Paper #2-22

SITING AND INTERIM RECLAMATION

Prepared by the Technology Subgroup
of the
Operations & Environment Task Group

On September 15, 2011, The National Petroleum Council (NPC) in approving its report, *Prudent Development: Realizing the Potential of North America's Abundant Natural Gas and Oil Resources*, also approved the making available of certain materials used in the study process, including detailed, specific subject matter papers prepared or used by the study's Task Groups and/or Subgroups. These Topic and White Papers were working documents that were part of the analyses that led to development of the summary results presented in the report's Executive Summary and Chapters.

These Topic and White Papers represent the views and conclusions of the authors. The National Petroleum Council has not endorsed or approved the statements and conclusions contained in these documents, but approved the publication of these materials as part of the study process.

The NPC believes that these papers will be of interest to the readers of the report and will help them better understand the results. These materials are being made available in the interest of transparency.

The attached paper is one of 57 such working documents used in the study analyses. Also included is a roster of the Subgroup that developed or submitted this paper. Appendix C of the final NPC report provides a complete list of the 57 Topic and White Papers and an abstract for each. The full papers can be viewed and downloaded from the report section of the NPC website (www.npc.org).

Technology Subgroup		
Chair		
J. Daniel Arthur	Managing Partner	ALL Consulting
Assistant Chair		
H. William Hochheiser	Senior Energy and Environment Manager	ALL Consulting
Members		
Mark D. Bottrell	Manager – Field, Eastern Division	Chesapeake Energy Corporation
André Brown	Associate	W. L. Gore & Associates, Inc.
John Candler	Manager, Environmental Affairs	M-I SWACO
Lance Cole	Operations Manager	Petroleum Technology Transfer Council
David DeLaO	Manager, Drilling Engineering, Southern Division	Chesapeake Energy Corporation
Larry W. Dillon	Completions Manager, San Juan Business Unit	ConocoPhillips
Donald J. Drazan	Chief – Technical Assistance Section, Bureau of Oil and Gas Permitting and Management, Division of Mineral Resources, Department of Environmental Conservation	State of New York
Maurice B. Dusseault	Professor of Geological Engineering, Department of Earth & Environmental Sciences	University of Waterloo
Catherine P. Foerster	Commissioner	Alaska Oil & Gas Conservation Commission
Linda Goodwin	President	DOT Matrix Inc.
Edward Hanzlik	Senior Consultant, Petroleum Engineering, Heavy Oil & Unconventional Resources	Chevron Energy Technology Company
Ron Hyden	Technology Director, Production Enhancement	Halliburton Company

Jake Jacobs	Environment, Health and Safety Advisor	Encana Oil & Gas (USA) Inc.
Valerie A. Jochen	Technical Director, Production Unconventional Resources	Schlumberger
Bethany A. Kurz	Senior Research Manager, Energy & Environmental Research Center	University of North Dakota
Matthew E. Mantell	Senior Environmental Engineer	Chesapeake Energy Corporation
John P. Martin*	Senior Project Manager, Energy Resources R&D	New York State Energy Research and Development Authority
Dag Nummedal	Director, Colorado Energy Research Institute	Colorado School of Mines
Jerry R. Simmons	Executive Director	National Association of Royalty Owners
Steve Thomson	Manager, DeSoto Water Resources	Southwestern Energy Company
Denise A. Tuck	Global Manager, Chemical Compliance, Health, Safety and Environment	Halliburton Energy Services, Inc.
Mike Uretsky	Member, Board of Directors Executive Committee	Northern Wayne Property Owners Alliance
John A. Veil**	Manager, Water Policy Program, Argonne National Laboratory	U.S. Department of Energy
Donnie Wallis	Manager – Regulatory Affairs, Air Programs and Design	Chesapeake Energy Corporation
Chris R. Williams	Group Lead, Special Projects, Environment, Health and Safety	Encana Oil & Gas (USA) Inc.
Ad Hoc Member		
Douglas W. Morris	Director, Reserves and Production Division, Energy Information Administration	U.S. Department of Energy

* Individual has since retired but was employed by the specified company while participating in the study.

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ABSTRACT

Balancing positive and negative aspects of oil and gas developments on environmental and socioeconomic outcomes remains one of the most important and challenging aspects of successful development of oil and natural gas resources. Creating a "win-win" situation for developers and community stakeholders usually requires a larger up-front investment of time and effort by all parties but returns value through smoother and more mutually agreeable outcomes in the long term.

There exist examples where negative impacts of oil and gas development have dominated socioeconomic outcomes but there also are case studies that demonstrate success in planning for, and accomplishing, beneficial outcomes. Prospects for positive outcomes are enhanced by early collaborations among developers and stakeholders, including summation of agreements in written documents that can be referenced by all parties as the benchmarks for evaluating progress and compliance.

Key factors in planning and execution of oil or gas projects with the best levels of community acceptance include context-sensitive designs and a deliberate approach to the balance between socioeconomic benefits and environmental impacts. Plans must be customized individually to accommodate different stages and extents of development as well as different metrics for benefits or impacts. Furthermore, the extent and magnitude of benefits and impacts must be accommodated differently for situations that include rural communities, small towns or villages or cities / urban complexes.

Principal milestones by development stage comprise (1) Exploration / Early Development; (2) Moderate Development; (3) Large / Full-Scale Development; and (4) Post-Development Production. Main metrics by benefit or impact include (a) Economics (Employment and Economic Activity); (b) Population; (c) Housing Services (Community Infrastructure, Facilities and Services); (d) Fiscal (State and Local Government Fiscal Conditions); (e) Attitudes and Values; (f) Quality of Life and Social Conditions; (g) Community Character. The interplay among the various milestones and metrics must be anticipated according to population density and lifestyle, namely, rural, town or city environments. Experience has shown that both perceptions and realities can be expected to change almost continuously as development begins, matures and concludes.

The crucial first step in organizing a successful outcome from the socioeconomic and environmental perspectives is to establish full and open communication among all stakeholders. Modern communication tools, including websites and social media, can be utilized to advantage although the most important attribute is to make available easily accessible information that is timely and reliable, including an expression of uncertainties where appropriate.

INTRODUCTION

Incorporating sustainable community planning practices and context sensitive site design principles into the process of permitting and developing natural gas and oil resources can assist in mitigating potential environmental and socioeconomic impacts. Sustainable community planning practices and context-sensitive site design principles not only benefit communities and environments potentially impacted by natural gas and oil resource development, but also benefit industry in its efforts to maximize long-term profits and corporate social responsibility. The "technology" of sustainable planning can be implemented at some level in all locations and within most regulatory structures.

SUSTAINABLE PLANNING PRACTICES

A. Identification of Sustainable Planning Principles

The adverse community and social effects of large-scale industrial developments are not unique to the oil and gas industry. However, unlike most large-scale developments, the development of oil and gas resources typically is not accompanied by a cooperative community development and planning effort. But where available, such efforts can assist communities to accommodate development and related population growth as well as establish a more transparent and efficient process for industry.

Proactive community planning is intended to influence the form of the local production build-out and develop strategies to address an array of topic areas such as housing, land use, economic development, open space, the environment, recreation, and transportation. A successful community planning process includes a public outreach component to establish a long-term vision that is sustainable from a fiscal, social and environmental perspective.

The community planning process can and should include a discussion of energy resources, including natural gas and oil resources. Incorporating those activities into a comprehensive planning process can help to shape a community and regional vision. It can also create certainty for developers (housing, commercial, or the energy industry), property owners and residents, which in turn could lead to a more efficient and less contentious siting, permitting and development process.

B. Energy for Society and All of its Ramifications

When weighing all the cumulative impacts on the area of development involved with producing hydrocarbons, one cannot ignore the major societal benefit of clean, reasonably-priced, domestically-produced energy. Produced hydrocarbons serve as fuel for transportation, heating, and electricity generation as well as feedstocks for numerous industrial products that appear in nearly every aspect of modern society.

According to the US Energy Information Administration (EIA), North American sources provide nearly all of the natural gas and almost one-half of the oil used by the USA (EIA, 2010). The EIA forecasts that, in spite of great advances in alternative energy, the nation will remain

dependent on natural gas and oil for more than one-half of its primary energy supply (EIA, 2011).

As the natural gas shortages of the 1970s showed, new wells must be continuously drilled to replace the natural decline of existing wells. . The adoption of new technology, though, has helped reduce the total number. A recent IHS report highlights that "… it takes fewer wells to produce the same amount as before. For example, prior to 2008, more than 31,000 annual new gas wells were required to sustain 58 BCF/d of gas production; now it is possible to produce almost 63 BCF/d with the drilling of only 19,000 new gas wells per year." (IHS, 2011) And thousands of wells create impacts.

A major point of contention is that the society's aggregate need for energy creates very real local impacts. Unlike a local shopping center, whose purpose is to serve the local community, a gas well and its ancillary infrastructure impact the local community whether the gas stays there or is sent to an interstate pipeline. The local impact is only offset by local revenue generation through local purchases by employees, lease payments or local tax payments. To minimize unfavorable local impacts, consideration must be given to reducing the negative impacts of site development within the community context.

C. Incorporating Sustainable Planning Principles

Community Preparedness. Proactive community planning integrates the ideas, concerns and preferences of residents, property owners, business owners and other stakeholders into a long-term vision and series of recommendations describing how the community should be developed, what development regulations should accomplish, what facilities and services levels are needed, what areas should be preserved and how improvements could be funded to should support the vision. Such comprehensive planning equates into a sustainable action plan or blueprint for a community that balances the fiscal, social, environmental, economic and cultural characteristics of that community for future generations. Communities should engage in planning in advance of development and growth and in a deliberate and proactive manner. Early preparations prevent reactionary planning which is not comprehensive and often does not result in efficient or beneficial outcomes either for the community or the developer.

While many growth management and comprehensive plans address a wide range of topics and elements such as residential and commercial growth, often resource development is not considered in a proactive manner, which leaves many communities unprepared to address the development of those resources in a sustainable way. It is important to incorporate resource development planning into these growth management and comprehensive plans at the local, regional and state levels. Basic inventorying and mapping exercises can assist communities to understand the resources available, the options for extracting, and the needs for the responsible development of those resources.

Planning Prior to Permitting and Site Development. Siting a well begins with the exploration process. With a focus on the subsurface, geologists and geophysicists work to identify potential drilling target with the goal to identify the sweet spots, formulate a land-control strategy, and design the infrastructure to rapidly bring wells into production. Early planning activities involve

collecting the necessary geological, geophysical and topographic information that will ultimately identify the best location for drilling operations. Seismic data acquisition and the possible drilling of an exploration well to collect rock core samples for geochemical evaluation are the most significant activities.

At the exploration stage, there are few environmental impacts that differ from the typical planning operation for any industry. Without proper design, either a seismic or geologic drilling operation can have a minimal impact on the environment or culture. Impacts can include site disturbance, damage to the foundations of structures, and noise. Land acquisition and logistics planning have little impact as individual activities but can drastically impact future operations.

Planning During Permitting and Site Development. The current design paradigm includes a flexible drilling site that can accommodate multiple wellheads. Those multi-well sites are the first of three key elements in reducing the overall cost of natural gas and oil production. The ability to centralize site operations eliminates duplicative ancillary activities such as drilling rig mobilization/demobilization. "Site preparation activities consist primarily of clearing and leveling an area of adequate size and preparing the surface to support movement of heavy equipment. The ground surface preparation typically involves placing a layer of crushed stone over geotextile fabric for the well pad and roads. Site preparation also includes constructing an access road, establishing erosion and sediment control structures around the site, and constructing pits for retention of drilling fluid and possibly fresh water." (Alpha 2009) Essentially, pad development resembles site preparation of a small construction project. The major potential environmental impacts of site development include erosion, habitat fragmentation and dust. Most impacts can be mitigated by locating a site in less-sensitive areas and with proper site design.

Multi-well sites usually have a slightly larger footprint compared to single well pads. (Alpha 2009) In the area adjacent to the pad, the larger and more permanent site can create a multitude of environmental issues from vegetation removal, noise, air emissions and amore conspicuous visible presence. But if a regional viewpoint is adopted, however, the perspective on land disturbance changes. Over an area that may have seen 8 or more individual well pads, each with a footprint of 1-5 acres, the multi-well pad design outcome is instead just one 5-6-acre location. Multi-well pads on a local and regional scale can similarly reduce environmental impacts, particularly by reducing forest fragmentation in wooded locations. Proper siting of well pads may actually improve the local forest ecology by providing an open meadow to increase habitat diversity.

In other instances, single well pads will be the norm. Examples include many structural plays with very specific target such as the Trenton- Black River carbonate play in the eastern United States and Canada where wells are set on single well pads spread out over the target structure. In other instances, site limitations may cause a series of smaller individual well pads to be the preferred approach.

D. Context-Sensitive Site Design Principles

Description of Context Sensitive Site Design Principles. Context-sensitive site design is an approach that aims to reduce the overall environmental impact footprint of new development and redevelopment by incorporating approaches to reduce impacts on watersheds, wildlife, air quality (beyond dust), visual resources, and historical resources as well as conserve natural areas and enhance the integration of stormwater treatment. Many concepts in this approach can lead to a reduction in the costs of infrastructure by preventing impacts rather than mitigating for them and by managing impacts, such as stormwater, as close to the source as possible. The use of the natural topography, vegetation and drainage patterns can often serve as a framework for better site design.

The context-sensitive approach is one typically applied to residential or commercial development. However, it is also applicable for industrial development and for the development of natural gas and oil resources. For example, pad development often resembles site preparation of a small construction project. The major potential environmental impacts of site development include erosion, direct habitat loss, habitat fragmentation, visual impacts and dust. Most impacts can be mitigated by locating a site in less-sensitive areas and with proper site design.

Incorporating Context-Sensitive Site Design Principles. A context-sensitive approach addresses site design at all stages and steps throughout the development process including site design, site construction, site management and interim site reclamation. Incorporation of context-sensitive site design principles need not be burdensome, but rather should be considered a logical approach. During the site design step, for example, general site characteristics are evaluated through engineering and survey work. Identifications are made of significant habitat areas, archeological resources, historical resources, drainage patterns as well as topographical and other environmental site conditions. The site is then carefully designed in a manner that works with the natural site characteristics, achieves the development program and avoids, to the greatest extent possible, resources that may be of unique value to the local community.

The site construction step utilizes the information obtained through the site design. This step involves activities such as well-pad and road construction, topsoil conservation, preparation of retention ponds and pits, establishment of berms and other site delineation. Other items considered during site construction include, but are not limited to the following:

- Surface waters - siltation and turbidity, spills
- Ground water - turbidity, methane release, spills
- Agriculture – land disturbance, topsoil, spills
- Historical sites – destruction, visual, noise
- Archeological sites - destruction
- Significant habitats – disturbance, species loss, habitat damage or loss
- Floodplains – floodway, erosion, spills

- Freshwater wetlands – physical damage, flow interruption, spills, access/overuse
- Streams – streambed/bank integrity, siltation, spills
- General habitat loss – topsoil loss, erosion and sedimentation, vegetation loss

Once a site is designed and constructed, site management during drilling and completion operations is critical to maintaining the context-sensitive nature of the site. Key ongoing aspects often involved in site management include stormwater management, mobilization/demobilization, cuttings management and disposal, and logistics including trucks. Environmental issues also continue to need management such as emissions, noise, visual, trucks, and spills.

Interim site reclamation generally includes site restoration, re-vegetation and habitat restoration. An appropriately planned and designed site can eliminate and avoid environmental degradations, thereby minimizing the costs, effort and impacts to the existing site vegetation and habitat.

E. Variations Based on Resource Type and Location

Resource Type and Well Density. Maximal resource extraction in different type of plays will require different well densities. Coalbed methane and shale, for example, require the greatest well density with many wells per square mile. Conversely, some fault-controlled plays such at the Trenton-Black River require very few wells per square mile. Site planning and design must account for the expected well density at build-out, not merely for the first phase of development. Industry's hesitation to make forecasts must be tempered by the community's right to know and to plan their future.

Geographic Distribution. North American onshore production comes from a number of unique geographic regions. The major differences can be characterized by differences in topography/geomorphology, rainfall and ecosystems (Table 1). Siting, drilling and production operations, as with any commercial project, should reflect some awareness to the unique characteristics of the natural and built-out environment. Working with those regionally distinctive characteristics, operations can minimize site-specific impacts.

Table 1. Regional variations that affect oil and gas development plans.

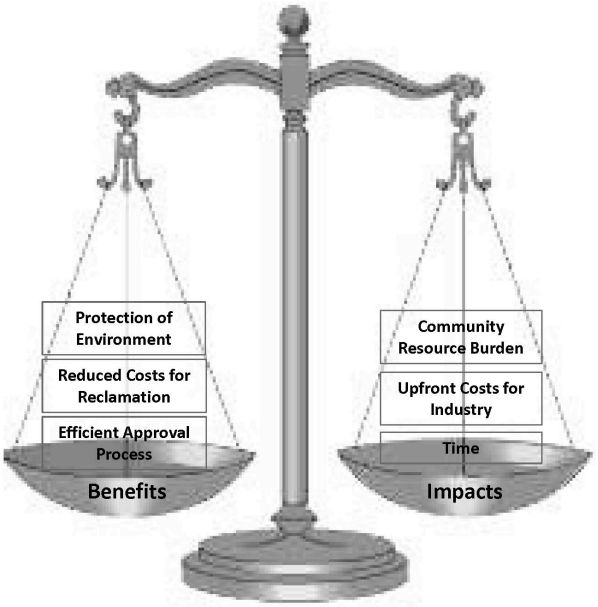
Region	Topography	Rainfall	Ecosystem
Northeast / Midwest USA and Canada	Hills and valleys, open flood plains	Rain and snow prevalent	Deciduous forests
Southwest / Mid-continent	Relatively flat plain / uplifted plateau	Mainly dry with rainy periods	Open rangeland
Western mountain region USA Canada	Upthrusted mountain ranges and foreland basins	Mainly dry with winter snows	Alpine
West Coast USA / Canada	Mixed terrain of high mountains and flats	Rainy on coast, very dry inland	Rainy forests near Pacific, desert

ENVIRONMENTAL AND ECONOMIC BALANCE

A. Environmental Balance

When applying risk evaluation to developing oil and natural gas resources, consideration must be given to all the potential outcomes, both positive and negative (Fig. 1). In many instances, federal and/or state environmental regulations require a close examination of the outcomes. The National Environmental Policy Act (NEPA) and the New York State Environmental Quality Review Act (SEQRA) are two such examples. However, with proactive planning and context-sensitive site design, many of the potentially negative outcomes can be mitigated substantially and potential benefits can be enhanced early in the proceedings, thereby minimizing the length and cost of the overall process. Sustainable planning practices and context-sensitive site design inherently include an overall consideration of environmental quality. The challenge rests in finding the balance between potentially positive benefits of development and potentially negative impacts. Planning for and siting a context-sensitive and long-term sustainable development cannot follow a one-size-fits-all approach. Local benefits and impacts may vary greatly based on geography, community size, project size and a host of other factors. For that reason, proactive community planning and context-sensitive site design are critical. Recognizing and understanding potential impacts early in the process can guide an appropriate site design, which could ultimately lead to the fine but acceptable balance of impacts and benefits.

Figure 1. Balance of benefits and impacts from oil and gas developments



As illustrated in Figure 1, potential impacts of engaging in a proactive, sustainable planning process and context-sensitive site design may include a burden on community resources for staffing or hiring of professionals, upfront costs for industry and added time to the process for both the community and industry.

Those impacts may be balanced with the potential benefits that may include protection of the environment and critical areas, reduced costs for site reclamation and a more efficient approval review process resulting from community buy-in. A more efficient process also reduces overall development costs.

Clearly, identifying all the potential negative outcomes without consideration of the positive is unfair. There are many potential positive outcomes of natural gas development, including income for the company, jobs for workers, royalties for landowners, indirect economic benefits to regional businesses, improvements in the built-out environment, tax revenues and energy to fuel society. There is also the potential for negative outcomes created by oil and gas development, including excessive demands on natural and community resources, habitat fragmentation, air emissions, waste, spills, and noise. With proper planning, many of the potential negative outcomes can be mitigated substantially. In places such as Chautauqua County, NY, where more than 6,000 wells have been drilled, multiple land uses coexist with natural gas and oil development. Farmers have benefited from royalties and affordable fuel, local tax revenues increased over a period of decades, and the lakes and drinking water remain clean.

In New York, the idea of balance was entered into case law in the Matter of the Town of Henrietta case (1980): "We must be cognizant that environmental amenities will often be in conflict with economic and technical considerations. To consider the former along with the latter must involve a balancing process. In some instances, environmental costs will outweigh economic and technical benefits while in other instances they may not; but SEQRA [State Environmental Quality Review Act] mandates a rather finely tuned and systematic balancing analysis in every instance." (Matter of Town of Henrietta v. Department of Environmental Conservation, 76 AD2d 215, 222 (4th Dept.1980)

B. Community Planning and Socioeconomic Effects

Large-scale oil and gas development creates correspondingly large-scale economic and fiscal benefits for local communities, states and the nation as a whole. In a time where many parts of the country are struggling economically, other areas are thriving where new oil and gas developments are expanding, especially shale and other unconventional resource plays.

Despite those substantial benefits, large-scale oil and gas development is often met with opposition, which stems from the perception of environmental, and health and safety risk, a legacy of boom and bust cycles and growing sentiment that oil and gas development – and energy/natural resource development in general – is incompatible with other types of development, particularly outdoor recreation, tourism and lifestyle migration.

While it is true that large-scale oil and gas development can result in substantial economic and fiscal benefits for affected communities, states and the nation as a whole, the fact is that communities within and near development areas have also been adversely affected. Potential adverse socioeconomic effects include labor shortages, workforce competition, housing shortages and escalating housing costs, additional burdens on local government infrastructure and service systems, local government fiscal deficits, congestion and other traffic problems, changes in community social conditions and character and community dissatisfaction.

Whereas most other types of large-scale industrial development involve a single or principal company, oil and gas plays are characterized multiple operators, who themselves employ a variety of contractors to perform the work. Operators have holdings in different locations within a development area, different resources and different development strategies. Operators can range from large multi-national companies (some among the largest in the world) to wildcat operators with a single lease, a single rig and limited resources. This decentralized nature of oil and gas development does not readily lend itself to cooperative planning efforts (for a variety of reasons).

It is recognized that very distinct stages of natural gas development exist. For the purposes of this paper, the stages of development of a natural gas play are grouped into five general categories: Exploration/Early Development, Moderate Development, Large-Scale Development, Production and Closure/Reclamation, although not every natural gas play progresses to the Large-Scale Development stage.

Each stage of development results in differing socioeconomic and community character effects, depending on the characteristics of an area and its communities. The stages and transitions between stages are necessarily discrete. For example, the Production stage begins during development and some wells are typically closed and reclaimed as production continues elsewhere in a field.

The stages of development listed above will potentially generate different beneficial and adverse effects for different types of communities. Although every community is unique, Table 2 lists some common types of communities. For each community and development stage certain types of beneficial and adverse effects can be anticipated.

Table 2 characterizes selected beneficial and adverse socioeconomics effects associated with natural gas development. The potential effects are differentiated by three general categories of communities and four different stages or levels of exploration, development and production, with the objective of providing the reader with examples of how effects may vary by stage of development and type of community. The three general categories of communities include Rural Communities, Small Towns/Villages and Cities/Urban Areas. The four stages or levels considered include Exploration/Early Development, Moderate Development, Large/Full Scale Development and Post-Development/Production. By definition, a summary requires simplification; therefore this table does not address every possible combination of development influences and community characteristics that would result in socioeconomic impacts or changes in community character but, it does illustrate the general types of beneficial and adverse socioeconomic effects that accompany natural gas development.

Table 2. Summary Characterization of Socioeconomic Effects of Natural Gas Development.

		Exploration / Early Development	Moderate Development	Large / Full-Scale Development	Post-Development Production
		Dispersed pattern of few well pads	**Multiple well pads, simultaneously in localized area, some production begins**	**Many well pads, multiple operators, regional area, service centers emerge, production begins**	**Overlaps with Moderate and Full-Scale, but also continues post Development**
Rural Communities	**ECN**	Limited, primarily indirect effects on jobs, spending and business revenues for other sectors of local economies. Landowners benefit from leasing revenue.	Short-term direct and subcontracting job opportunities. Some landowners receive royalties. May see support infrastructure construction begin.	Investment stimulated in local retail and services. Landowners receive royalties. Active ancillary support infrastructure. Potential conflicts with agriculture & tourism / recreation / resort economies.	Long-term, primarily indirect effects on jobs, spending and business revenues. Royalty revenues continue.
	POP	Limited and temporary	Potentially moderate, temporary increases, particularly in communities with temporary housing. Limited production-related population begins to increase.	Moderate to major, short-term, especially in communities with existing or new temp. housing. Migrants mostly single-status at first, but can become more households if development is sustained over the long-term.	Limited, long-term during life of the field.
	H	Limited demand for existing temporary housing (motels & RV parks)	Demand for existing temporary housing; may see investment in new temp. housing, e.g., RV parks. Limited demand for production-related conventional housing.	Depending on proximity to major population centers, demand for housing may stimulate construction of RV parks and multi-family rentals. Localized demand for production-related conventional housing.	Demand for temporary housing abates as development ends. Communities where temporary and rental housing supply expanded could experience excess capacity. Long-term demand is for conventional housing.
	SVC	Limited, primarily to law enforcement, emergency response / medical and road maintenance	Potentially moderate increases for all services. Some communities see demand on utilities.	Moderate to major. Demands on utilities, building departments. Some increase in school enrollment related to production employment build up.	Demand abates. Communities that have expanded infrastructure and service capacity to accommodate development could experience excess capacity.
	FISC	Limited - primarily sales tax on consumer-type purchases	Minor to moderate increases in sales taxes; direct and indirect property taxes, utility revenues & intergovernmental revenues. Production-related tax revenues begin.	Minor to major increases in sales taxes; direct and indirect property taxes, utility revenues & intergovernmental revenues. Production-related taxes build over time.	Sales taxes, utility revenue and intergovernmental revenues decline, but remain higher than pre-development. For jurisdictions hosting development, production-related taxes peak, then decline but

		Exploration / Early Development	Moderate Development	Large / Full-Scale Development	Post-Development Production
		Dispersed pattern of few well pads	**Multiple well pads, simultaneously in localized area, some production begins**	**Many well pads, multiple operators, regional area, service centers emerge, production begins**	**Overlaps with Moderate and Full-Scale, but also continues post Development**
			to accrue, but jurisdictional mismatches may occur.		continue for many years. Aggregate production-related taxes are significant. Property taxes fluctuate in response to price changes.
	A&V	Limited but may simultaneously raise hopes for supporters and raise concern for expanded development among some residents and interested parties	Attitudes and values become more pronounced as concerns and hopes for expanded development become more well-defined and are supported by local / regional examples of beneficial and adverse effects.	Attitudes and values are solidified and polarized, based on local experience and interests in development.	Development-related effects abate but lingering divisiveness may occur.
	QOL	Limited, temporary and localized effects. May provide employment opportunities and increased income for some but noise, traffic and industrial activity may affect perceived quality of life for others.	Scale of localized effects on noise, traffic and industrial activity increases, affecting perceived quality of life for more residents.	Potentially major and geographically widespread effects on quality of life. Disparities in distribution of benefits and adverse effects.	Some long-term effects on QOL continue, some new long-term residents in community, migrant population reduced.
	CC	Limited and generally temporary, but placement of wells in sensitive areas could affect community character	Character of rural communities at the center of development affected by moderate traffic, industrial activity, noise, land use changes.	Character of rural communities at the center of development affected by substantial and sustained traffic, industrial activity, noise, land use changes. Migrant population can affect established social structures.	For some communities, return to near pre-development rural setting could occur. For others, change in setting related to development-related residential, commercial and public investment would persist. For some, perceptions that adverse change in community character have occurred may remain after development ceases.

		Exploration / Early Development	Moderate Development	Large / Full-Scale Development	Post-Development Production
		Dispersed pattern of few well pads	**Multiple well pads, simultaneously in localized area, some production begins**	**Many well pads, multiple operators, regional area, service centers emerge, production begins**	**Overlaps with Moderate and Full-Scale, but also continues post Development**
Small Towns / Villages	**ECN**	Limited local job opportunities, limited local spending, Limited effects on other sectors of local economies	Short-term, moderate scale direct job opportunities. Effects from ancillary infrastructure begin. Moderate scale indirect effects on jobs, spending and business revenues. Some field offices develop and production-related jobs begin to become available.	Many direct, indirect and induced jobs. Production-related jobs build over time. Investment stimulated in local retail and services. Indirect effects benefit un/underemployed residents. Labor force competition results in higher wages. Labor shortages possible. Potential conflicts with tourism / recreation / resort economies. More field offices and service firms develop. Community income rises, in some cases substantially.	Long-term, direct and indirect effects on jobs, spending and business revenues. Some shrinkage of retail and service sector compared to the development peak. Royalty revenues continue. Community income rises.
	POP	Limited, short-term and temporary.	Potentially moderate, temporary increases in communities with existing temporary housing, including those within reasonable commuting distance of development.	Moderate to major, short and long-term, especially in communities with existing or new temporary housing. Many single-status migrants, but also families associated with field offices, service centers and expanding production employment. Population increase peaks.	Some communities will experience substantial declines in population. Others will lose population but still be larger than pre-development. Long-term population will have more families.
	H	Limited demand for temporary housing (motels & RV parks).	Demand for existing temporary housing; may see investment in new temp. housing, e.g., RV parks. Temporary housing costs may escalate. Limited demand for production-related conventional housing.	For communities distant from major population centers, demand expands for both temporary and conventional housing, potentially stimulating real estate subdivision and construction of RV parks, motels, and conventional housing for both rental and sales. Housing costs escalate.	Housing demand and costs abate. Some communities may have excess capacity in temporary and rental housing. Improvements in housing stock persist.

		Exploration / Early Development	Moderate Development	Large / Full-Scale Development	Post-Development Production
		Dispersed pattern of few well pads	**Multiple well pads, simultaneously in localized area, some production begins**	**Many well pads, multiple operators, regional area, service centers emerge, production begins**	**Overlaps with Moderate and Full-Scale, but also continues post Development**
	SVC	Limited primarily to law enforcement, emergency response and health care and road maintenance.	Up to moderate increases. Some communities see demand on utilities and building departments. Potential infrastructure expansion in some communities.	Moderate to major demands on full spectrum of local government facilities and services including planning / building departments. Infrastructure expansion likely. Some increase in school enrollments, particularly if development is sustained and production-related employment increases.	Demands on community infrastructure and services abates. Long-term demand associated with production likely greater than pre-development demand, but resembles pre-development demand in nature. Development-related infrastructure improvements continue to benefit communities.
	FISC	Limited, primarily sales tax on purchases and lodging.	Up to moderate increases in sales tax, building and tap fees, intergovernmental revenues. Indirect effects on property taxes. Production-related tax revenues begin to flow. Some communities face infrastructure expansion costs. Potential for jurisdictional mismatches.	Moderate to major increases in sales tax, building and tap fees, intergovernmental revenues. Indirect effects on property taxes. More communities face cost to expand infrastructure and services. In some cases costs exceed development-related revenues in early years. Production-related revenues tend to climb throughout the development period, but are sensitive to gas prices.	Substantial declines from peak sales tax, building fees and intergovernmental revenues. Indirect effects on property taxes. Property taxes peak but continue. Some towns and districts that incurred debt to fund improvements may have unretired long-term debt. For jurisdictions that host development, production-related taxes persist for years, but typically begin to decline, based on declining production volumes and gas prices. Total development and production-related taxes would be significant. Post-development revenues generally higher than pre-development levels.
	A&V	Limited but may arouse concern for expanded development	Attitudes and values become more pronounced as concerns about and hopes for expanded development become more well-	Attitudes and values are solidified and polarized, based on local experience and interests in development.	Development related effects abate but lingering divisiveness may occur.

		Exploration / Early Development	Moderate Development	Large / Full-Scale Development	Post-Development Production
		Dispersed pattern of few well pads	**Multiple well pads, simultaneously in localized area, some production begins**	**Many well pads, multiple operators, regional area, service centers emerge, production begins**	**Overlaps with Moderate and Full-Scale, but also continues post Development**
			defined and are supported by local/regional examples of beneficial and adverse effects		
	QOL	Limited, temporary and localized effects. May result in increased job opportunities and income for some but noise, traffic and industrial activity may affect perceived quality of life for others	Employment and income benefits increase and become more long-term. Scale of localized noise, traffic and industrial activity increases, affecting perceived quality of life for more residents. Some communities on periphery of development also affected.	Potentially major and geographically widespread effects on quality of life. Elevated levels of traffic, noise and industrial activity and changes in the environmental and aesthetic setting. Disparities in distribution of benefits and adverse effects. Expansion of goods and services and investments in residential, commercial and public infrastructure enhance QOL for some. Higher costs adversely affect low and fixed income populations.	Some beneficial effects on QOL such as production-related employment and income, and improvements in residential, commercial and public infrastructure. Reductions in economic activity associated with development may adversely affect some residents and business owners. Quality of life effects associated with traffic, noise and industrial activity and change in the environmental and aesthetic setting would be substantially reduced and combined with interim reclamation may result in a return to near pre-development levels for some. Others may perceive ongoing levels of these effects to be detrimental.
	CC	Limited and generally temporary, but placement of wells in sensitive areas could affect community character.	Community character of small towns at the center of development affected by traffic, industrial activity, noise and changes in land use and environmental, visual and social settings.	Community character of towns at the center of development affected by traffic, industrial activity, noise, and changes in environmental and social setting. For some a sense of vibrancy exists. For others the presence of many newcomers is unwelcome. The degree of change in community setting can range from negligible to dramatic and be	Depending on the level of development that occurs, and the predevelopment nature of the community, the cessation of development and the corresponding reductions in traffic, noise and industrial activity and the gradual reduction in environmental and aesthetic effects associated with interim reclamation, could result in a return to near-pre-

		Exploration / Early Development	Moderate Development	Large / Full-Scale Development	Post-Development Production
		Dispersed pattern of few well pads	**Multiple well pads, simultaneously in localized area, some production begins**	**Many well pads, multiple operators, regional area, service centers emerge, production begins**	**Overlaps with Moderate and Full-Scale, but also continues post Development**
				seen as mildly beneficial to substantially adverse, depending on the pre-development character of the community, the level of development that occurs, and the attitudes of residents toward development.	development character for some communities. For others, the changes long-term changes would still be seen as adverse. Communities in economic decline that have experienced development-related revitalization may see the long-term change as beneficial.
Cities / Urban Areas	**ECN**	Increase in economic activity commensurate with level of exploration and early development occurring in surrounding areas. Increase in employment in non-skilled direct and indirect and induced jobs	Short-term, minor to moderate scale direct job opportunities, including effects from ancillary infrastructure. Moderate scale indirect economic effects. Some field offices develop.	Investment stimulated in local retail and services. Indirect impacts benefit un/underemployed residents. Conflicts with tourism / recreation economies less pronounced due to larger / more diverse economy. More field offices and service firms develop. Community income rises.	Long-term, primarily indirect effects on jobs, spending and business revenues. Some shrinkage of retail and service sector compared to the peak, but typically higher than pre-development. Result is higher community income.
	POP	Potential for minor, temporary increase in population, primarily transient workers.	Potentially moderate, temporary increases in communities with existing temporary housing, including those within reasonable commuting distance of development.	Moderate-scale, short- and long-term, especially in communities with existing temp. housing. Many single-status migrants, but more families associated with field offices, service centers and indirect changes. Population increase peaks.	Some cities see substantial population decreases, others will lose population but still be larger than pre-development. Long-term population will have more families.
	H	Increase in demand for primarily temporary housing resources.	Demand for existing temporary housing; may see investment in new temp. housing, e.g., RV parks. Cost of temporary housing may escalate, depending on the size of the city, but would be less pronounced than in	Depending on the predevelopment available housing stock, housing demand may stimulate real estate subdivision and construction of motels and conventional housing for both rental and sales. Housing costs may escalate,	Housing demand and costs abate. Some communities may have excess capacity in temporary housing and moderate excess capacity in conventional housing, but improvements in housing stock persist.

		Exploration / Early Development	Moderate Development	Large / Full-Scale Development	Post-Development Production
		Dispersed pattern of few well pads	**Multiple well pads, simultaneously in localized area, some production begins**	**Many well pads, multiple operators, regional area, service centers emerge, production begins**	**Overlaps with Moderate and Full-Scale, but also continues post Development**
			smaller town.	but less pronounced than in smaller towns.	
	SVC	Limited, primarily law enforcement, emergency response / health care and road maintenance services	Up to moderate increases. Some communities see demand on utilities and building departments. Potential infrastructure improvement in some cities.	Moderate to major, depending on the size of the city. Demands on utilities, and full range of community services including building departments. Infrastructure expansion possible for cities central to several development areas. In some cases, needs predate development. Communities benefit from enhanced fiscal capacity. Increase in school enrollments likely, depending on location in relation to development areas.	Development-related infrastructure and service demand eases, but improvements continue to benefit communities. Demand from production-related population resembles typical population demand. Communities that expanded infrastructure and service capacity to accommodate development experience excess capacity.
	FISC	Limited, primarily increases in sales tax and lodging revenues.	Up to moderate increases in sales tax, building and tap fees, intergovernmental revenues. Indirect effects on property taxes. Some communities face infrastructure expansion costs. Some costs could precede revenues.	Moderate to major increases in sales tax, building and tap fees, intergovernmental revenues. Indirect effects on property taxes. Some cities could face cost to expand infrastructure and services. Some costs could precede revenues.	Substantial decline over peak sales tax, building fees and intergovernmental revenues. Indirect effects on property taxes. Development and production-related tax revenues would be significant. Post-development revenues generally higher than pre-development levels. For communities that have financed development-related infrastructure expansion, some long-term debt obligations could remains.

		Exploration / Early Development	Moderate Development	Large / Full-Scale Development	Post-Development Production
		Dispersed pattern of few well pads	**Multiple well pads, simultaneously in localized area, some production begins**	**Many well pads, multiple operators, regional area, service centers emerge, production begins**	**Overlaps with Moderate and Full-Scale, but also continues post Development**
	A&V	Effects likely to be modest depending on proximity to exploration / development activities and pre-existing attitudes towards development	Attitudes and values become more pronounced as concerns about and hopes for expanded development become more well defined and are supported by local / regional examples of beneficial and adverse effects	Attitudes and values are solidified and polarized, based on personal attitudes toward development and interests in development. Local and regional experiences with development and the city's proximity to development also help inform and solidify attitudes and opinions.	Development related effects abate but lingering divisiveness may occur.
	QOL	Increased employment, income and economic activity could improve living conditions for some.	Improvements in QOL for some due to improved economic climate, particularly if current economy is depressed or stagnant. Few likely to be directly affected by increased traffic, noise and industrial activity.	Economic QOL improvements possible for many people. Development-related, residential, commercial and public infrastructure improvements could improve QOL for many residents. Residents with interests outside the city and in areas where development occurs could perceive deterioration in QOL in changes in recreation settings or places with special meaning.	Development-related employment, income and other economic effects cease, potentially diminishing QOL for many residents. Those that previously perceived development as diminishing their QOL may now experience a return to near pre-development levels.
	CC	In most cases, changes in community character would not be anticipated, depending on the proximity of exploration and early development to the city.	For most cities, changes in community character are likely to limited depending on the city's proximity to development and capacity to accommodate moderate increases in employment with existing infrastructure.	Economic aspects of community character typically more vibrant, signs of growth, development and investment can be apparent, depending on the communities' pre-development economic climate. Some smaller cities centrally located in large-scale development areas may experience changes in their social setting which can be	Depending on the size of the city and its proximity to development, a wide range of long-term effects in community character is possible. Some cities may revert to near pre-development character, with modest improvements in infrastructure. Others may leverage infrastructure improvements to develop or attract new industries. Still others

		Exploration / Early Development	Moderate Development	Large / Full-Scale Development	Post-Development Production
		Dispersed pattern of few well pads	Multiple well pads, simultaneously in localized area, some production begins	Many well pads, multiple operators, regional area, service centers emerge, production begins	Overlaps with Moderate and Full-Scale, but also continues post Development
				perceived as both beneficial and adverse.	may experience economic decline.
	ECN	Economics - Employment and Economic Activity			
	POP	Population			
	H	Housing			
	SVC	Services: Community Infrastructure, Facilities and Services			
	FISC	Fiscal: State and Local Government Fiscal Conditions			
	A&V	Attitudes and Values			
	QOL	Quality of Life and Social Conditions			
	CC	Community Character			

C. Success in the Field

Case Study: Fort Worth Basin. In 2008, the City of Fort Worth created the Fort Worth Gas Well Drilling Task Force. This Task Force of 18 members was appointed by the City Council and included community members, business leaders and industry representatives to review, and make recommendations to improve, existing drilling regulations. Working with experts in various fields, a new zoning ordinance and drilling regulations for urban development were created. The existence of this Task Force also enables the City to be flexible and respond to new technologies and emerging ideas, tweak its guidelines and work to enforce its ordinance. The Task Force held regular meetings that were open to the public and also held formal public hearings to solicit public input. A website page on the City's website allows for user-friendly interaction and information distribution (City of Forth Worth, 2009). This type of open planning process can be a successful model.

Case Study: Piceance Basin. The Rifle, Silt and New Castle Community Development Plan - As oil and gas development intensifies in northwestern Colorado, the communities of Rifle, Silt, and New Castle have joined two energy companies, Antero Resources Corporation and Galaxy Energy, through a collaborative process supported by the Grand Valley Citizen's Alliance to create the Rifle, Silt, New Castle Community Development Plan (RSNC-CDP; Grand Valley Citizens' Alliance, 2006). The RSNC-CDP encourages communication and cooperation between community members and the natural gas industry in hopes of minimizing the impacts of oil and gas development in Garfield County. Specifically, the goal of the RSNC-CDP is to "create productive development while minimizing impacts to individuals and communities." (Grand Valley Citizens' Alliance, 2006, p. 7).

Although the RSNC-CDP is not legally binding, it sets guidelines, agreed upon by community participants and industry leaders, for industry to follow when planning development, such as employing Best Management Practices, clustered well development, managing development in sensitive areas, monitoring air and water quality, and addressing community health and safety. Along with protecting the environment, responsible development will, hopefully, enhance the natural resource values of the area and reduce conflicts between industry and the residents of Garfield County. With a predicted increase from 1,000 to 20,000 wells in the Grand and Roaring Fork Valleys, the RSNC-CDP will help to manage the growth of the natural gas industry so that the communities of this area can sustain their quality of life.

Watershed Plan for the Town of Palisade and the City of Grand Junction. Palisade and Grand Junction, Colorado, two communities sharing a watershed and oil and gas development, have successfully worked with Genesis Gas & Oil to plan for development within the watershed in a way that protects it as much as possible and keeps the communities involved as the development progresses (Palisade and Grand Junction Watershed Stakeholders, 2007). Though the watershed plan. is not legally binding, involved parties are committed to resolving issues related to energy development in the communities. While Genesis voluntarily accepted the plan's provisions, should the leases be transferred or sold to another company, the Bureau of Land Management (BLM) would hold new lessees to the plan as a template for their operations.

Through public meetings and surveys, and news releases, community members were able to identify potential issues stemming from energy development in the watershed, establish working relationships between stakeholders, create an ongoing forum for communications, and formulate the watershed plan. The plan contains elements of risk analysis, third-party baseline studies and monitoring, voluntary commitments by Genesis, best management practices for protection of the watershed and risk mitigation, and an overview of agency roles and responsibilities and relevant permitting and regulations.

The intent of the watershed plan is that the economic, social, and environmental health of the involved communities will be considered and addressed appropriately as energy development progresses.

Case Study: Overthrust Industrial Association. There are joint public/private initiatives that have involved industry organizations and local and state governments to identify and address socioeconomic impacts. This case study highlights a successful joint public-private partnership between the natural gas industry and state and local governments in the western United States during the 1980's. The Overthrust Industrial Association (OIA) was an initiative designed to specifically address the effects of large-scale natural gas development (RMOA, 2006). The OIA example was a voluntary initiative organized by the natural gas industry with active involvement of state and local government. Touted as a success from both sides, this model of long-term public-private partnership could serve regionally across the United States as well.

INNOVATION AND FUTURE USE

A. Opportunities for Innovation

National and local trends in community planning are currently focused on sustainable communities and infrastructure. Those trends are evidenced by a number of national, state and local government initiatives and funding opportunities. In addition, organizations such as the American Planning Association are highlighting the connection of planning for growth and development with the energy resources and infrastructure required to serve it.

An important lesson that can be drawn from recent large-scale natural resource development experience is that joint industry/community planning for development is essential. Planning can help enhance the benefits of development and avoid, manage and mitigate many of the adverse effects. It is also clear that with proper planning, the investments made to accommodate development can be leveraged to create infrastructure to meet long-term economic and community sustainability objectives.

Public-private partnerships, involving cooperative research and development activities among industry, government laboratories, and universities, can play an instrumental role in accelerating the development of new technologies from idea to market.

The initial step in planning is the development of a common information base. Existing tools and ever-improving technologies exist to create and manage a common information base. The use of geographic information systems (GIS) is one commonly used tool among community planners that can serve this function. Interactive websites are also a useful tool.

One of the most commonly voiced concerns from local governments is that communities in new development areas lack information about the expected pace, timing and ultimate extent of development and how such development will affect their community and way of life.

The decentralized nature of the natural gas industry, the volatility of gas prices and uncertainty about productivity, costs and environmental/regulatory constraints, particularly in relatively new plays, limits the availability and certainty of development information. Companies are often reluctant to provide information and share development forecasts. Companies do not want to disclose their plans for competitive reasons and also do not want to be held responsible when plans change because of external forces, as they often do.

Forecasting the pace and ultimate extent of development in a new development area is fraught with uncertainty. Companies recognize that uncertainty but the public is often unaware of it. Without some information and an understanding of the uncertainties involved in development, the public often assume the worst – or the best – and both can have equally adverse outcomes for communities.

Providing communities with information about current plans for development with appropriate caveats to account for uncertainties, would allow them to understand how development may proceed and to work with companies to avoid, manage and mitigate adverse impacts and enhance beneficial impacts. It would also provide communities with perspectives about when

development might moderate and about the potential for slowdowns and interruptions, which can help communities and businesses alike avoid over building, over extension of services and help avoid debt financing that does not account for potential uncertainties in development. If those forecasts are regularly updated, discussed with communities and presented to the public, communities can become aware of the factors that influence development and plan their infrastructure and service levels and financing arrangements accordingly.

Once a common information base is in place it is desirable for industry to engage the community in the planning process. The first step in the process is to understand how development might affect communities and the steps that can be taken to avoid, manage and mitigate adverse effects and enhance beneficial effects for both the communities and industry. Communities also need some certainty that development will actually occur and that they will receive the necessary revenues from development to pay for needed infrastructure and service improvements in a timely fashion. Advance information allows communities to factor in sustainability considerations as they plan for development.

B. Long-Term Vision

Local and regional economic/community development organizations would benefit from advance information to develop strategies for capitalizing on industry-related investment in infrastructure and demand for goods and services. Industry could in turn benefit from local proposals for such things as industrial parks, workforce housing facilities, workforce training centers and inventories of local vendor capabilities.

Experience has shown that when industry proactively engages communities on development issues and becomes a partner in the planning and community development process, the experience is typically positive. Some companies, as part of their corporate philosophy or corporate social responsibility policies have strong community engagement programs. To date, there have been few examples of joint industry engagement efforts in development areas. But in at least one instance where a substantial engagement effort occurred, the results were widely considered to be positive. One voluntary initiative organized by the natural gas industry with active involvement of state and local government is the Overthrust Industrial Association (OIA).

Another benefit of an ongoing working relationship between companies and communities is that it avoids a sense of “powerlessness.” Community officials are more likely to try to resolve problems in collaboration with industry.

Energy development can be a win-win situation. Oil and gas companies typically make substantial infrastructure investments in new development areas. With early engagement on the part of companies, communities can often leverage those investments to help achieve their long-term economic development strategies and community vision. On the other hand, communities often have a variety of resources that can be used to ease industry’s entrance to the community and in some cases reduce costs.

FINDINGS

Balancing positive and negative aspects of oil and gas developments on environmental and socioeconomic outcomes remains one of the most important and challenging aspects of successful development of oil and natural gas resources. Creating a "win-win" situation for developers and community stakeholders usually requires a larger up-front investment of time and effort by all parties but returns value through smoother and more mutually agreeable outcomes in the long term.

There exist examples where negative impacts of oil and gas development have dominated socioeconomic outcomes but there also are case studies that demonstrate success in planning for, and accomplishing, beneficial outcomes. Prospects for positive outcomes are enhanced by early collaborations among developers and stakeholders, including summation of agreements in written documents that can be referenced by all parties as the benchmarks for evaluating progress and compliance.

Key factors in planning and execution of oil or gas projects with the best levels of community acceptance include context-sensitive designs and a deliberate approach to the balance between socioeconomic benefits and environmental impacts. Plans must be customized individually to accommodate different stages and extents of development as well as different metrics for benefits or impacts. Furthermore, the extent and magnitude of benefits and impacts must be accommodated differently for situations that include rural communities, small towns or villages or cities / urban complexes.

Principal milestones by development stage comprise (1) Exploration / Early Development; (2) Moderate Development; (3) Large / Full-Scale Development; and (4) Post-Development Production. Main metrics by benefit or impact include (a) Economics (Employment and Economic Activity); (b) Population; (c) Housing Services (Community Infrastructure, Facilities and Services); (d) Fiscal (State and Local Government Fiscal Conditions); (e) Attitudes and Values; (f) Quality of Life and Social Conditions; (g) Community Character. The interplay among the various milestones and metrics must be anticipated according to population density and lifestyle, namely, rural, town or city environments. Experience has shown that both perceptions and realities can be expected to change almost continuously as development begins, matures and concludes.

The crucial first step in organizing a successful outcome from the socioeconomic and environmental perspectives is to establish full and open communication among all stakeholders. Modern communication tools, including websites and social media, can be utilized to advantage although the most important attribute is to make available easily accessible information that is timely and reliable, including an expression of uncertainties where appropriate.

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