Rico, Colorado: 2009 Sustainability

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MNGN 503
Colorado School of Mines
Spring 2009

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Project Rico

Colorado School of Mines

MNGN 503

Spring 2009

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Introduction

A 1987 report of the World Commission on Environment and Development, created by the United Nations General Assembly, defined sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs."[1] This report is more commonly referred to as the Brundtland Commission Report. Sustainable development is a very important topic and is increasingly present in politics, media, and business and academic environments. Sustainability affects people and communities not only on a global level, but also a national, state, community and personal level.

There are three approaches to sustainable development, or the "triple bottom line," economic, environmental, and social.[2] In the developmental process, a balance of these three dimensions is necessary and they are "used to gauge the success of a particular development program or project."[3] Sustainability takes into account the relationship between the three concepts. These approaches are defined as follows: "economic approach--maximize income while maintaining constant or increasing stock of capital; ecological approach--maintain the resilience and robustness of biological and physical systems; socio-cultural approach--maintain the stability of social and cultural systems."[4]

These three concepts were used in determining the present and future sustainability of Rico, Colorado, a small post-mining town in the southwestern part of the state, at an altitude of 9,000 feet, in the midst of the San Juan Mountains.[5] It is known for its historical, small town

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[1] Report of the World Commission on Environment and Development, "Our Common Future, Chapter 2: Towards Sustainable Development," United Nations, http://www.un-documents.net/ocf-02.htm, visited 27 April 2009.
[2] Peter Pl. Rogers, Kazi F. Jalal, and John A. Boyd, *An Introduction to Sustainable Development* (London: Earthscan, 2008), 42.
[3] Ibid., 42.
[4] Ibid., 43-44.
[5] Marty Durlin, "A Rico renaissance, Post-mining economy threatened by proposed moly mine," *High Country News*, http://www.hcn.org/issues/364/17519, accessed 27 April 2009.

setting and mining boom and bust cycles including gold, silver. As Rico's residents and local government try to create a post-mining economy, the small town has a number of economic, environmental, and social aspects both past and present that affect the town's sustainability.

The Spring 2009, Mining Technology for Sustainable Development Class (MNGN 503) at the Colorado School of Mines has teamed up with a panel from Rico to coordinate and cooperate on the future of Rico and their sustainability potential. This project included research from Internet sources, the local newspaper, and communication with concerned residents though a questionnaire (Appendix A) and a face-to-face meeting with four citizens (see Appendix B for a list of attendees and their backgrounds). This report is the first of many in this newly found friendship and joint effort between Rico and the Colorado School of Mines. The Spring 2009 MNGN 503 class is made up of 13 graduate students from a multitude of programs including mining, engineering, and social sciences, bringing in many different views and helping make this project unique. One meeting was held during this semester on 17 March 2009, allowing both parties involved to gain valuable information about the purpose of this project.

The intent of this cooperation is for a long-term relationship that does not end with the publishing of this report, but is passed on among classes so each group can build upon the last. Additionally, the purpose includes education for both the classes and the Rico residents and to determine short, medium, and long term goals to reach sustainability and in the future aid in the execution of these goals.

Chapter 1

Economic Sustainability

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Introduction

The economic dimension of sustainability reflects natural, human, and human-made capital.[1] It is a very general concept that must be translated locally because the goal and definition for economic sustainability may be different in every location. Having better infrastructure and public facilities capable of sustaining and enlarging the town is the main concern of the town of Rico. Another economic sustainability goal for the town is to evolve to a state much less dependent on the economy of nearby Telluride while at the same time retaining its unique community atmosphere. This conclusion is based on the desire from Rico's citizens to have better infrastructure and public facilities because without improvement there is a concern people, particularly those with families, may leave the town. Migration away from the town due to poor economic and social infrastructure is a prime concern to the citizenry as it essentially makes the town unsustainable.

Public facilities and infrastructures can help retain the current populous, but sufficient demand is also necessary to justify the development. Infrastructure and public facilities are human-made capital and require operating and maintenance monies to remain in existence. The existing town composition is a primary resultant created from the past development of mining in the area. Since these boom and bust years, Rico's resulting decline was due to a failure to stimulate continuous and sustainable economic activity to operate and maintain much of the original infrastructure that mining brought. Sufficient demand can cover these costs and justify the development of new infrastructures and public facilities. However, it is difficult to advocate the creation or improvements to existing infrastructures and public facilities due to the low population in the town of Rico.

[1] Rogers, Peter P., Jalal, Kazi F. and Boyd, John A., 2008, *An Introduction to Sustainable Development*, Earthscan, VA – USA.

The town of Rico can attract more people to live in the town through economic activities. This occurred previously during the mining booms resulting in much of the current infrastructure and historic housing stock. However, there are not many economic activities now in the town of Rico. The U.S. Census Bureau notes that most activities in the Dolores County (where Rico is located) in 2002 were in wholesale and retail trade, and in accommodation and food services.[2] It is reasonable to interpret that most of those economic activities are related to the demand from people that live in and around the town or for tourists. The main economic engine appears to be servicing the needs of businesses and people in Telluride and the summer vacationers.

The town of Rico should consider its resources in creating and developing economic activities. Natural resources (geothermal and mineral resources) are the most promising resources for attracting more people and create the expected multidimensional effects (funding for infrastructures, reducing its dependency on Telluride, more population and subsequent economic activities) for this town. The town of Rico can achieve its long-term economic sustainability through the use and conversion of its natural resource capital. The potential opportunity for the use of Rico's natural capital must be planned carefully so its proliferation can help in developing Rico's human and human-made capitals. However, Rico expressed great desire to minimize or mitigate the perceived damage to the current quality of life in Rico.

This segment of the report will focus on the economic aspects of using natural resources and financial and human capital by the town of Rico to achieve economic sustainability within those criteria. To move from its current state to a more economically sustainable position ,the town must accomplish three things: begin development of its geothermal resources, improve its water and sewer system (along with continued environmental clean up), and improve and increase its housing and building infrastructure stock through the enhanced development of

[2] http://www.census.gov/econ/census02/data/co/CO033.HTM

social framework. Paying for these developments will require both private and government capital and will present the greatest challenge to Rico. Theoretically, the government has benefited previously from the mining activity and now it is paying backs its benefit with interest. The remainder of this segment will examine the economic sustainability of the geothermal resource, then the water and sewer infrastructure and finally the major areas of improvement in the physical and social infrastructure.

Geothermal Resources

Geothermal energy is a significant natural resource in and around the town of Rico. Geothermal Energy is heat energy from the earth contained in the rock and fluid in the earth's crust. It is a clean (low greenhouse gas emissions), reliable (95% average system availability) and renewable energy resource.[3] Therefore, the use of this energy would be unlikely to reduce the perceived environmental and quality of life in Rico.

Geothermal energy can be used for electricity generation and other direct applications. However, financing seems to be one of the most significant barriers for the development of geothermal power plant. There is also a low demand factor concerning the development of a geothermal power plant. As such, electric generation from geothermal energy is still possible in the long-term for the town of Rico.

In the short-term (0-5 years), the town can look at many different applications from its geothermal energy resources. The important thing in the short term is to show and prove the potential of geothermal energy resources through direct-use applications and data-gathering to possible interested parties (investors, government, research institutions, etc).

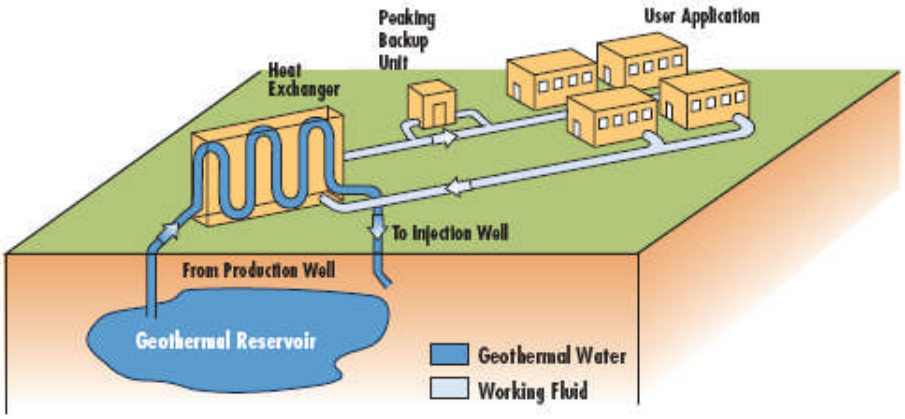
[3] Energy Efficiency and Renewable Energy U.S. Department of Energy, 2004, Geothermal Technologies Program:Direct Use, National Energy Laboratory- The DOE National Laboratory

The town of Rico should consider performing more initial geothermal exploration in their area. Geophysics and geochemistry methods are the most reasonable exploration methods to be done due to their lower cost compare to other methods. It may also be possible to have shallow depth drilling after the geophysics and geochemistry exploration. The existence of exploration data will encourage more detail exploration activities in this area. The town of Rico can have cooperation with academic and research institutions in this exploration stage.

The town of Rico can also use its geothermal energy for district heating by supplying hot water or steam through piping system to residential or commercial areas. In district heating system, the heat can be used for space conditioning (heating/cooling), domestic water heating, and industrial process heat with geothermal well as the primary source for the heat.[4] Figure 1 illustrates the geothermal direct use for district heating. District heating application can be done to a small town with a low population like the district heating in Midland, Haakon County, South Dakota. Midland, a small town of 250 inhabitants, uses geothermal energy to provide heating for 30,000 square feet (2,800 m2) of floor space.[5] The estimated annual saving from the district heating application is $15,000. However, the plan to develop a district heating system in Rico should be compatible with the water and sewer development plan and the Rico's master plan because it requires massive excavation processes.

[4] Lund, John W. and Lienau, Paul J., 1994**, Onion and Garlic Dehydration in the San Emidio Desert, Nevada**, Geo-Heat Center Bulletin July, Vol. 15, No. 4, Geo-Heat Center, Oregon Institute of Technology, Klamath Falls, OR.

[5] Lund, John W., 1997**, Midland**, **South Dakota Geothermal District Heating**, Geo-Heat Center Bulletin December, Vol. 18, No. 4, Geo-Heat Center, Oregon Institute of Technology, Klamath Falls, OR.



Source: U.S. Department of Energy

Figure 1. District Heating with Geothermal Energy.

Other direct-use applications that can be considered by the town of Rico are the agriculture, aquaculture, food dehydration applications. Commercial greenhouse development for vegetable or flower-growing is the possible agriculture application for geothermal energy in Rico. Commercial greenhouse industry can be attractive due to its low entry barriers (no dominant leaders in terms of net sales or size).[6] Greenhouse operators estimate that geothermal energy use save 5 to 8% of the total operating costs.[7] The two largest greenhouses are in New Mexico and they serve out of state buyers. The town of Rico should consider the possibility to become the vegetable and/or flower suppliers to the region. Economies of scale and transportation will be the major considerations for this geothermal application.

Food (vegetable and fruit) dehydration application is also a potential direct use of geothermal energy in Rico. Vegetable and fruit dehydration is one of the oldest food preservation

[6] Boyd, Toni, 2008. ***Geothermal Greenhouse Information Package***, Geo-Heat Center, Oregon Institute of Technology, Klamath Falls, OR

[7] Energy Efficiency and Renewable Energy U.S. Department of Energy, 2004, Geothermal Technologies Program:Direct Use, National Energy Laboratory- The DOE National Laboratory

methods.[8] One example of this application is the onion and garlic dehydration in Nevada that gets onion and garlic supplies from California. The large scale of the plant can cover transportation costs and other costs, if similar applications were used in Rico's case. Therefore, the town of Rico should consider the demand size and production capacity for the direct use applications of its geothermal energy resources.

However, in the immediate future Rico may wish to consider the development of demonstration scale systems for all the above. As part of this process Rico will be able to demonstrate to outside investors the community commitment towards developing this resource, create a local skills base capable of operating and maintaining such systems, and perhaps incorporating all of this into either a regional or national training center on how to use and operate geothermal power. A particular benefit of becoming a training center is it will bring people and money into the community during the week. The taxes and revenues generated by these outside sources will help fund other improvements in the town on its way to sustainability.

While direct use of geothermal applications as the short-term strategy are expected to bring new economic activities to the town of Rico, in the medium-term (5-10 years) strategy, the town of Rico should be more active in looking at the electricity generation from geothermal energy. Coal power plants will continue to be less preferable due to its high emission. Therefore, the town should look at the possibility for out-of-town consumers for its electricity.

The long-term strategy (after 10 years) the town of Rico should employ is to continue efforts to develop the geothermal energy power plant. This will not only generate jobs related to the operations, it will also supply a consistent tax base. This may be particularly relevant if Rico

[8] Andritsos N., Dalampakis P., and Kolios N., 2003, Use of Geothermal Energy for Tomato Drying, Geo-Heat Center Bulletin March, Vol. 24, No. 1, Geo-Heat Center, Oregon Institute of Technology, Klamath Falls, OR

develops a utility district and authority with the ability to levy a small tax on the electricity leaving the district boundaries.

Sewer and Water System

In order to create economic sustainability or growth, a level of self-sufficiency must be attained. As such, the town must have a viable water and sewer system. Unlike new development, Rico is not starting from scratch as a water and sewer service was installed prior to construction. The result of not having adequate water and sewer facilities will make it difficult for new residences and businesses to emerge, as well as potentially leading to condemnation of existing properties.

The town of Rico currently is served by an old water supply system dating back to its mining days. The ability of the current system to supply the current residents is being stressed by its capacity, age, and possible environmental concerns. The ability of the town to sustain or increase its population will require an upgraded water system conforming to national standards. The system will have to provide not only clean water for consumption but be able to supply water for use in fire fighting activities.

The town does not have a centralized wastewater (sewer) collection or treatment facility. The current housing stock uses individual septic tanks and drain fields or discharge directly into the ground via percolation through dry wells or cesspools. The town has received offers of grant money to install a wastewater and treatment facility, as the current system is likely to be violating or will be violating clean water statutes. The likelihood this money will cover the full cost of the system is unlikely but it gives the town a starting point.

The master plan for Rico, shows an increase and density of households within the central core of the town. The increase in population and its increased density needs to be accounted for

when developing the replacement water and sewer system. The same plan also shows current and future residences outside of the central core of the town. These residences could still be served by the central water system but would not necessarily need or benefit from having the sewer system extended as existing residential treatment facilities maybe sufficient to maintain clean water.

Having and maintaining clean water is one of the fundamentals of having a viable sustainable community. It is one of the priorities that the town must address if it wishes to continue to exist. Having clean water allows the town to grow, increasing its tax base and allowing it to provide more of the services that will in turn attract more people starting a virtuous cycle, which would grow the town to its planned limits while increasing economic activity to a level that will allow it to be sustainable.

In the short term, the town needs to develop its basic service plan to provide water and sewer services to the town residences. Grant money has been available in the past for the initial engineering studies to be undertaken, but as of yet there has been limited final design work. To continue to receive grant money the town needs to move forward with implementation and how to pay for it.

The following options may be beneficial to include in the water and sewer plan: As noted during the presentation by town representatives one of the most expensive items in installing a water and sewer system is the excavation for the pipelines. As noted previously in this document, the town has access to a substantial geothermal resource that may be used to generate either power or residential heating. By combining the excavation for water and sewer lines, the same excavation may be used to lay lines capable of transporting heated fluids from the geothermal resource. The primary benefits of combining the lines within a single excavation

include reduced cost as these lines could be laid close to the sewer lines thereby providing some heat and increasing the biological activity as the sewage is transported to the treatment plant. It would also put in place the infrastructure to for residential and commercial heating.

As another cost-savings measure, the wastewater treatment plant should be located near/adjacent to the treatment plant being used to treat the St. Louis Mine discharge water. Combining the two plants will reduce operational overhead as fewer licensed personnel will be needed to operate the plant. Additionally the sludge generated from the treatment plant can be treated and used as bio solids aiding in the reclamation efforts by providing a nutrient rich top cover over abandoned tailings.

The economic justification of implementing and running the water and sewer system would be difficult if looked at in isolation. By combining the project with other priorities, the cost to install and operate will be reduced. It will also provide the infrastructure for future development as well as demonstrating the town's willingness to avoid a chicken and egg scenario where everything is in limbo, with people and business waiting for water and sewer while the town is waiting for people and business before putting the system in. The task of paying of for the system will require several different avenues of funding with the majority of it coming from grants and the issuance of bonds. While grants do not need to be paid back the bonds, will.

To pay back the bonds the town it is suggested the town incorporate a water/sewer/thermal authority with imminent domain and taxing/billing rights. Key to paying back the bonds is to make it mandatory to connect to the system if it is within so many feet of a structure. For existing buildings, the fee will be collected immediately or a lien put in place. The lien will increase by the proportional interest rate of the bond. For new buildings, a

connection fee equal to the amount plus the interest paid on the bond would be collected before a building permit was issued. In addition to an actual usage charge, the authority would have mandatory minimum monthly fee. By structuring the system in this way, the connection and monthly fees collected on properties, which are not occupied year round, will allow a system capable of supplying all current and future residents to be built. It is also likely to increase the current and resale value of existing properties thereby increasing the tax base to provide other services. With a substantial water/sewer geothermal system in place it will make it less expensive for business to set up shop as well as reducing operating costs during the winter when space heating costs go up and may be particularly appealing to businesses considering different locations. It will also allow them to claim to be "green and environmentally friendly."
In constructing and operating the system there might initially be a significant amount of outside labor jobs during the construction but the technology transfer of maintaining and operating the geothermal system will provide a working skill set from which an electric geothermal operator would like to have available.

Overall, in the short-term the economics of spending money now and moving forward on installing a joint water/sewer/geothermal system even if it means long-term debt will allow the town to lay the framework for future sustainable development.

Social Infrastructure

The primary focus suggested for the town of Rico, Colorado from the period 5 to 15 years in the future is to focus on development in social infrastructure. While there are many crucial areas that need focus throughout the process of development, including continued development of geothermal infrastructure, the increased development of social infrastructure will provide more reasons for there to be a more permanent influx of year-round residents, including children, in

the town. If Rico could promote itself as more than a resort town by strengthening these areas, it could bolster the population, providing new capital to stimulate Rico's internal economy of small businesses as well as possibly creating room for needed expansion in this area.

However, key to further economic proliferation for the town of Rico reqiures emphasis on developing more inclusive and self-sustainable social infrastructural elements aimed at increasing economic efficiency as well as utility for the town's citizens. By creating sustainable elements within the realm of social development, Rico will be able to provide its current citizens with basic needs as well as enticing attraction to the further proliferation of small businesses in town. This in turn would serve to create reasonable population growth that will provide a year-round consumer base to combat the fluxing population demographic resulting from seasonal residents. Within this mid-range scope of development, there are two primary areas of emphasis. The first will be funded through community taxes and grants the other through private development. For both to succeed they must be coordinated and progress together.

- **Education** – *due to the current academic schedule structure, the town elementary school holds session four days a week leaving one day where Rico parents whose occupations take them from home must find alternative means of supervision for the children on the fifth day. This along with other social program infrastructure will serve to support the current community and prompt growth.*
- **Residential Development** – *There are currently 258 water taps sold now, another 400 build-able lots in platted town, plus 304 to be annexed as a planned unit development. By developing these lots into residential homes, in light of the further development of other social systems, Rico could entice a fresh, new population.*

While the primary phase of each of these areas must be to acquire and allocate the proper support and funding for such operations and development, the value of each of these will help to boost Rico's economic sustainability.

At the current time, there exist limited elements in regard to educational infrastructure. The school in town is preschool – 6th grade and runs Monday through Thursday. Yet, the population of citizens whose ages fall between six and eighteen is considerable and increasing. As such, a primary focus for Rico, in regard to education, exists in the ability to keep and continue to develop its elementary school as well as be able to provide quality childcare for the children of the town who are not of age for elementary and primary school and whose parents commute to Telluride and elsewhere daily.

- **Elementary School -** The school as currently run and organized operates four days a week. The primary focus relative to the current school would be to expand this schedule to all five days as to provide a more stable educational schedule as well as remediate the situation regarding childcare.

- **Daycare -** The inherent value in establishing and promoting a system of educational fostering for developing toddlers and children creates incentive for the migration of families to the area while still retaining their employment in nearby towns (primarily Telluride). It further enables these families to have a supportive outlet for their children during the workweek, even if the preschool through sixth grade school does manage to expand its schedule to five days a week. Rico's population demographics are shifting younger and as such, there is a strong need to develop quality educational infrastructure to promote migration to the town as well as decrease the cost of finding alternative childcare in neighboring towns. It is believed this is one of the primary reasons why families are literally forced to move from Rico, making the town unsustainable in the long run.

Based on economic figures and statistics (See Appendix), there is an emphasis to expand the residential sector as a means to open up space for housing expansion. With the current town

population resting at a mere 200 and with geographical confines limiting population growth to just 2000, there is a capped extent to which the town can grow. However, the development of a housing district provides opportunity and possibility for the current residents, as well as providing further impetus for migration to Rico to occur. If Rico is to grow substantially, homes must be available to new residents. Neighborhoods must exist for children too and from which the day care and elementary school can draw. Homes must be created for families to return following the commute to and from work in Telluride.

If these areas are explored, expanded on, and developed they would provide strong incentives for the population to stabilize at year-round levels closer to the town's capacity prompting the necessary expansion of Rico's internal economy and strengthening and further legitimizing its existence as more than merely a summer retreat for seasonal residents. The funding and coordination between the private entities, building the residences, and local governments building and operating the school will require close coordination.

In the long term, after Rico has established and implemented water and sewage and other social infrastructure developments, their focus should be on maintaining revenue and citizens in the community as well as attracting more through other forms of development. These developments should be based on sustaining a population that has increased during the development of its geothermal, physical, and social infrastructure. Once infrastructure to support a larger population has been build out, Rico may find itself a full town wishing it could expand and facing the possibility of becoming a desired mountain town destination.

Mine sites and areas along the Dolores River that require additional cleanup

Continuing the cleaning and rehabilitation of old sites will improve the image of Rico along with enabling the possible development of those sites into wildlife zones. The St. Louis

Tunnel is currently the main focus for the river discharge cleanup and the abandoned mine sites will provide the town a clean image to accompany a “green” renewable geothermal mining operation.

As the geothermal resources are developed, Rico will want to focus much of their development around the theme of geothermal and renewable energy. Broadcasting the message that Rico has this unique aspect along with the fact that they have “green” heated housing, and have the physical and social infrastructure in place will attract population that will spur further economic development through increases in labor forces as well as potential additional small businesses.

To expand upon the geothermal resource in Rico, the town should continue to look to develop a hot springs resort, and a museum exploring Rico’s history as a town and its progress from a mining town to a renewable energy town. The earth-friendly themes supports one another will certainly provide the Rico Peace Garden something else to celebrate as well.

In the long run, once Rico has expanded its population close to the 2000 limit, they may want to consider developing snow-shoeing and cross country backpacking, and riding and skiing trails. While this does not correlate to the geothermal plant, it does offer a different dimension to the town that will help ensure an economic sustainable future.

There are a few alternative economic strategies available other than establishing a geothermal resource center (heating, electricity, training etc.) that will provide the economic stimulus to complete the transitions to an economically sustainable town. The review of these strategies delves into principally economic aspects that would generate revenue critical to the sustainability of Rico.

Creating a hot springs resort similar to what Dunton has is a possibility. However, since Dunton is relatively close to Rico and is already established with their geothermal hot springs resort, Rico would have to provide what Dunton does not. The main aspect of that would be lower rates for stays. Dunton is an exclusive resort, which offers luxury style cabins which run upwards of $800 a night and more. This may work as a cheap alternative, to Dunton.

Encouraging the development of new mining operations is another way to pump money into the town. Rico has a very long history of being a mining town, and it has done well for the town's sustainability (it would not exist otherwise). Mining brings in jobs, some degree of infrastructure, as well as outsiders who may consider staying and supporting Rico. Unfortunately for Rico, there is a general stigma to mining companies due to careless operations in the past. The development of a social license that works well for both parties is also going to be a tough issue to tackle because of the lack of interest and desire for mining companies in Rico.

One more possible economic strategy they could implement is to advertise to those who are from the cosmopolitan regions looking to build a summer mountain retreat. With the availability of water and fire lines aiding in the insurability million dollar summer mansions are not outside the realm of possibility. This increased tax base a low impact on social infrastructure services would aid the town in its further investments into becoming economically sustainable.

Summary

In summation of the overall goals established for the town of Rico in regard to economic stabilization, there will be a series of steps and phases as a means to accomplish economic sustainability. The primary focus for Rico is to create economic opportunity and enhance incentives for new residents to join the community. By doing this, Rico would enable itself to

exist independently of Telluride. Funding, as well as possible and alternative strategies are key focal points of this process.

Of critical importance is the acquisition of appropriate funding to begin the projects and steps illustrated in this report. Many of these projects require substantial funding; and it is a key-determining factor in the rate of progress Rico will achieve toward its goal of economic sustainability.

In focusing its energies toward raising funds with the aim of implementing various elements in the short, medium, and long-term, Rico will continue towards economic sustainability. However, the primary concern related to each of these phases deal with the acquisition of proper funding while yet choosing not to develop mining and industry involving their valuable natural resources.

The first step toward this progression is to determine whether the town will attempt to appropriate necessary funding to financially support the early stages prior to the development or whether to attempt to acquire funds as there is progress made toward each step. It is in the best interest of the town to locate and raise funds as soon as possible in order to necessitate hasty development. However, regardless of which funding route is chosen, funding will be key to this advancement.

By establishing a funding and development plan, Rico will take steps toward reaching economic sustainability through entrepreneurial economic development. Rico must promote itself as a great and opportune town in which to establish a business and raise a family. Not only this, but as time progresses and these developments are made, there may be some desire to return to developing some of the promising natural resources Rico has to offer. While these options

may not necessarily include the possibility of mining (molybdenum and other minerals in the region), but expansion on their rich geothermal capabilities.

Chapter 2

Environmental Sustainability

Analysis by

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Introduction

Rico is a small mining town near Telluride with a population of about 250 people. During the Spring 2009 Semester, the Mining Technology for Sustainability Development (MNGN 503) class at Colorado School Mines have researched the town of Rico. The purpose of this research was to determine if Rico is a sustainable community. We evaluated past, present, and future states of Rico during this process. After we had a chance to research Rico, we had the opportunity to meet with representatives of the town to discuss their goals in becoming a sustainable community. The focus of this report is to pass the knowledge gained this semester by the Environmental team to the future courses that will have the privilege to work with this community to help them meet their future goals.

History of Rico

Rico was established as the result of mining activities in the area surrounding the area that is now Rico, CO. The first gold was discovered in 1866 by a group of prospectors from Texas. The Ute Indians drove away many early miners. In 1878 the Brunot Agreement was signed by the Utes, surrendering their land claims in the area. The Pioneer Mining district was established in 1876 which led to many mining claims being made in the area.

In 1879 silver was discovered and Rico became incorporated. In 1887 the Enterprise Lode was struck and the Rio Grande RR created a stop in Rico due to the mining activity. In 1892, Rico reached the height of its population with 5000 people. The mining district at it peak had 23 saloons, a 3 block red-light district, 2 newspapers, a theater, and boarding houses. In 1893 the silver panic struck Rico and the population dropped to 800 people by 1900. In the 1920's the Rico Company was started and began to revitalize mining near Rico. In the 1960's mining efforts were focused on lead and zinc. Currently there are no mining operations in Rico. The

town has organized groups in the recent years in attempts to revitalize the town with failed effort.[1]

Meeting with Rico

During one class meeting in the Spring 2009 semester, we had the opportunity to meet with representatives from the town of Rico. We were able to submit questions to the town representatives prior to this meeting. These questions were the focus of the discussion and the questions and responses from Rico are being supplied in Appendix A of the class report. The meeting with Rico was the basis for developing the five priority goals for Rico: Develop and expand the sanitary and water systems, develop the social infrastructure, explore the geothermal resources, continue with the mine cleanup efforts, and develop a system for treating the St. Louis tunnel discharge. Along with these five priorities, there was one main point from the conversation that should be kept in mind while continuing to work with the community; they want to maintain the current atmosphere of the town in respect to the way the town operates and the way the people within the town interact with one another. It is a small town, and they want to maintain that "small town feel" as Rico develops.

Environmental Overview

The primary focus of the work done this semester was to review the sustainability of the town of Rico. The class was divided into three teams: Environmental, Social, and Economic. Each team was tasked with reviewing the sustainability of Rico as it pertains to their group. As the environmental team, we primarily researched the environmental concerns of the past mining activities in and around the community. The abandonment of the mines resulted in a lot of land area in which environmental cleanup is necessary. Typically in environmental cleanup efforts,

[1]

the party responsible for creating the hazard must pay for the clean up of the area which was disturbed by their activities. In the case of Rico, a lot of the miners left the area and went broke, so there was no money from the mine owners and operators available to help in these efforts. This has left the burden of the environmental problems on the community.

The primary areas of concern we were able to identify were the potential lead contamination, the tailings piles, the underground workings of the mines, the acid mine discharge (AMD), and the town septic system. There have been studies performed on the lead contamination. These studies have indicated that the lead levels measured are not as toxic as once believe.[2] These reports are available on the Rico website. Although these reports indicate these findings, there is still the potential for additional lead problems to stem from the long undisturbed mining claims and mine wastes.

The extent of the tailings pile and underground mine concerns have not fully been determined. As part of ongoing cleanup efforts by the town, these areas are being identified and treated, but due to limited funding, this has been a slow process. The AMD is a problem and is contaminating the local streams, which eventually feed into the Dolores River. The primary source identified is the discharge form the St. Louis tunnel. It is estimated the amount of AMD from this single discharge is accounting for approximately 85% of the AMD being detected in the local watersheds.

All of the residents in the town are currently on septic systems. It was indicated in our meeting with the town representative from Rico that it is believed some of the septic systems are leaking into mine shafts and mine borings. This has not been confirmed, and there was not

[2] http://www.ricocolorado.org/gov/lead.htm

further information available on this which was found as part of this course. This is an environmental concern that stresses the town need for a proper sanitary sewer system.

In its current state, Rico could be considered environmentally sustainable based on the fact that there is currently no new activity resulting in environmental concerns. Also, there are currently cleanup efforts in process which are creating a better environmental situation for Rico.

Overview of Environmental Sustainability

The three primary dimensions of sustainability are economic, environmental, and social, and are all used "to gauge the success of a particular development program or project."[3] These three dimensions are deeply integrated and should not be thought of as separate dimensions when looking at sustainability, they must all achieve a balance. All three must be taken into account when considering a project and continue throughout the project's development and future operations. Environmental sustainability is probably the most common dimension of sustainability observers think about when concerned with this subject. It has been an increasingly present topic in media, including the news and Internet, as well as politics on both the local and global level. An Introduction to Sustainable Development states the "ecological approach: maintain the resilience and robustness of biological and physical systems"[4] as a description of environmental sustainability. Furthermore, the director of Green Innovations, Philip Sutton, defines environmental sustainability as "the ability to maintain the qualities that are valued in the physical environment."[5] In 1980, the International Union for Conservation of

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[3] Peter P. Rogers, Kazi F. Jalal, and John A. Boyd, eds., *An Introduction to Sustainable Development* (London: Earthscan, 2008), 42.

[4] Ibid., 44.

[5] Philip Sutton, "A perspective on environmental sustainability? A paper for the Victorian Commissioner for Environmental Sustainability," Commissioner for Environmental Sustainability, Victoria, http://www.ces.vic.gov.au/ces/wcmn301.nsf/childdocs/-441BB07721D61152CA256F250028C5FB?open, visited April 18, 2009.

Nature (IUCN), the World Wildlife Fund (WWF), and The United Nations Environmental Programme (UNEP), proposed three objectives of living resource conservation, which in essence defines sustainable development. They are "to maintain essential ecological processes and life-support systems, to preserve genetic diversity, and to ensure the sustainable utilization of species and ecosystems."[6] Furthermore, in a 1991 report, Caring for the Earth: A Strategy for Sustainable Living, by the same organizations, define sustainable development as "improving the quality of human life while living within the carrying capacity of supporting ecosystems."[7] There are many definitions of sustainable development or even environmental sustainability; all include an environmental aspect in terms of protecting the ecological systems of the present and maintaining or improving them for future generations.

There are numerous challenges in maintaining the environment, or environmental sustainability. Some everyday items that increase pressure on the environment include but are not limited to, transportation, natural disasters, economic activities, domestic and industrial waste, population changes, climate change, land development, and pollution. When considering a development project or even reconstruction, the short, medium, and long-term effects must be taken into account. A project may seem very sustainable in the near future, but in the long run may pose grave threats such as degradation of the environment, or depletion of natural resources. Philip Sutton describes a comprehensive environmental sustainability program as including

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[6] IUCN, UNEP, and WWF, *World Conservation Strategy: Living Resource Conservation for Sustainable Development* (Switzerland: UNEP, 1980), http://data.iucn.org/dbtw-wpd/edocs/WCS-004.pdf, executive summary.

[7] IUCN, UNEP, and WWF, *Caring for the Earth: A strategy for Sustainable Living*, (Switzerland: IUCN, 1991), http://data.iucn.org/dbtw-wpd/exec/dbtwpub.dll?AC=GET_RECORD&XC=/dbtw-wpd/exec/dbtwpub.dll&BU=http%3A%2F%2Fdata.iucn.org%2Fdbtw-wpd%2Fcommande%2Findex_newsite.htm&TN=iucn&SN=AUTO15460&SE=1543&RN=3&MR=20&TR=0&TX=1000&ES=0&CS=1&XP=&RF=WebRes&EF=&DF=WebAff&RL=0&EL=0&DL=0&NP=254&ID=&MF=&MQ=&TI=0&DT=&ST=0&IR=886&NR=0&NB=0&SV=0&BG=&FG=&QS=&OEX=ISO-8859-1&OEH=ISO-8859-1, visited April 18, 2009, 10.

"actions to prevent threats and impacts from arising, actions to protect the environment form threats and damage, and restoration to reverse damage already done."[8]

Rico, Colorado is a unique, small town with a population that values the physical environment that they currently live in. As the community strives to make the town more sustainable, they also want to maintain and enhance the natural beauty of the surrounding areas and ecosystems that they live within as well as increase the quality of life of all present and future community members. Past mining activities did not take into account sustainable operations, so the town must now deal with the actions and results of the past as well as look toward the future. This section will focus on the environmental sustainability of Rico, Colorado, specifically concentrating on the previously mentioned five priorities.

Environmental States of Rico

Past and Present Condition of the Environment

The former mining industry in the Rico Region has provided a rich cultural history but has also left behind a legacy of environmental damage. Impacts from previous mining activities include mill tailings, mine dumps, shafts and tunnels, water quality degradation and soils with lead contamination. The history of mining has a legacy of water quality impacts and soils contaminated with high concentrations of lead. For example, Depot Park is the area that is centrally located, already impacted by past mining and rail road activities, and adjacent to road access to West Rico. The process for lead clean up in the soil still on going process in Rico. The

[8] Philip Sutton, "A perspective on environmental sustainability? A paper for the Victorian Commissioner for Environmental Sustainability."

latest data about the lead contamination and the mining waste zone as shown in the following figures:[9]

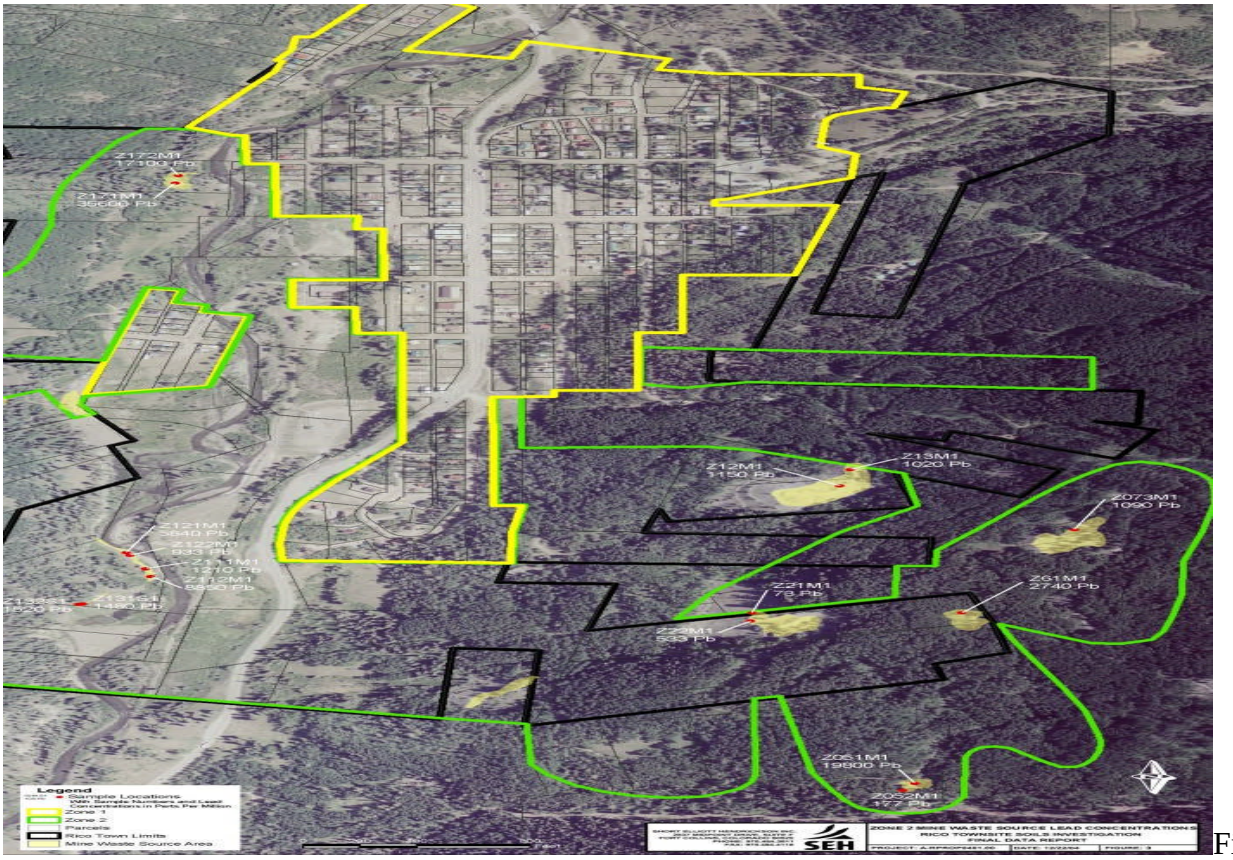
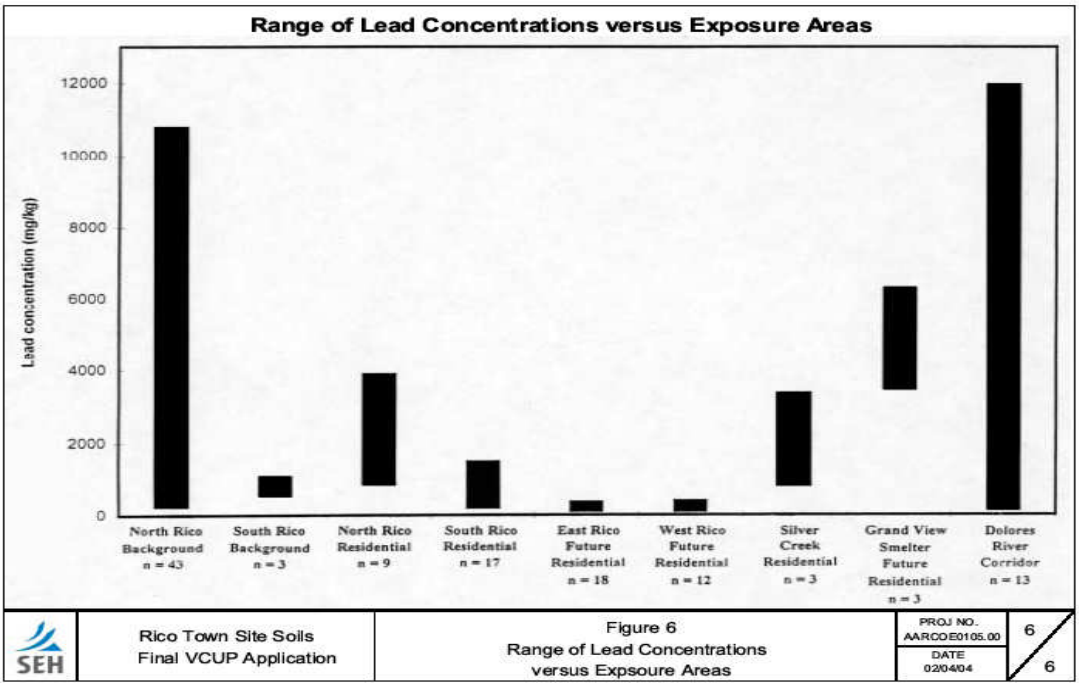


Figure 1 Mining waste zone source of lead concentration

[9] http://www.ricocolorado.org/gov/lead.htm



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igure 2 Range of lead concentrations versus exposures areas

Land contamination of animal waste in Rico also exists. Cattle increased by 40% from 1987 to 2007. Total animals increased by 39% from 1987 to 2007[10].

The real nature, historic mining town and hot springs of Rico are another aspect that should be sustained. Scenic surroundings and the beauty of nature from spring bloom, to fall colors, and winter's frozen recreation are the environmental issues that could make Rico a sustainable city in the future. Post ski hot tub (the steam from the local hot springs near Rico), tracking deer and skiing at all the surrounding areas and great for the peace and the proximity to all things outdoors are some of the best parts of Rico fantastic environment. Municipal hot spring is the area around the existing water tank can be used as hot springs through the thermal mineral water.

[10] http://www.ricocolorado.org/gov/lead.htm

There is an organization such as Green Rico Organization (GRO) that has events planned for the winter annually. GRO is hoping to organize and host a sustainable living conference in Rico. This event will bring together organic growers, natural builders, environmental educators and any other pertinent movers and shakers in the sustainable living field to learn, share and move the ball forward. ARCO reclamation site is as a part of a mill site reclamation effort, the ARCO mining company constructed a small community parking area and picnic shelter. Another organization is Rico Renaissance, a group of local and out-of-state investors, bought all of the old mining claims around town in 1994 in the hope of developing an economically viable community.[11]

Another example of good sustainable effort for maintaining Rico environment is Rico River Park that is the site which has a plan for possible visitor parking and trail access point for the Rico River Park river trail. Possible forest service interpretive site & pedestrian bridge across Silver Creek is under ongoing development. Another one is Rico has an annual green celebration called Rico Peace Garden festival since 2005 and this festival attracts many people from outside Rico to come and see the festival and makes it a good promotion for the town.

Another effort of sustainability of the present Rico environment is some residents have raised $20,000 to develop a large greenhouse, called Roots in Rico, on the river corridor. To be built in the next three to five years, the greenhouse would provide fresh organic greens to residents in the winter. Also in September 2005, residents approved the construction of a town-wide sewer system.[12]

Environmental Goals

[11] http://www.ricocolorado.org/gov/lead/2004-03-01_newsletter.htm

[12] Ibid.

As mentioned previously, after meeting with the town representatives of Rico, the class prioritized the goals of the town. There are many components to each of these goals. Each group, the Environmental, Social, and Economic, are all assessing these items as they pertain to the work their respective group has done this semester. The information offered on these items below will focus on the environmental aspects.

Sanitary Sewer and Water System

The sanitary sewer and water systems are important for Rico to develop. In order for a town to grow and become a sustainable community, proper infrastructure is required. The town is currently on septic systems and the water systems only has the capacity for about twenty more domestic water taps than what it currently supports. Environmentally the septic systems are proven to pose a threat to groundwater, due to contamination of nitrates, phosphates, bacteria or viruses.[13]

The sanitary sewer system has environmental benefits for the town. As previously stated, there is a belief that the septic systems are currently leaking into old mine workings including exploratory borings, mine shafts, and fractures in the rock. Some studies for wastewater management and water system are in the process, and is planned to be sponsored by a company that shows interest in investing in Rico.

There are many environmental aspects to constructing this type of system. These include the wastewater treatment system, the impact during and after construction, and the removal of the existing septic systems. The town does have engineering plans for the treatment system and

[13] Hammond, Cecil and Tyson, Tony. 1999. Septic Tank Design and Construction. University of Georgia. Accessed via www.scribd.com April 20, 2009

some portion of the mainline system, and they are expecting some funding necessary to construct this system.

The largest environmental concern in developing a larger portable water system seems to be the availability of water sources for domestic use. A lot of the fresh water in both the streams and aquifers are contaminated due to the AMD. The water system needs to be expanded, but also more sources of clean water need to become available. Still, groundwater contamination of the Dolores River is a concern that needs to be addressed as stated in the town's Master Plan. Some possible options of the water cleanup are described in the "Geothermal Development" and "Mine Cleanup" section of this document.

As stated by Daigger (2000) in the 21st century it is important to view wastewater management and clean water systems as a whole integrated system. Speaking from the point of view of his profession, it is about management of water, therefore managing the water supply and wastewater. The only way to have a community sustainable in maintaining a system like such is to develop improved approaches according to the resource-constrained environment they live in.[14]

Along with the tools and research that have already been developed by the town, i.e. Rico Sewer System Preliminary Environmental Report (PER) and plans for what is going to be developed i.e. PER for the Rico Water System, new knowledge of various resources for these projects can be researched on the EPA website: http://www.epa.gov/OWM/mab/smcomm/tools.htm.

Among these tools, there are the Asset Management and Vulnerability Assessment, Financial Analysis and Funding Resources, Information Management and Planning New

[14] Daigger, Glen. 2007. Wastewater Management in the 21st Century. Simon W. Freese Environmental Engineering Lecture, Journal of Environmental Engineering ASCE July 2007. Accessed via www.EBSCOhost.com April 19, 2009.

Facilities.[15] Further as a precaution to Rico, for the use of TIF or Tax Increment Funding as a funding mechanism for these projects, TIF is criticized by Markarian (2007). The research on Vermont's growth center wastewater projects; which consists of municipalities that originally do not have the wastewater treatment capacity -similar to Rico- has shown that: (1) to obtain a TIF debt, a town will still need to provide a security pledge, thus eventually giving additional burden to the existing tax base and (2) the use of TIF is not practical given the extensive process to establish a TIF district. Finally, it is best to thoroughly research regional and state repercussions on utilizing TIF due to use of state property tax revenues.[16] As an alternative, the following rovides information on Clean Water Revolving State Fund (CWRSF) and Drinking Water Revolving State Fund (DWRSF): http://www.epa.gov/ow/funding.html.[17]

Social Infrastructure

Social infrastructure is an extremely important aspect to the future development of Rico that can be seen in Appendix A. The panel's answer to the classes questions reveal that a medical clinic, day care, recreational facilities, school expansion, and a community center are a few of the structures and programs that would be welcomed in the community and would help the community become sustainable. Environmental sustainability in respect to the development of the social infrastructure for Rico would need to be taken into account during the development and construction stages of the desired facilities as well as future operations.

[15] http://www.epa.gov/OWM/mab/smcomm/tools.htm
[16] Markarian, Molly. 2007. Flushing Sprawl Down the Drain: Is TIF an Option for Vermont Growth Center Wastewater Projects? Massachusetts Institute of Technology. Accessed via www.scribd.com April 20, 2009.
[17] http://www.epa.gov/ow/funding.html

Some environmental concerns in the development projects include but are not limited to: the increased transportation during construction, the pollution during construction, the land disturbance, the additional population in Rico, and the increased population load on the local environment. The potential hazards during the construction activities would be outweighed by the finished product and the added social benefit to the town in the long run. The addition of social programs combined with the construction of affordable housing could result in a population increase as the community becomes more attractive.

Rico does not currently have the capacity to absorb a large increase in population, but the attempt to cleanup mine sites and trade lands with the federal government may make this a future possibility. The estimate of the maximum capacity of Rico is 2000 people. The available land for development is restricted by the topography of the San Juan Mountains surrounding Rico. In order to meet the goals of environmental sustainability, the development will have to consider items such as waste minimization, land and building reuse, ecosystem impacts, and may other items. Additionally, capital costs of developing energy efficient, "green" solutions should be considered into the design, construction, and operation of these facilities during the project planning, which could be used in assisting education of the community and be also considered a social aspect of the development.

Environmental Concerns for Geothermal Development

Rico has a great potential for geothermal development but careful consideration should be addressed for geothermal application in Rico especially for environmental aspects. There are two main considerations of environmental aspects in geothermal application of Rico as described below:

Geologic Affects and Considerations

There are some effects and implication from the geology point of view related environment when geothermal is applied in Rico geologic condition. Two considerations are in focus that is consideration when designing a geothermal system and the effects on locality as described below:[18]

1. Considerations when designing a geothermal system. This consideration is related to depth to constant temperature, depth of ground water, depth to bedrock at locality, type of soil and/or bedrock at locality, lot area (surface area that can be disturbed) and the potential geologic hazards. Particularly for type of soil, there are two main parts that should be taken into consideration which are soil and rock type that may affect the length of pipe needed and the stability of the soil structure. Potential geologic hazards that could happen due to the in accurate well drilling point may contribute great impact to the environment such as the movement (faulting, landslide or creep) and in turn may rupture the pipes itself. Also there could be a seismic activity if the piping design is inappropriate and cross the geologic faults.
2. Effects on locality mean that the drilling should be done from inside the structure (basement) and also for the trenching; it should be prepared for the appearance of a significant disturbance in a short period of time but for vertical boring done outside structure there is only a minimal surface disturbance for short period of time. After the geothermal system is finished take a careful look again about a visible signs of potential for erosion. The erosion potential could exist if trenches are not back filled properly and there may be minimal subsidence.

[18] DOE, 1990. Renewable Energy Excursion: Supporting Analysis for the National Energy Strategy. U. S. Department of Energy – Energy Information Administration. December.

Groundwater Protection

Responsible protection of groundwater aquifers must be a priority. Improperly designed or installed boreholes or water wells can result in environmental impacts to groundwater aquifers. For closed-loop vertical boreholes it is important to properly install a grout seal in the borehole annulus to prevent the borehole from becoming a conduit for migration of groundwater from one zone to another or for contaminants to migrate into groundwater. To act as an effective thermal transmission medium and as an effective environmental seal, grouting must conform to guidelines issued by the International Ground Source Heat Pump Association in conjunction with the National Groundwater Association at the particular country.[19]

Ground water and piping concerns are some of the most factors that should be taken into serious consideration when designing a geothermal system. A potential leaks may cause contamination to ground water. This leaking process is caused by the degradation of the pipe. The leaking could be also caused by the inner pipe corrosion problem and in turn may cause corroded pipe line contaminates the heat water and the surrounding area of the pipe line including the groundwater.

Piping system design consideration

The metallic pipe can cause an external corrosion if the pipe is direct buried in the ground and also the expansion/contraction along the piping system must be considered. For the piping system copper pipes usually attacked by H2S and solder line to connect the pipe are the most part that can be corroded by the soil. To avoid the corrosion that which in turn will harm the environment the non-metallic pipes are used but the problem is those pipes can only resist to

[19] Field Tests for Ground Thermal Properties – Methods and Impact on Ground Source Heat Pump Design; Kavanaugh, S.P., 2000, ASHRAE Transactions, 106 (1): 851-855.

accept <200°F. Materials such as plastics are successful in resisting most of the corrosion and, therefore, can be used in some applications. Unfortunately, plastics are good insulators and cannot be used for heat exchangers. Another problem with plastics is that some are easily deformed under increased pressures and, therefore, are not suitable for pressure applications[20]. The use of asbestos cement to hold the pipes for the piping system can cause environmental damage for surrounding environment due to internal and external corrosion such as pitting corrosion.

General recommendations for the installation of a geothermal pipe system include:[21]

1. Carefully choose the type and location of the system. The geothermal should be isolated from wells and potential sources of contamination. Check local ordinances for any specific requirements;
2. Hire only qualified and experienced contractors. It is recommended that the contractor be certified by the International Ground Source Heat Pump Association (IGSHPA). Ask for customer references;
3. Use only proper materials, testing methods and procedures to install the systems. It is recommended that IGSHPA standards are followed;
4. Maintain, monitor and periodically inspect the system; and
5. Record the locations and construction details of the underground portions of geothermal systems.

Antifreeze Selection

[20] Geothermal Heat Pump Systems; Applications and Technology Development (1007397). Final Report, Electric Power Research Institute, October 2003.
[21] http://www.epa.gov/ow/funding.html

When installers connect sections of pipe, they heat fuse the joints, making the connections stronger than the pipe itself. The fluid in the loop is water or an environmentally safe antifreeze solution that circulate through the pipes in a closed system. The burial depth, type of soil, horizontal, vertical, or submerged ground loops and geographic location all impact whether or not antifreeze protection will be needed in the ground loop fluid. Water alone is the most preferred choice for a closed ground loop system circulating fluid, as it poses no environmental hazard.

Solar thermal collectors almost always use propylene glycol for both antifreeze and anti boiling protection, whereas methanol is the preferred antifreeze additive for closed ground loops, where environmental and health regulations permit its use. Three types of antifreeze commonly used for geothermal applications are[22]: Methanol, Ethanol, and Propylene glycol explained in the following paragraph.

Methanol is toxic and flammable. For environmental reasons, it has been banned for geothermal use in some jurisdictions. It has more favorable pumping properties and heat transfer properties than the other choices. Ethanol has much lower human toxicity than methanol, although its environmental toxicity is not necessarily low depending on receptors and available exposure pathways. Like methanol, ethanol is flammable. Ethanol pumping properties are poor compared to methanol.

Propylene glycol in its pure form (i.e., without inhibitors) is a food grade type of glycol and is often used as a food additive. It has low human and low environmental toxicity and has the added benefit of low flammability. The viscosity of propylene glycol (which governs

[22] Ground-Source Heat Pumps; Design of Geothermal Systems for Commercial and Institutional Buildings. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE), S.P. Kavanaugh and K. Rafferty, 1997.

pumping properties) is similar to ethanol. Thermal exchange properties of propylene glycol are slightly lower than methanol or ethanol.

Inhibitor agents are often added to antifreeze products to reduce corrosion and to create a more stable solution. Inhibitors should be selected based on heat pump manufacturer recommendations and other criteria. Note that some inhibitor agents may be toxic.

Environmental Impacts of Metal Mining and Mitigation Plan

Some of the most common environmental concerns associated with metal mining operations are the physical disturbances to the landscape, the waste rock disposal, the development of metal-bearing and acidic soils and waters, and the public safety.

The largest physical disturbances and visual/aesthetic impacts at a mine site are the actual mine workings, such as open pits and the associated waste rock disposal areas. These impacts remain on the landscape until the disturbed areas are stabilized and reclaimed for other uses, such as wildlife habitat or recreation areas, after mining has ceased. Underground mining generally results in relatively small waste rock disposal areas ranging from a few acres in size to tens of acres (0.1 km ^{2}). Some waste rock areas, if not properly managed, can be sources of significant environmental impacts, such as stream sedimentation due to erosion, or the development of acidic water containing metals. Open pit mining disturbs larger areas than underground mining, and thus results in larger visual and physical impacts. As the amount of waste rock in open pit mines is commonly two to three times the amount of ore produced, tremendous volumes of waste rock are removed from the pits and deposited in areas nearby.

Waste rock disposal is not only a visual impact but has various other concerns associated with it. Although the waste rock may contain metals, such as lead, zinc, copper, or silver, the rock is still considered a waste, because the cost to process it would exceed the value of the

metals it contains. If not properly managed, erosion of mineralized waste rock into surface drainages may lead to concentrations of metals in stream sediments. This situation can be potentially harmful, particularly if the metals are in a chemical form that allows them to be easily released from the sediments into stream waters. When this occurs, the metals are considered to be “mobilized” and “bioavailable” in the environment. In some cases, bioavailable metals are absorbed by plants and animals, causing detrimental effects.

Although the character of waste rock varies with the type of ore, many waste rocks contain sulfide minerals associated with metals, such as lead, zinc, copper, silver, or cadmium. An important sulfide mineral common in waste rock is pyrite, iron sulfide (FeS2). When pyrite is exposed to air and water, it undergoes a chemical reaction called “oxidation.” Oxidation of pyrite results in the formation of iron oxides that typically impart an orange or red “rust” color to waste rock. The oxidation process, which is enhanced by bacterial action, also produces acidic conditions that can inhibit plant growth at the surface of a waste pile. Bare, non-vegetated, orange-colored surface materials make some waste rock areas highly visible, and they are the most obvious result of these acidic conditions. If water infiltrates into pyrite-laden waste rock, the resulting oxidation can acidify the water, enabling it to dissolve metals such as copper, zinc, and silver.

This production of acidic water is commonly referred to as “acid rock drainage.” If acid rock drainage is not prevented from occurring, and if it is left uncontrolled, the resulting acidic and metal-bearing water may drain into and contaminate streams or migrate into the local groundwater. The acidity of contaminated groundwater may become neutralized as it moves through soils and rocks. However, significant levels of dissolved constituents can remain, inhibiting its use for drinking water or irrigation. Where acid rock drainage occurs, the

dissolution and subsequent mobilization of metals into surface and groundwater is probably the most significant environmental impact associated with metallic sulfide mineral mining. Acidic and metal-bearing groundwater occurs in abandoned underground mine workings and deeper surface excavations that encounter the groundwater of a mineralized area. Because they are usually located at or below the water table, underground mines act as a type of well which keeps filling with water.

Removal and treatment of this accumulated water in underground mines must be continuous in order to conduct operations. However, after mining ceases, the mine workings will fill up with water and some of the water may discharge to the surface through mine openings. Because these waters migrate through underground mine workings before discharging, they interact with the minerals and rocks exposed in the mine.

If sulfide minerals are present in these rocks, especially pyrite, the sulfides can oxidize and cause acid rock drainage. If left unmanaged, significant volumes of acid rock drainage can form at large mine preventing and treating acid rock drainage from mine workings is a key environmental challenge. Treating these workings, which can degrade the quality of surface waters into which it flows. Discharge at the source is typically more cost effective than treating it a water treatment facility.

Old mining sites are inherently interesting to people, but potentially dangerous as well. They may have surface pits, exposed or hidden entrances to underground workings, or old intriguing buildings. Another safety consideration at some mine sites is ground sinking or “subsidence.” The ground may sink gradually where underground workings have come close to

the surface. Because an unexpected collapse can occur without warning, such areas usually are identified and should be avoided.[23]

Mine Clean-up

The former mining activities such as gold, silver, lead, and zinc in the Rico region resulted in environmental disturbance from such items as mill tailings, mine dumps, shafts, tunnels, water quality degradation and soils with high lead contamination. There are some sources of water contamination in the Rico region, for example, old mining shafts, exploratory boring holes, and the St. Louis Tunnel, etc. Especially, the residents feel considerable concern about contamination of the Dolores River and Silver Creek by the discharge from the Saint Louis Tunnel. Rico has been granted from EPA funds to improve the sewer or a new water supply and distribution. But the cleanup needs to progress constantly and successively for a long period. As a result of the disturbances, cleanup procedures are necessary to prevent and alleviate further contamination. The major potential environmental impacts associated with metal production, mining plus associated mineral processing operations, are related to erosion, soil, water, and air quality. Environmentally the cleanup measures may include the items such as reclamation, soil treatment, and water treatment.

Reclamation entails the re-establishing of viable soils and vegetation at mine waste rock and tailings. The simple approach is adding lime or other materials that will neutralize acidity plus. After the soils is deemed neutral, a cover of top soil or suitable growth medium to promote vegetation growth. Modifying slopes and other surfaces in addition to planting vegetation as part of the process helps to stabilize the soil material and prevents erosion from surface water runoff.

[23] Metal mining and the environment by American Geological Institute (Travis L. Hudson, Frederick D. Fox, and Geoffrey S. Plumlee)

Promising reclamation options in the future may include using sewage sludge or bio-solids as an organic soil amendment and growing plant species that are more tolerant of acidic conditions. Soil treatment is the handling of contaminated soils from the mine operations. A common approach used in dealing with contaminated soil is to move it to specially designed repositories. This approach can be very expensive and controversial, but it is sometimes required. More effective soil treatment approaches may include following: using chemical methods to stabilize metals in soils, making them less mobile and biologically available, using bacteriacides that stop the bacterial growth that promotes the oxidation of pyrite and the accompanying formation of sulfuric acid, using bioliners, such as low permeability and compacted manure, as barriers at the base of waste piles.

Water treatment is needed when water discharges from the mine site are determined to be environmentally hazardous. The most common treatment for acidic and metal-bearing waters is the addition of a neutralizing material, such as lime, to reduce the acidity. This active treatment process, which causes the dissolved metals to precipitate from the water, usually requires the construction of a treatment facility. The ongoing maintenance that such a plant requires makes this treatment technique very expensive. Aside from the expense, some active treatment plants generate large amounts of sludge. Disposal of the sludge is a major problem. Because of the cost and the physical challenges of dealing with sludge, alternatives to active treatment facilities are needed. Some possible alternatives include the following: (1) Using passive wetland systems to treat metal-bearing water. This approach will be successfully used where the volumes and acidity of the water are not too great. Passive wetland systems have the added advantage of creating desirable wildlife habitat; (2) Using in-situ treatment zones where reactive materials or electric

currents are placed in the subsurface so that water passing through them would be treated, and (3) Combining treatment with the recovery of useful materials from contaminated water.

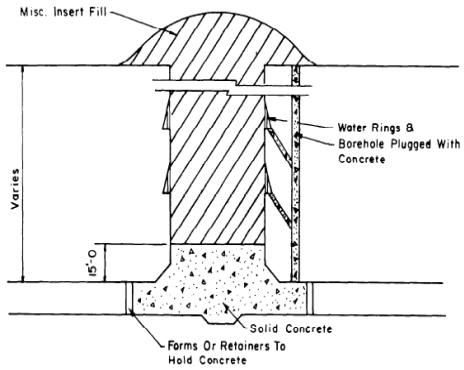
Another consideration is sealing of underground openings, in which the following parameters should be considered in sealing shafts: (1) Eliminate any danger to the health and safety of the general public, (2) Control release of hazardous, acid/toxic-forming materials or gases to the atmosphere, and (3) Control the movement of underground water or hydrologic communication.

Before a sealing method is selected, the degree of mine closure must be determined. Potential future geologic or economic value, historic value, hazards, and costs must be considered.

The different degrees of mine seals can be considered as follows: (1) Permanent, A safeguard that would completely seal off abandoned workings and would preclude the rehabilitation and future access to the mine. This would be the case if all the ore reserve has been mined or economics dictate that future profitable operation is not deemed probable, (2) Temporary, Seals that prevent deliberate or accidental entry into a working mine while preserving the general condition of the opening for future use. If there is some potential future value that can be gained by maintaining an opening to the mine, then this type of closure method should be used. Methods employed are fencing around shafts, glory holes, audits, or drifts, locked doors for adits, drifts, or slopes, and concrete covers for shafts, and (3) Semi-Permanent: A system of seals that completely seals or otherwise blocks an opening while maintaining the general integrity of the opening. Future access to the workings may be desirable. This method should be employed when there is future economic value, but by employing only the temporary method of closing the opening, a threat to the public may exist such as emission of radon or other gases.

Hydraulic sealing methods are depicted below (Figure 3) and others are: Dry seals can be used to close slopes, drifts, and adits when there is no hydraulic head anticipated at the mine opening.

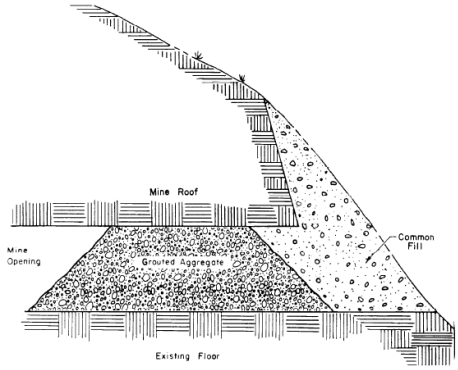
When the opening is accessible, a concrete wall is often constructed inside the 25-ft (8-m) zone and backfilled. Aggregate can be pumped pneumatically through a pipeline from a location accessible to large equipment to the inaccessible mine opening that is to be sealed. If necessary, the aggregate can also be injected with a grout. Wet seals are can be used at locations where a hydraulic head is anticipated. A variation of a wet seal that is meant to keep air from entering the mine is called an air seal. These can be constructed at mines where an attempt is being made to limit the oxygen content of the mine atmosphere and thereby limit acidic water production.[24]



-Hydraulic shaft seal -

(Conversion factors: 1in. =25.4 mm,

1ft. = 0.3048 m)



-Hydraulic seal of an adit or drift using

grouted aggregate -

Figure 3 Hydraulic seal

Note: Current EPA regulations require that all mine water discharges be within acceptable limits. The limits vary according to mine type. After mine closure, mining companies have been required to continue to treat the mine discharge unless it meets the effluent discharge limitations. To eliminate treatment cost and to improve the environment, hydraulic seals have been designed and installed to act as dams and eliminate water discharge.

St. Louis Discharge

[24] Mining engineering handbook by Thomas A. Gray and Richard E. Gray (Mine closure, sealing, and abandonment)

The St. Louis discharge accounts for an estimated 85% of the water contamination in the local stream near Rico. This discharge eventually outfalls into the Dolores River. At this time, we are unaware of a study detailing this information, but based on the conversation with the representatives of Rico, there seems to be something available. This should be further discussed and researched to see what the extent to the contamination actually is.

It was indicated in our meeting with Rico that a treatment system was in place in the past. The system was described as a series of settling ponds. It is our understanding that one of the dam embankments failed and the system was breeched and destroyed by erosion as a result thereof. A new system is desired by the town, but financing for research and development prohibits this from happening. The treatment of this discharge may be an option for expanding the available clean water supply. More detailed information about the treatment of mine discharge was described previously in this report.

Way Ahead

One of the most difficult items we have been tasked with is to assist in the transition form this course to future classes so that they can continue where we have left off and not start over in researching Rico. For this task, we have prepared the information above and would also like to present conclusions to the report.

In its current state, Rico could be considered environmentally sustainable. This is based on the fact that the current activities surrounding Rico are not are not adding any burdens to the ecosystem. Also, the current activities of the town are actually improving the environmental condition.

Rico has many goals in mind and all have some environmental impacts. Rico wants to allow development of both the community and infrastructure, but the sentiment was that mine

development would not be allowed. There are mining companies with interest in the area, but the people of Rico are skeptical to allow mining to begin based on the results delivered by the previous mining operations.

The people of Rico have been good to work with, and hopefully the relationship between CSM and Rico can continue and Rico can reach its goal of becoming a sustainability community. A final thing to pass along and to keep in mind is that it will likely take many years for the development and expansion of Rico to begin so whichever students have to opportunity to continue this project need to set small goals for their progress with Rico and not get to ambitious to make giant steps forward in one semester as development planning and funding can take years to accomplish.

Chapter 3

Social Sustainability

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Introduction

Social sustainability is a philosophy and a framework integrated with economic vitality and environmental quality. Simply put, its philosophy is meeting the needs of one's community now without compromising the ability to meet the needs of future communities and its framework reflects the values of the community. The following is a summary of essential social dimensions that comprise a sustainable social environment.

Social sustainability:

- meets basic needs: for food, shelter, education, work, income, safe living and working conditions;
- is equitable: ensures that the benefits of development are distributed fairly across society;
- enhances, or at least does not impair, the physical, mental and social well-being of the population;
- promotes education, creativity and the development of human potential for the whole population;
- preserves our cultural and biological heritage, thus strengthening our sense of connectedness to our history and environment;
- promotes conviviality, with people living together harmoniously and in mutual support of each other;
- is democratic, promoting citizen participation and involvement.

A socially sustainable community must have the ability to maintain and build on its own resources and have the resiliency to prevent and/or address problems in the future. There are two types or levels of resources in the community that are available to build social sustainability:

individual or human capacity, and social or community capacity. Individual or human capacity refers to the attributes and resources that individuals can contribute to their own well being and to the well being of the community. Such resources include education, skills, health, values and leadership. Social or community capacity is defined as the relationships, networks and norms that facilitate collective action taken to improve upon quality of life and to ensure that such improvements are sustainable. To be effective and sustainable, both these individual and community resources need to be developed and used within the context of four guiding principles - equity, social inclusion and interaction, security, and adaptability. Rico representatives propose that this definition be adopted as the basis of our work towards the town fulfilling its sustainability goals.[1]

Addressing these principles require both horizontal and vertical considerations. For example, if Rico decides the best course of action is to implement a geothermal facility to increase energy savings and their local economy; it is important to consider that no matter how new technology is introduced it still has the ability to change a community's socio-political fabric. With this in mind, it is crucial for Rico to marry their economic well being and their identity as a small mountain community. Cultural conceptions of identity are profoundly influenced by the fabric of one's political economy. What is the community's political economic ideology? Do they want to be a sustained competitive entity in the global market? Or do they desire a sustained locally based communal economy? Either way, if the community wants a market-based economy then diversifying local commodities ensures community cohesiveness in case of economic downturns in one or two industries.[2]

[1] Peter P. Rogers, Kazi F. Jalal, & John A. Boyd, "***An introduction to Sustainable Development.***" (UK: Earthscan, 2008) 219-257.
[2] Ibid., 219-257.

In the case of Rico several key considerations must be examined to develop social sustainability. The following section details Rico's demographics to help determined their environment and capabilities. The statistics are followed by discussion of social sustainability as outlined by the town's leadership. Rico's infrastructure priorities are based on a questioner and open discussion with Rico's officials. Rico's social infrastructure requires financial support; therefore alternative solutions and strategies are offered at the end of this section.

Rico's Demographics

As of 2009, Rico's population was 246 people with 124 households. The average size of household is 1.91 people. Approximately 57.35 percent of the people are male and 42.65 percent are female. The population density is 314 people per square mile. The median age is 37.7, which is similar to that of the USA, 37.6. According to state statistics 42.39 percent of the people in the town are married and 12.17 percent are divorced. The racial makeup of Rico was 92.51 percent white, 0.00 percent Africa American, 2.55 percent Asian, 3.43 percent Native American, and 0.86 percent other races. Approximately 3.41 percent of the total population is Hispanic ethnicity. Most of the local residents have been living in the town for many years and in some cases for many generations. The town enjoys the small community environment that makes the town unique and peaceful. The town's population increases during summertime when most of the vacation homes are occupied.

Health

There is no physician in the town in comparison with 169.7 physicians per 100K in the USA. The lack of a physician in town makes the town unable to meet basic needs of sustainability; nevertheless the town residents commute to other areas for health care. According to the Environmental Protection Agency (EPA), the air quality in Rico, which is based on ozone

lert days and number of pollutants in the air, marks 94 on a one hundred scale (higher is better). Water quality is 60 on the scale compared to the rest of the country, which are 55. Superfund index also high, marking 98 on a scale to 100 (higher is better).

Economy

The median income for household in Rico records $47,095 and the income per capita is $28,877, which includes all adults and children. Among the most common occupations in the town are 30.52 percent in construction, extraction, and maintenance occupations, followed by 21.43 percent in sales and office occupations. Approximately 16.23 percent of the employment is in service and 11.69 percent professional and related occupations. Rico has an unemployment rate of 13.80 percent with recent job growth of -27.20 percent and future job growth over the next ten years of -28.20 percent, compared to the national unemployment rate 4.60 percent with recent job growth rate 1.40 percent and future job growth rate 11.90 percent. Many local residents are employed in Telluride.

Housing

The median home value records $187,110. Renters account for 23.11 percent of the total population. Approximately 45.51 percent of houses and apartments are vacant during the winter. Most of the vacant houses belong to owners who only visit the town during the summer. The most common price levels of houses are between $200,000 and $299,000, which occupy 36.23 percent of the houses in the town. [3]

Cost of Living

The overall cost of living index marks 92 in comparison with the US average of 100, which means the cost of living in the town is cheaper than the US average. However, food price

[3] City-Dta.com, "Rico CO," http://www.city-data.com/city/Rico-Colorado.html, Accessed April 27, 2009.

index is 108, which exceeds the US average by 8. The cost of living in the town is often times and incentive for prospect residents.

Crime Index

The town has a low crime rate. The index for violent crime records is 1 on a scale from 1 (low crime) to 10. Violent crime comprises of four offenses: murder and manslaughter, forcible rape, robbery, and aggravated assault. The US average of violent crime is 3. However, property crime is 3 on a scale from 1 (low) to 10, which is the same degree of the USA average. Property crime includes the offenses of burglary, larceny-theft, motor vehicle theft, and arson.

Education

The number of students per teacher is 12 pupils. The School spends $5,916 per student, while the average of the nation amounts to $6,058. In Rico the school is only pre-school to 6th grade and meets only Monday thru Thursday. The town would like to have a full week of school but is currently unable to do so due to lack of teachers. The older children use the public bus system to attend junior and senior high school in Telluride (27 miles) or to Dolores (38 miles). Commuting students endure 2-hour drives each way often through treacherous road conditions. The town's day care facility is held at the local school building.

Transportation

The average one-way commute in the town takes 28 minutes during good conditions. Approximately 48 percent of commuters drive their own car alone, while 27 percent carpool with others. Additionally, bus transportation is provided from Telluride for the high school students that commute in a daily basis. The road to access the town is in fair condition, but several of the town's streets are unpaved and need work. [4]

[4] Sperling's Best places, "Rico, CO, Transportation, " http://www.bestplaces.net/city/Rico-Colorado.aspx#, Accessed April 27, 2009.

Religion

Approximately 58.02 percent of the people in the town follow a specific religion. Protestants account for 23.32 percent of these people, followed by Catholic at 16.90 percent, Methodist at 8.95 percent, and Lutheran at 8.86 percent. There are two churches in Rico, First Baptist Church of Rico and Rico Community Church.[5]

Rico Community overview

Unfortunately, many of Colorado's mining towns suffer from the "superfund" stigma and the boom/bust syndrome. For many Colorado mining towns, their main source of income is now tourist dollars. Rico like many other mining towns continues cleaning the soil, due to led contamination from previous mining operations. Having both a health risk stigma and a singular economy may affect the town and subsequently people may suffer from low cash flows. Low cash flows, traditionally impact the social aspects of the community, such as structures (health, education, jobs, etc.).

Rico, for the most part, is actively trying to avert these consequences through embracing sustainable living measures. Thus far, according to the watershed study, community members actively participated in stakeholder meetings and remediation efforts.[6] In addition, there is a very active NGO start-up called Roots in Rico that has been heading their greenhouse sustainability project and offers education classes and fundraising efforts. The town itself has a natural food store, an "eco-living" architect and developer, and homes with solar panels and bio-energy. Rico's commitment to sustainability reflects their growing awareness that action must

[5] Sperling's, "Religion," http://www.bestplaces.net/city/Rico-Colorado.aspx#, accessed April 27, 2009.
[6] Rico, CO Town Hall, "Ordinance 208-4," Water Shed protection District, http://www.ricocolorado.org/gov/documents/Ordinance_2008-4_Establishing_Watershed_Protection_District.pdf, accessed April 27, 2009.

be taken to conserve their resources and minimize negative impacts on the environment and community.

III. Rico's Priorities

During a meeting with Rico's representatives the town's objectives for social sustainability within guidelines established by their community were addressed to answer submitted questions. Several questions were put forth to Rico to pinpoint their community's needs and desires that would aid in their efforts to secure a socially sustainable future. In short, their priorities are fundamental beginning with establishing recreational facilities, Friday educational program for school kids, AA/NA meetings, medical facilities (community rural clinic), community greenhouse, and improvements to their local law enforcement (capacity, materials and training).

Currently their main town gathering places for social activities include the Rico Theater and café, firehouse, school, park, town hall, hotel, post office, gas station, and coffee shop. Rico representatives also suggested that any workshops that would address growing home business/cottage industries, avalanche training, woodworking, artist cooperative, outdoor recreation hospitality, historic tourism, fly-fishing, and alpine horticulture/greenhouse design would be very beneficial.

As was previously discussed, sustainability requires three components and four guiding principles. The three components - basic needs, individual or human capacity, and social or community capacity and the four guiding principles - equity, social inclusion and interaction, security, and adaptability -are the framework that we will work within to meet Rico's social sustainability goals. The following offers a broad framework from which the final section will base its strategies and recommendations:

1. Basic needs of residents can continue to be met through:

    - Appropriate, affordable housing, with flexibility to meet changing needs - the needs of those on low and moderate incomes, the needs of those with special circumstances such as physical and mental illness, and the needs of all as they age.
    - Appropriate, affordable health care available in the community
    - Locally produced, nutritious food that is affordable
    - Jobs that enable people to be productive and utilize their skills and abilities
    - Sufficient income for people to be able to financially support themselves and their families
    - Safe communities and workplaces

2. Individual or human capacity can be maintained and enhanced through:

    - Opportunities to develop and upgrade skills
    - A variety of local employment opportunities throughout the region
    - Opportunities to develop and make use of creativity and artistic expression
    - Appropriate, affordable formal and informal life-long learning
    - Appropriate, affordable recreation, leisure and cultural facilities and programs
    - A range of opportunities for individuals to contribute to the health and well being of the community.

3. Social or community capacity can be maintained and enhanced through:

    - Support and encouragement for community economic development
    - Community “identity” is reflective of community diversity
    - Involvement in public processes and their results, and in government
    - Opportunities and places for social interaction throughout the community

- Opportunities, resources and venues for a variety of arts, cultural and community activities
- Support and encouragement for community organizations and networks.

Recommendations

Rico's commitment to sustainability reflects their growing awareness that action must be taken to conserve their resources and minimize negative impacts on the environment and community. Social sustainability deals with complex issues such as quality of life, health, equity, livability, and social inclusion; therefore, it has significant implications for the short, medium and long-term health of its citizens. The following describes the short, medium and long-term goals. These goals were identified during a meeting between Rico's town representatives and the Colorado School of Mines Students.

Short Term 3-5 years

1. Increasing school capacity: According to recent data Dolores county as compared to the state average is experiencing a less than normal dropout rate and a higher than average rate of graduates. This is a good indicator and suggests that if Rico extended their school capacity to service up through 12th grade there would only be positive growth to those numbers. The number of current school students indicates that the volume of high school students from Rico will increase.
2. Affordable housing: for future occupants, such as workers of new projects or new residents.
3. Park and trails: the town needs recreational activities for their local population as well as for visitors.

4. Hard Infrastructure (water, sewer, roads): Current roads are in need of pavement, some households have outdated sewer utilities such as pits and old septic tanks. Current water lines and sewer are not capable of supporting new developments without further infrastructure.

Medium Term 5-15 years

1. Residential development: Affordable housing must be a consideration due to the income of the town.
2. Capitalizing on geothermal capacity (hot springs resort, geothermal district heating, geothermal power generation): it is important to note that market-based economic success does not always beget social justice (as has been shown with past mining operations), and can often sacrifice human dignity in return for economic or political gain. Social justice refers to social, economic, and political egalitarianism that includes the elimination of race and class-based partitioning, promotion of investment in human capital and inclusive decision-making. Self-determination is the view that everyone must be free to determine their political status and freely pursue their economic, social and cultural development. Dignity is the by-product of social justice and self-determination. Therefore, it is ultimately up to that community as to how they wish to shape their socio-political landscape and incorporate new technology or, at least, anticipate how the technology will affect them.
3. Water quality: Continue water cleaning is necessary due to previous contaminants

Long Term >15 years

1. Sub-surface mining: social justice. Due to previous environmental damage the community prefers to wait on any mining project. The community still has an ongoing cleaning process of the soil due to previous mining in the town.
2. Cross-country ski resort: The community would like to develop a cross country ski resort to attract more tourism.

Suggested Strategies

The town needs a source of financial support in order to develop any social project, infrastructure development or creation of new employment activities. The town does not have financial state support or local financial support to develop any projects; therefore a choice must be made to accept incoming financial support from future investing sources. As stated before the town has currently the choice of accepting mining and or geothermal developing companies. Based on the town priorities and their current status, the following strategy recommendations are suggested. There are three main priorities that should develop together: Community center, high school, and hot springs resort. These three infrastructure developments would provide a source of income, tourism attraction and social development.

The town should request investments up front for a local community center. The community center could serve as an awareness center to maintain the town informed of upcoming or projected developments in the town. Awareness of pros and cons of any incoming company may allow the town to fully support and adapt to new technology and development. Classes and workshops may not only develop awareness, but may also aid in the development of new skills for recreation, creativity and innovation. The community center may also serve as a day care center.

In absence of financial support from any company the town could be marketed for tourism. The town could hold local fests to sell the town's local produce and art. This could be done by internet advertising, word of mouth or fliers, these methods required minimum money. Fund raising is a viable option; nevertheless it would take a long time to acquire the money necessary to develop major infrastructure developments. The current and future development of organic produce could be sold in fairs and in nearby communities; this could also benefit the town and attract new business, while supporting the local economy.

The development of a local hot springs resort could be accomplished by recruiting outside investments and use of local employment. Outside investments could be from a private investor or a project company such as geothermal. The resort would bring new jobs, tourism and money for future town projects. The resort could house any visitors all year round. Funds accumulated from a hot springs resort could be used for development of future parks, trails and maintenance of local schools. A hot springs resort would promote the town and give greater outside visibility; enhancing state tourism and support. A resort could also provide financial support for regular maintenance expenses of the town.

It is known that in order to developed the above infrastructures the sewer and water infrastructure must be established, however they could be developed simultaneously with any infrastructure project. Due to lack of state funding, these projects must come from future private investments in the town. The development of any infrastructure would bring jobs during the construction cycle as well as jobs to run and maintain the resorts, geothermal plants or any other project. New infrastructure could enhance the town's social sustainability and prestige.

Allowing geothermal investments in the town could help to develop the set up for a hot springs resort. A hot springs resort could house engineers and investors during the planning and

developing phases of any short and long term projects. Geothermal engineers could also do the planning and development of the sewer lines. Future housing developments would come with any investing company because they will need a place for the employees. These projects do not need to wait more than two years, once the investments are decided the development of infrastructure should be fast in order to allow the companies to successfully establish themselves for work.

A high school needs to be built in order to retain the current population and facilitate the daily lives of current residents and future students. The infrastructure could be accomplished by either fund raising or investment of an incoming company. The current population of high school students is not large enough for the state to approve funding. However, the current amount of growing children indicates the need for a high school. Many people often move out of the town in order to be near a high school for their children.

As stated earlier the town's infrastructure needs should be requested upfront as part of the deal with any investing company, whether it is geothermal, solar or mining. These projects would benefit both parties; the local community and incoming companies. A recreation center could be used by incoming investors or developers to disseminate information and acquire local support during the development of their projects. In the long run these developments would provide social sustainability and financial support for the town long after the companies have left. It is fair to ask for these infrastructure developments in order to provide social sustainability for the town.

Additionally a health care facility needs to be developed as well. Currently there are no health care facilities or physicians in the town, which is not socially sustainable for the current population. Rico's residents normally have to travel to Telluride or Dolores for health care. Any increase in population would require additional health care, especially during the process of new

investments. Development projects bring workers that would require a health care facility nearby for routine and emergency care. Current residents would definitely benefit from the development of a new health care facility. The development of a health care facility could be established as need it during increase of population due to acceptance of geothermal or mining investments. Physicians could be recruited from Telluride or other areas. The health care facility would meet the basic needs of the community and future residents.

The Way ahead

Town meetings should be arranged between the town and corporations to keep the town informed of current or future investments. These meetings could disseminate information of technology to be used, pros and cons, as well as to provide overviews of planning. In order to gain approval for future projects it is essential that everyone knows of the benefits and requirements for sustainability. Communication would allow dispelling any unwarranted fears and recruiting support. Many town residents do not have in depth knowledge of new renewable technologies that could enhance the town's sustainability; briefings would greatly enhance their perspectives in the subject.

The town is open for informational gatherings and briefings on current technologies available and future projects that could enhance the town's development. The town's theater could be use for town hall briefings from outside sources. Briefings on current developments and future investments could allow the town to make sound and wise decisions to support or reject incoming projects. Lack of knowledge is often times an obstacle for development. It is the social responsibility of any incoming company to keep the town informed and create an environment for open communication.

The development of a geothermal plant would benefit the town economically and socially as well as it would provide energy for a large sector of the state. A geothermal plant in the area would allow the town to become self sufficient in terms of heated water, electricity and heating using geothermal energy, while providing an income for development. Greenhouse developments are another use of geothermal energy. The town seems more open to renewable energy projects that are environmentally safe than to mining; because of the ongoing cleaning of the soil. Nevertheless, is up to the corporations to inform the community of current technologies that would prevent environmental damage, whether they are mining operations, geothermal or any other operations.

The above possibilities are not all inclusive; the town could be further developed after the basic structures are completed. This is not the end of a project; it is the beginning of new social development ties with the town of Rico for social sustainability. It is the foundation to start building relationships that will enhance communication and interaction with the community for future developments.

Summary

Based on the meeting with Rico, the class determined five priorities that were important to the town and/or essential for future growth and sustainability to narrow the focus of this report. These priorities include: (1) a water and sewer system, (2) social infrastructure including a school, a recreation center, health facilities, and day care facilities, (3) geothermal energy production, (4) past mining clean-up and containment, and (5) the clean-up and containment of the St. Louis Tunnel discharge.

The largest obstacle for Rico to be sustainable is capital. It will need capital to build and maintain any of the above infrastructures or conduct clean-up activities. This will require attracting both private funds through investors and research institutions and public funds through taxes, government stimulus packages, or available grants and loans. If Rico is serious about sustainability but weary about potential mining investors, debt will be one consequence that the town will have to weigh early on with the benefits of the future successes of the programs. In the short term, setting priorities for construction of a much needed sewer and water system will lay a sustainable foundation for the city even though it results in long-term debt. A sewer and water system is of the highest priority for the town to ensure the safety of its current and future population as well as provide a better quality of life. The local community must be active in searching for monies available for such projects both in the private and public sectors.

A geothermal project is another option for the town that could be used in many different manners to promote growth, capital, an increased quality of life, and sustainable living. More tests will be required, but initial research indicates that there is great geothermal potential for Rico and this should be capitalized on. This resource can be used for electricity generation, which is currently being provided from one power line across the mountains and has many

interruptions. Also, community heating and ice melt can be other capabilities from a geothermal project. This project should be used in a way to promote education on geothermal activities through a training center, which can be used by state governments and educational facilities as well as private firms. This new technology will in turn will attract visitors and potential residents and as a result increase economic activity while moving Rico toward a sustainable future.

Furthermore, long term projects that could be developed from the geothermal potential of Rico is a hot springs resort, capitalizing on the outdoor, tourism based activities available in both the summer and winter in the local areas. As well as a greenhouse to produce organic produce year long. This is a commodity that local communities such as Telluride do not provide and therefore would give Rico an economic advantage. A greenhouse project can also be an educational tool for citizens of the community and local schools.

The cost of a geothermal project brings up the obstacle of acquiring capital. One option is to develop a plan that involves the "bundling" of projects. The water and sewer projects along with the geothermal project and possibly a water treatment plant for the St. Louis Tunnel discharge could be combined so that excavation and construction can be completed in the most cost effective manner as well as minimizing the amount of construction, degradation to the environment, and waste that is produced.

Additionally, attracting new residents is also critical to increase capital and sustainability. Social infrastructure is important to long-term growth of the city. Health care facilities, (especially for the children and elderly populations), educational programs, a recreation center, and day care facilities are among the most important for improving the quality of life of the current population and attracting new, year-round residents. These types of social programs will

enhance the incentives of people to move to Rico as well as keep current citizens from moving to more developed areas with the types of programs they require. Additionally, by improving the image of the town to attract both potential residents and visitors, it is essential for the town to continue past-mining clean-up and containment activities.

Participation by the local citizens and government will be vital during development initiatives and projects, whether they are city initiated, funded and executed or they are a product of outside investors such as a mining company or geothermal investor. If a project is investor based, the town must have a set of priorities and negotiate these objectives as part of the investment, for instance, the investor helping with past mining clean-up or with building much needed infrastructure. The city must stay actively engaged in the projects, through information sharing, educational briefings, debates and discussions with the investors or builders, and through town hall meetings where the community should be empowered to help in the planning process, for example with Rico's Master Plan. In addition, plans for all projects must not only include construction, but also monitoring all progress, and continued responsibility well into the future. Participation is a key to the future of any sustainable project.

Lastly, Rico's past mining activities have developed a negative stigma of all activities that include mining. With new rules and regulations that govern mining and clean-up activities, consideration should be given to the potential of new mining operations in the area. The area is very rich with natural resources and this is one of the best ways for Rico to build capital, promote economic growth, and increase sustainability. The first and one of the most important steps in this process is to educate the community on how mining operations have changed, the new requirements of mining companies when extracting minerals, what benefits the community

could gain from these operations, and how it could keep its small town atmosphere with large-scale operations.

Rico has vast resources, a wide assortment of outdoor activities, and an active, committed community that is concerned about their future and maintaining their small town way of life. It has great potential as it moves toward a sustainable post-mining economy, even in the face of numerous economic, environmental and social obstacles.

Appendix A: Class Questions for Rico with the Rico Panel's Answers

NOTE: Questions were submitted to the panel and returned during the meeting on 17 March 2009.

Social Sustainability

1. What social programs the town will like to have?

    - recreational facilities, Friday educational program for school kids, AA/NA meetings, medical facilities (community rural clinic), community greenhouse, law enforcement

2. What are the main town gathering places for social activities?

    - Rico theater & café, fire house, school, park, town hall, hotel, post office, gas station, coffee shop

3. Is there a particular workshop that they would benefit from having in town?

    - Home business/cottage industry work shop, avalanche training, woodworking, artist cooperative, outdoor recreation hospitality, historic tourism, flyfishing, alpine horticulture/greenhouse design

Economic Sustainability

1. What are the key economic goals for Rico, CO?

    - economic sustainability (long-term), environmental tourism, cottage industries, telecommuting, passive outdoor education and economy based on outdoor resources.

2. Are there certain aspects or businesses, that Rico aims to avoid or promote (i.e. mining, seasonal tourism, etc.)

    - sec 216 of RLUC which covers permitted uses in town.

3. Is the town looking to expand?

    Population (Seasonally or Permanent residence)

- 2,200 at buildout, currently we have 250 year-round, 500 in summer

Housing/Residential Units

- 258 water taps sold now, another 400 build-able lots in platted town, plus 304 to be annexed as a planned unit development

Current infrastructure, water sewer, roads, school etc.

- Water to supply about another 20 homes, there is no sewer system. The town has preliminary design docs for a town-wide sewer system estimated to cost between $8 - $14 million. Roads are all dirt. School is preschool – 6th grade m-th. Bussing for junior and senior high to Telluride (27 miles) or Dolores (38 miles).

If so, what kind of business diversification are they envisioning?

- Cottage industry, tourism services, service industries, hospitality, passive outdoor recreation, hotsprings resort, geothermal, xc skiing. The town is not opposed to mining as long as there are no negative environmental impacts to the natural environment or the quality of life of residents and surrounding wildlife

What kind of business opportunities do Rico citizens deem important/valuable for the town as well as the surrounding area?

- groceries, hardware supply, liquor, construction, cottage industry, outfitting, art studios, restaurants, concerts, festivals, historical museum, community greenhouse

4. Is there a time frame they would like us to focus on?

Short Term 3-5 years

- water, sewer, roads, school expansion, affordable housing, transportation, geothermal research and development, environmental clean up, river corridor clean up, park and trails

Medium 5-15 years

- residential development, hot springs resort, geothermal district heating, geothermal power generation, water quality improvements

Long Term >15 years

- sub-surface mining, xc ski resort

5. Can they provide us with what they consider key economic indicators and various statistics?

- http://scan.org/regional_data.html

6. In their quest for economic sustainability is the town willing to use the all the resources of Rico, CO to their full advantage to maintain sustainability?

- No

For Example utilizing mining exploitation as a means to an end, i.e. development of infrastructure, notably power and population increase to be used in development of geothermal resources.

- Rico values quality of life and has tried to be a good environmental steward, therefore uses contrary to those values are not encouraged.

7. To what extent does Rico prefer that the town's economic advancement come from within the town's resources and current population as opposed to outside help and assistance, which may require ceding control of some aspects either to a business or regional or county development authority?

- The town acknowledges that its resources are slim and does not have critical mass, but the town would like to maintain as much autonomy as possible.

8. What amount of cooperation and or opposition might be expected from those outside the town, notably the citizens of Telluride and the rest of the county?

- Telluride is not in the same county. The town of Telluride is generally supportive of Rico's efforts to develop. Rico already supplies Telluride with housing for a large portion of its professional workforce, and would love to see Rico have a viable school.

- The county seat is 90 minutes away and to get there, you have to drive through another county. The cultural demographic gap between the two towns in the county is phenomenal. Rico citizens have investigated ceding from the county and either joining another county, or forming their own as there is no support coming from the county.

Environmental Sustainability

1. Aside from the current cleanup efforts for lead in the soils and the research into a wastewater treatment system, are there any additional environmental concerns in the town or the surrounding areas which raise immediate or long term concerns?

- Water quality of the Dolores River for riparian habitat, future impact to Silver Creek and Dolores River from proposed mining activities, discharge from the

Saint Louis Tunnel, revegitation of pre-existing VCUP tailings piles, point source discharge of other seeping adits at abandoned mine sites, subsidence

2. What is the status of the lead cleanup efforts?

- All of the residential lots who's owners have signed access agreements have been completed, and a few lots still need work. This summer ARCO will finish up. The town is in the process of adopting institutional controls to prevent future exposure to lead soils on lots with high lead levels.

3. What is the status of the wastewater treatment plant?

- Shovel ready, just need millions of dollars. There have been three prior preliminary engineering reports and cost estimates. The most current cost estimate was drafted in June of 2007. The town has conducted a blight study and formed a DDA, and could develop other financing mechanisms like a URA or metro district to help fund the project.

4. Are there any specific short term or long term environmental goals which you would like to share with us?

- Short term – finalization of lead VCUP, develop North Rico Non-proft to take title to environmentally contaminated properties to manage and maintain as a brownfield project.

- Long term – restore the river corridor: treat 4 point source discharges, Saint Louis Discharge treatment, stabilize and reveg. Group Dump, Enterprise, Globe, Mountain Spring mine dump, Iron Clad Group, and Santa Cruz adit

5. What is the status of the 2004 Master Plan, and does it address any current or future environmental concerns of the town?

- We are in the process of discussing updating the master plan, we are going to draft a three mile plan, and we are also considering drafting a mineral extraction plan. Article V of the master plan is a section called "environmental protection."

6. Is the town open to allowing mining companies to invest in your area?

- It depends on the impact of the proposed use. In order to get acceptance from the community, the project has to also include elements in our master plan, and have a long term post-mining economic plan, as well as financing and a well thought

out plan for closure and environmental reclamation. There will be opposition to any visual and aural impacts on the surface. Likewise, there has to be investment in the increased demand for social services that would accompany mining (health and safety, law enforcement, traffic control…)

7. As we progress in discussions between our class and your town, what would you see is most beneficial area for us to focus these communications and efforts?

- Geothermal field studies, research geothermal financing options, feasibility studies, watershed studies, planning

8. What are the current sources of financing in place for development efforts?

- So far, the town has a $964,000,000 from an EPA Stag grant which can be used for sewer or a new water supply and distribution. The town has been in discussions with a municipal finance specialist from Vectra bank regarding bond financing through TIFs for sewer as well.

Appendix B: Rico Panel, Meeting 1

17 March 2009, 3:30 pm, Colorado School of Mines

Panel Members and Backgrounds

Mayor Barbara Betts: Mayor of Rico and serves on several Boards and Commissions in the Telluride and Rico area, Colorado resident for past 20 years

Matt Downer: Rico resident, small business owner, local craftsman, geothermal/renewable energy advocate

Ramon Escure: Rico resident, legal representative for Rico Renaissance

Rebecca Levy: Rico resident, owner/publisher/writer of Rico Bugle, active participant in city government since 2004,