variations in water demand versus seasonal and climatic variations in supply,
- Process water availability, handling and reuse,
- Water consumption, or other impacts to water, resulting from new infrastructure,
- Water used for energy generation and population growth, and
- Long-term impacts to water after site closure.

Objective 3.1 Manage water resources to satisfy water demand and quality requirements (Objectives are provided in the Appendix Table).

Strategy 3.1.1 Understand water requirements of unconventional fuels resource development

The Plan will identify hydrologic, geologic, land use, water quality, resource characterization, and other data and reports relevant for the simultaneous planning and management of unconventional fuels development, and the protection and conservation of water resources. It will be particularly important to incorporate new understandings of water impacts using recently developed technologies because much of the published information dates to the oil shortages of the 1970's. New assessments of impacts to water resources using state of the art technology in conjunction with updated hydrological data are required to accurately predict and avoid adverse impacts. Knowledge gaps and needs for additional data will be identified and prioritized. These data will be used to

characterize and rank water resource issues of concern by region and by resource type.

To facilitate data analysis, communicate complex water use relationships and improve the quality information used to make decisions, relational, geo-referenced databases will be developed for regions and SUF resources. Existing and new data will be incorporated in the database. The Plan will interface with Department of Interior and Energy-Water Nexus programs and will incorporate or link to other databases and technology development activities. Relevant historical characterization data will either be specifically integrated or linked to existing data so that common data sets can be utilized. The database will be open, transparent, traceable, unbiased, and publicly accessible to all interested parties.

Communication to a wide array of stakeholders with varying backgrounds and interests is an important aspect of the strategy to understand impacts to water resources from SUF development. Computer models are well suited for integrating and simplifying complicated sets of water data. Output can be tailored to answer specific questions posed by decision makers, environmental regulators, water managers, special interest groups and others. Computer models for groundwater and surface water quantity and quality will be implemented to assess spatial and temporal water supply distribution issues and to serve as tools to maximize efficient utilization of water resources for multiple purposes. The models will help decision-makers identify obstacles (including legal and regulatory problems) to making more use of produced water (e.g. from oil and gas operations) for greater beneficial use (i.e. agricultural, industrial, development of unconventional fuels, human consumption, etc.). Relevant scales may range from local or regional watersheds to multi-basin scale models. Previously implemented calibrated models, including available documentation and input files, will be identified and incorporated in the database and new modeling efforts will be added to the database as they are undertaken. Results from field-scale demonstrations will be incorporated into the models to increase confidence in their accuracy and reliability.

Strategy 3.1.2 Employ conservation, recycling, and treatment processes and technologies to put water to greater beneficial use

Water is not generally destroyed in the extraction of unconventional hydrocarbon resources and, with careful management; utilized water can be made available for other uses. The Plan will strive to ensure that developments are "closed" hydraulic systems and only supplemented minimally by waters from outside the process (e.g., purchase of additional water rights). The Plan will identify and promote:

- Methods to maximize water re-use,
- Technologies to clean contaminated water and methods to responsibly dispose the removed contaminants,
- Regulation changes to facilitate re-introduction of treated water to natural systems,
- Incentives to manage water rights negotiations,
- Enhanced use of lower quality water for industrial processes,
- Beneficial re-use of water for other purposes,
- Process changes to reduce evaporative losses to the atmosphere.
- Cross-industry cooperative use of water (e.g. reject water from one industry used in the process of another).

Another major thrust of the Plan will be identification (and communication) of technologies needed to enhance resource development while simultaneously protecting and preserving water resources. The data

management tools developed under this plan will be used to identify gaps in knowledge and identify water-related constraints to resources development. Uncertainties in water management will be estimated and methods identified to reduce decision sensitive uncertainty. Robust, high-confidence approaches to mitigate constraints and reduce costs will be identified, evaluated, and recommended.

The Plan will solicit input from industry, government agencies, and other stakeholders to identify RD&D needs to protect and preserve water. Some of these needs include, but are not limited to, 1) technologies to control contaminant leakage or leaching from the energy resource to surface or ground water during or after processing, 2) improved definition of the geochemistry of potential contaminants generated by unconventional fuel production, 3) changes to the permeability and porosity of the subsurface that may occur due to hydrocarbon extraction, and 4) the impacts to water quality and quantity. Water needs for associated infrastructure (e.g., communities and roads) will be incorporated into the analyses.

Objective 3.2. Protect rights of existing and prospective water users and meet all relevant laws and regulations

Strategy 3.2.1 Baseline and monitor water to ensure protection of quality and quantity.

State and federal agencies have collected important data on water resources for decades. The first step in this strategy is to gather this information and take advantage of existing monitoring programs that can be used to more efficiently manage water resources during development of unconventional fuels. A monitoring plan will be developed and implemented to fill data gaps and to meet regulatory needs, particularly at large scales and over long-time periods. This sort of monitoring might generally be considered outside the scope of resource developers. Short- and long-term monitoring strategies will be developed, modeled, tested, and evaluated to ensure that potential water impacts can be monitored. Existing instruments, sensors, and other systems to monitor water quality will be evaluated, additional needs identified and relevant research, development and demonstration needs will be recommended. Long-term monitoring of water systems will be initiated in collaboration with existing state and federal programs to create a baseline for early notification of unexpected performance and to avoid unintended consequences. Monitoring plans during operations and post-closure will be developed.

Characterization needed to protect water will be identified and a program implemented. This will include information on geochemistry and potential contaminants generated during and after hydrocarbon extraction is performed.

Strategy 3.2.2 Improve efficiency of regulatory process

Permitting and approval of many new resource development projects has become expensive and time consuming, adding years to when an industrial resource development can expect to receive a return on investment. Water quality and quantity are protected by a wide array of federal, state and local statues. Careful planning of the permitting process, including consolidated or parallel reviews by regulating agencies and other approaches may compress the schedule of the regulatory process while preserving the oversight needed to ensure protection of water resources. Federal and state controls and permitting of water resources will be evaluated and changes recommended streamlining the permitting process for new developments. This strategy will help reduce regulatory uncertainty and improve the efficiency of the permitting processes. Options will be identified to mitigate long-term liabilities due to unanticipated events and suggest incentives to

minimize water losses and maximize water re-use.

Strategy 3.2.3 In collaboration with existing programs, enable public/private outreach for water related issues of concern

Several state and federal programs have viable programs specifically aimed enhancing communication with all stakeholders in the development of unconventional fuels. These programs will benefit from the updated and state-of-the-art assessments and models of water related impacts from unconventional fuels developed under this plan. An advantage of the cross-cut approach is that experiences gained in outreach and communication in one industry can be transferred to other SUF industries with minimal expense and effort. Output from ground water and surface water models developed under the plan can be used to communicate at the regional level an understanding of water impacts by individual developments. The Plan will enable integration of ongoing and proposed activities within industry, federal and state agencies and departments, R&D providers (universities, national labs, consultants, non-governmental organizations, etc.) and other stakeholders. In particular, it will interface with the Department of Energy's Energy-Water Nexus Program, the Department of Interior's Water for the 21st Century Program, the Bureau of Land Management's Environmental Impact Statement process, the U.S. Geological Survey's water monitoring and resource assessment programs, and other relevant activities specified in the Energy Policy Act of 2005,(primarily pertinent sections under Title III, Subtitle F, Sections 365 and 369, Subtitle G, Section 384, and Title IX, Subtitle G, Sections 977 and 979).

Objective 3.3. Ensure adequacy of water infrastructure

Strategy 3.3.1 Assess current and required infrastructure to support people, industry development and operations

An often over looked consequence of new developments is the need for more water to support more people, build new roads, new houses, new schools and so forth. These impacts are generally more extreme in rural, arid western sites and less extreme in populated, moist eastern sites. Unconventional fuels development will increase water demand due to power generation and for potable water to support population growth. Increased water demand could strain existing supply, particularly in the west. Disposal of waste water may also present challenges. The Plan will consider issues of supply and demand, needs of other water users, water rights, infrastructure for water storage and deliverability, preservation of water quality, impacts to replenishment due to roads and other community growth, and impacts of waste water disposal. These issues will vary in applicability and magnitude, depending on the resource, technologies applied, and region. Where unconventional fuel development overlaps with other resource development, water resource and quality issues could be more complex and may present opportunities to put water to greater beneficial use.

Power generation for both resource development and infrastructure requires significant quantities of water. In fact, 52 percent (USGS Circular 1268, September 29, 2006) of all surface water withdrawals in the U.S. are made for power generation purposes. As such, changes in power consumption and/or power generation may lead to greater efficiencies in water use for the development of unconventional fuels. For instance, new power generation technologies that use less water are available, but often with cost and efficiency penalties. Power conservation both

in processes and infrastructure may also lead to reduced water use. The Plan will assess power requirements by region and resource and identify where improvements can be made to better manage water resources. Recommendations will be made for advancements in technology, necessary to properly support the infrastructure power needs of a new unconventional fuels industry.

This strategy will integrate the results from Objectives 3.1 and 3.2 and project water needs and its availability in the future for various planning scenarios. The results will be used to create an assessment of existing water infrastructure and to evaluate infrastructure needed to support resource developments.

MAJOR ACTIVITIES

The Plan will focus primarily on regional and national level activities to benefit a wide range of stakeholders, including but not limited to local communities and governments, Indian tribes, state and federal environmental agencies, state and federal land management agencies, energy producers and energy consumers. The Plan will address the following activities for each resource type and for each region where development of that resource is probable (Activities are identified by strategy, i.e., 3.1.2.n indicates the n^{th} activity under Strategy 3.1.2):

Near-Term (1-3 years)

3.1.1.1 Identify and rank water resources issues of concern by resource and by region

Collect and review hydrologic, geologic, land use, water quality, resource characterization, test results of water consumption by process, industry documents and other data and reports to create a summary by region and by resource for water issues of concerns. These issues will be ranked according to the potential for limiting resource development in a region using a numerical ranking scheme to be developed under this activity. The data and information collected in this activity will be used to develop a comprehensive relational, geo-referenced database. The results of this activity will be summarized in a report that summarizes by region of the United States the general occurrence of water resources, the potential adverse impacts from resource development and the possibility for mitigating adverse impacts.

3.1.1.2 Predict potential impacts and provide recommendations to manage water resources

Computer models of groundwater and surface water will be developed to 1) assess spatial and temporal water supply and quality issues 2) maximize water resource utilization, 3) ensure water protection, and communicate water related issues to a wide range of audiences. Laboratory and field tests in conjunction with modeling efforts will identify and characterize potential contaminants and fluxes during and after hydrocarbon extraction operations. Three scales may be addressed: local, watershed, and multi-basin. Quality assurance guidelines will be established to ensure consistency among new models and previously used calibrated models.

3.1.2.1 Identify and recommend water conservation, recycling and treatment processes

Processes and technologies that conserve, recycle or treat water to prevent or mitigate unwanted impacts on water resources will be identified and assessed for potential application to unconventional fuels development. This activity will aid industry in implementing existing technologies and develop RD&D plans to identify, promote and expedite development of emerging technologies and promote new technology development.

3.2.1.1 Baseline and perform water quality and quantity monitoring

Collect water data at regional or other appropriate scales integrating with the activities of private entities or other

stakeholders. Develop and implement characterization and monitoring plans including Q/A procedures. Monitor surface and groundwater conditions in regional watersheds and hydrogeologic basins to provide input to predictive models and decision-making tools and to enable prompt pre-emptive corrective actions when necessary. Perform data collection, analysis and quality assurance activities, in collaboration with regional, state and federal water-resource entities

3.2.2.1 Evaluate regulatory processes and find areas to make more efficient.

Solicit input from industry partners and non-governmental organizations to obtain an inventory of all currently required permitting procedures and other legal processes. Provide an opportunity for these and other stakeholders to identify not only duplicative processes, but also those processes most critical in protecting the environment and serving local needs. Determine the legislative and regulatory foundation for each procedure. Identify technical solutions that are precluded by current regulations or practices. Prepare comprehensive time lines for a prototypical installation for presentation at a workshop involving representatives from all pertinent regulatory bodies to explore possible alternative and cooperative approaches.

3.2.3.1 Implement public/private outreach programs and initiate collaboration with existing programs.

Collaborate with local, state and federal agencies as they engage stakeholders to define water issues, regulations, jurisdiction, and policies. Use stakeholder input to produce a framework for developing appropriate water-management processes, data gathering activities, decision tools and water quality protection technology. Integrate and establish consistency with private and other stakeholder efforts.

3.3.1.1 Assess current and required infrastructure to support industry development and operations.

Perform an infrastructure analysis to determine opportunities to optimize water and power inputs to the resource development process, as well as minimize impacts to water and wetland resources resulting from societal and industrial changes triggered by the fuels resource development. Minimize water used for power requirements. In collaboration with the Energy-Water Nexus Program, advance technology that serves to minimize water used to meet process and community power requirements.

Activities Mid-Term (4-6 years)

All of the near-term activities will extend into the mid-term, with an emphasis shifting to analysis and recommendations based on accumulated data.

Activities Long-Term (7-12 years)

3.2.1.1 Perform long-term monitoring, site closure analyses, including the development of a long-term water-resource surveillance monitoring programs.

Implementation of these activities for each new unconventional fuel resource will ensure that the appropriate water-resource goals are defined prior to resource development, and that these goals are met as development takes place. This approach will identify water-resource issues up front, establish management protective measures and reduce the likelihood of costly post-development remediation efforts.

SCHEDULE

Schedules have been developed for satisfying the three objectives of the Plan as described in the preceding sections. The start date for the schedule assumes that projects are initiated during the second half of FY-07. Water management activities and schedule are presented in Figures II-53 through II-55.

Figure II- 53. Water Management Cross-Plan Objective 1, Activities and Schedule

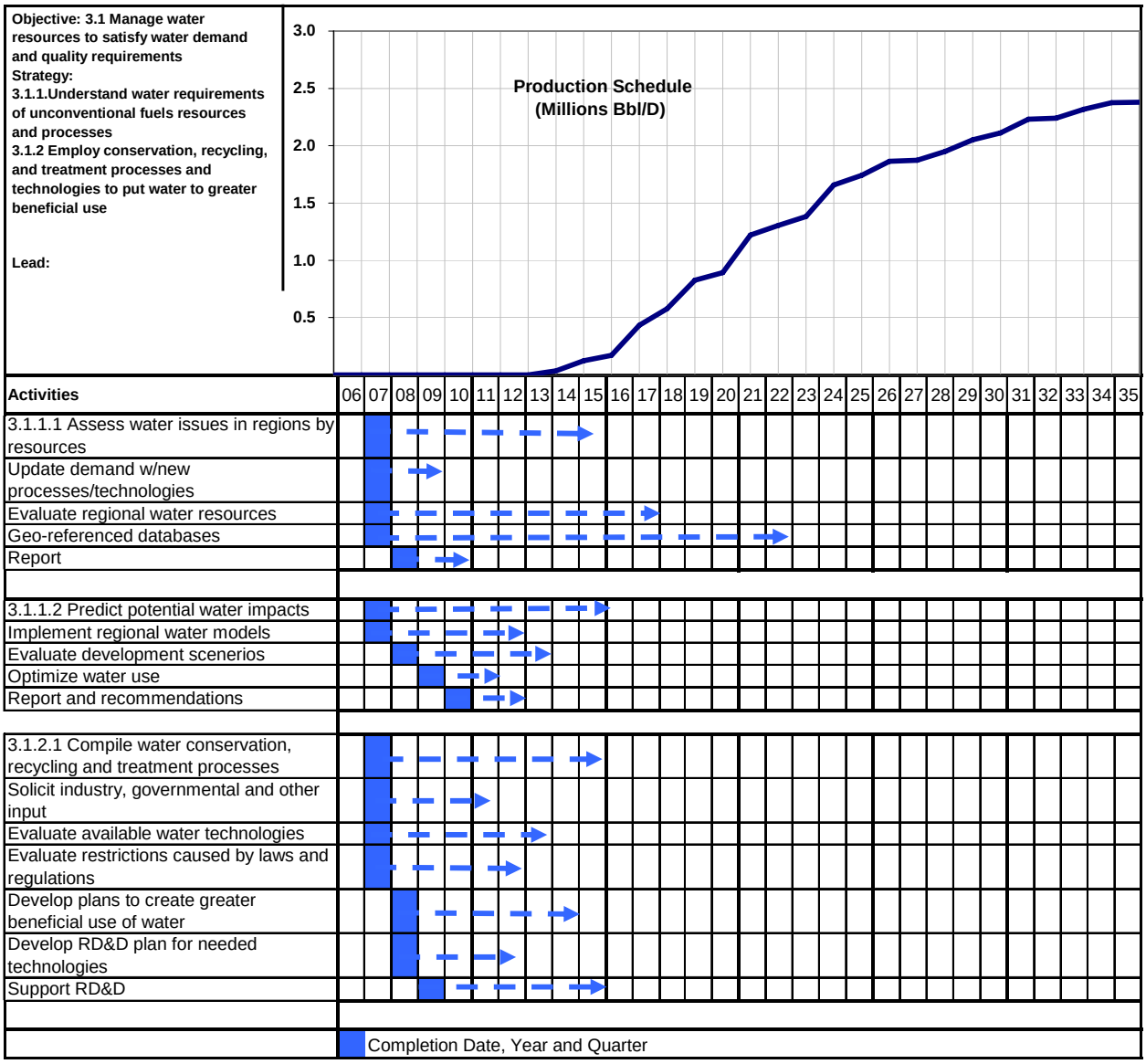


Figure II- 54. Water Management Cross-Plan Objective 2, Activities and Schedule

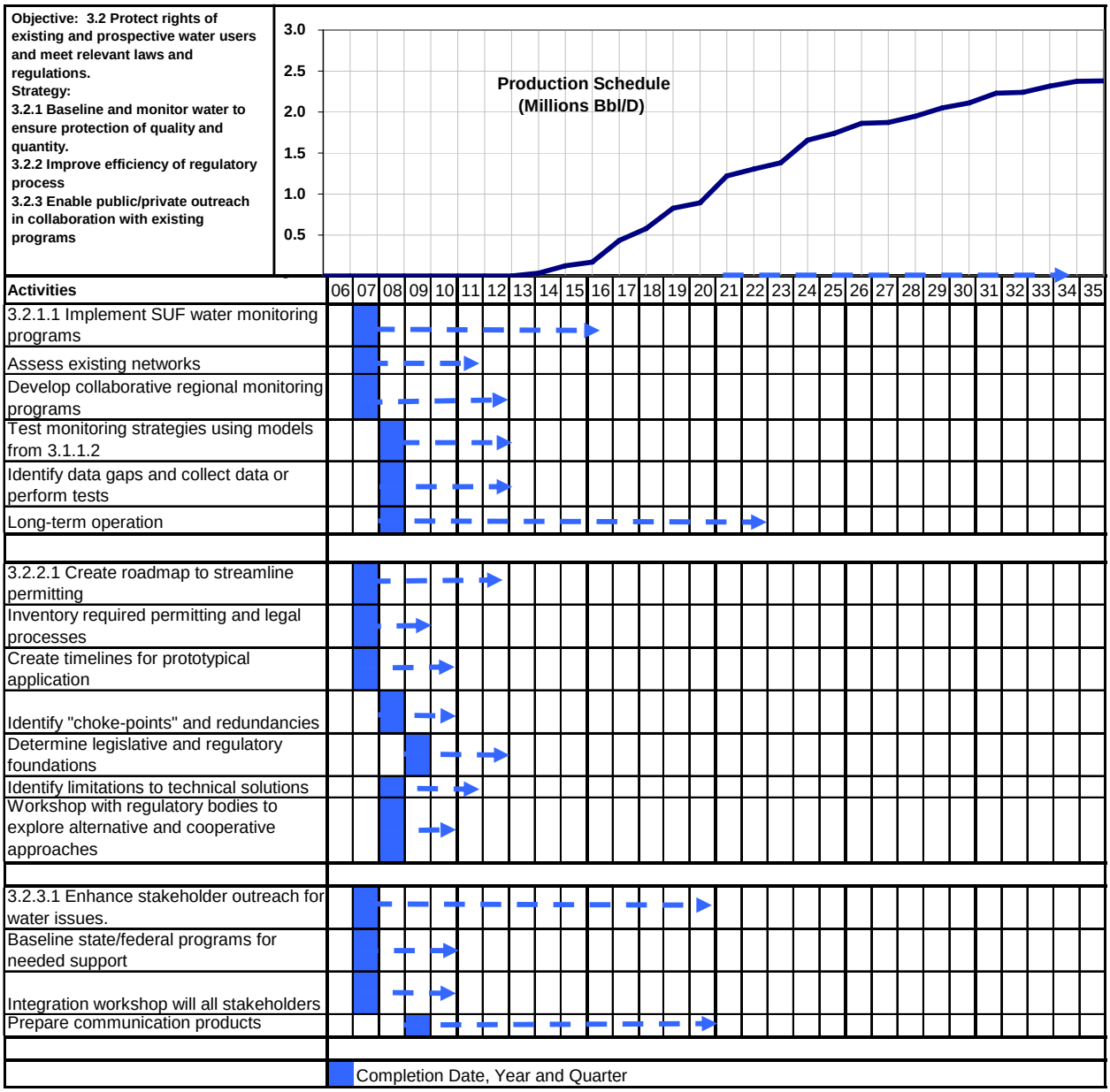
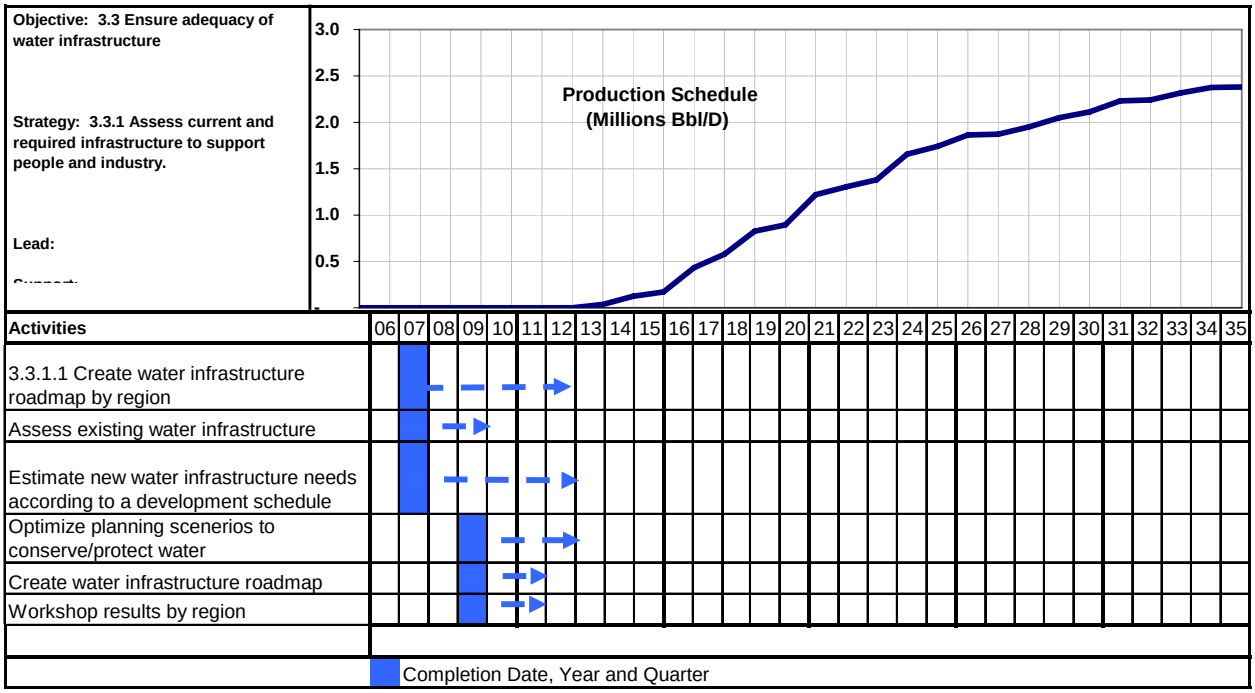


Figure II- 55. Water Management Cross-Plan Objective 3, Activities and Schedule



APPENDIX: WATER MANAGEMENT GOALS, OBJECTIVES, STRATEGIES, AND ACTIVITIES

Subprogram goal: Address crosscutting issues that impact multiple unconventional resources
Development objectives by program element: Address crosscutting issues that impact multiple unconventional resources
Objectives
3.1 Manage water resources to satisfy water demand and quality requirements. 3.2 Protect rights of existing and prospective water users and meet relevant laws and regulations. 3.3 Ensure adequacy of water infrastructure
Strategies
3.1.1 Understand water requirements of unconventional fuels resources and processes 3.1.2 Employ conservation, recycling, and treatment processes and technologies to put water to greater beneficial use 3.2.1 Baseline and monitor water to ensure protection of quality and quantity. 3.2.2 Improve efficiency of regulatory process 3.2.3 Enable public/private outreach in collaboration with existing programs 3.3.1 Assess current and required infrastructure to support people, industry development and operations
Key Activities
3.1.1.1 Identify and rank water resources issues of concern by resource and by region 3.1.1.2 Predict potential impacts and provide recommendations to manage water resources 3.1.2.1 Identify and recommend water conservation, recycling and treatment processes 3.2.1.1 Baseline and perform water quality and quantity monitoring 3.2.2.1 Evaluate regulatory processes and find areas to make more efficient. 3.2.3.1 In collaboration with existing programs, enhance public/private outreach for water related issues of concern. 3.3.1.1 Assess current and required water infrastructure.