Report

Town of Bristol

Drainage and Stormwater Improvement

Feasibility Study

Sociology Water Lab

Colorado State University

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INTRODUCTION

This report has been prepared for the Town of Bristol, Colorado by the Sociology Water Lab at Colorado State University. It includes a discussion of the main issues confronting Bristol in its efforts to reduce damage from reoccurring stormwater flooding of the community during the irrigation season. The report is designed to help Bristol apply for grants or loans to finance improvements in its stormwater system. The potential cost of an improved stormwater system is discussed, including a simple benefit/cost analysis of three options selected by the community for study. No formal engineering design has been prepared for the community as part of the study, only an estimate of the costs and potential engineering considerations associated with the three options.

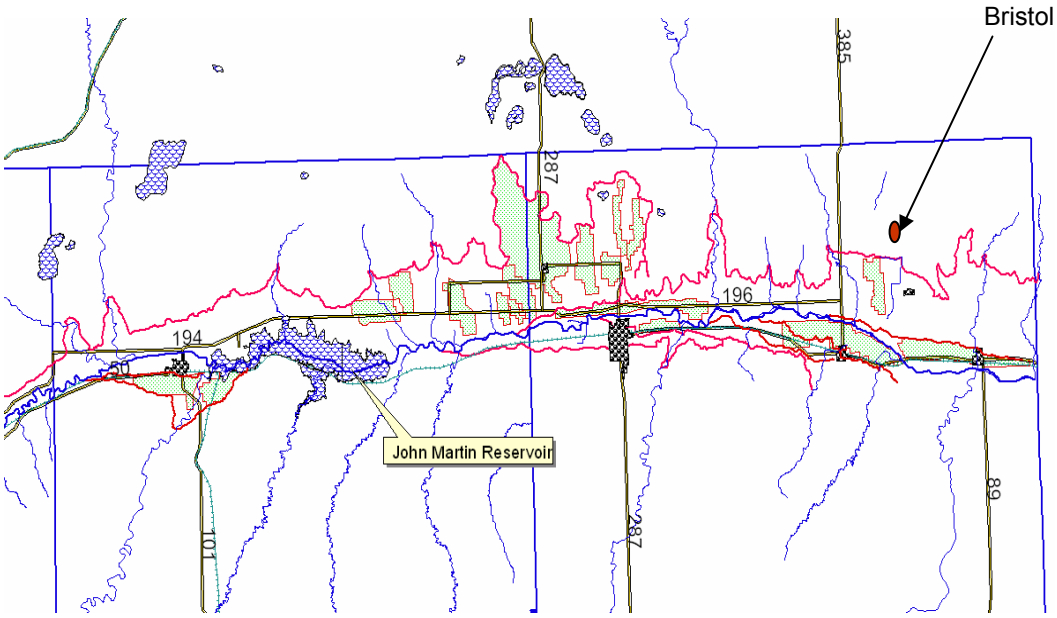
The residents of Bristol approached the Prowers County Commissioners in Fall, 2004 about obtaining assistance from Colorado State University (CSU) to conduct a preliminary feasibility study on how the town could improve its stormwater system to prevent future flooding. After agreement with CSU, a team was organized to conduct the study with the provision that the community become actively involved. This included organizing an advisory group and encouraging residents to attend workshops organized and conducted by CSU. The workshops were designed to assist the residents of Bristol in identifying and ranking options to address recurrent flooding. The three highest ranking options were then selected for study. The workshop activities are documented in Appendix A.

Bristol is located in the lower Arkansas Valley about four miles north of the Town of Granada in Township 22 South, Range 44 West (Figure 1). Colorado State Highway 385 passes through the town, connecting the community to U.S. Highway 50. No formal history has been written on the community, but it is believed that the town was organized around 1906-07. In 1960, it is estimated to have had a population of about 200 people. Presently, there are about 160 residents.

Presently, Bristol is unincorporated and residents are unclear as to whether the community was ever incorporated. Except for the Bristol Water and Sanitation District (Water Board) that operates and maintains the town's potable water system, wells, sewer

system, and treatment lagoon, other necessary services are provided by the Prowers County government and its agencies.

Figure 1 –Location of Bristol in the Lower Arkansas River Valley



Natural drainage in the Lower Arkansas Valley contributes significantly to flooding in the smaller communities, particularly those located along the bench lands. Bends in the Fort Lyon Canal and Amity Canal (in red on north side of the Arkansas River) frequently negotiate bench land drainage, the origin of many flood flows for the small communities.

In 1960, Bristol had a grocery store, café, filling station, clothing store, school, post office, fire station, three churches, and two cooperatives. Presently, there are three churches, a fire station, post office, an auto body shop, an auto repair shop, a firearms store and one cooperative in the community. There are no designated or registered historical buildings in town, although one of the churches appears to be a fine stone structure that could conceivably have important historical value to the area (Appendix B). Residents currently use retail outlets in Granada and Lamar, and school children are bussed to Granada.

The Bristol Water and Sanitation District has two wells that it manages for its potable water supply. There are 65 potable water connections and electrical connections in the community. The town has a sewer system and a lagoon at the south edge of town to aerate sewage. Electricity is provided by the City of Lamar. Except for the state highway, all roads in the town are unpaved. The only liability that the town is carrying presently is a balance of

about $29,000 on a loan it entered into with USDA's Rural Development program in 1980 to rehabilitate the community's potable water supply system.

Today, the 160 residents live in approximately 56 occupied houses. There are an additional six unoccupied houses in the community. Some of these unoccupied houses have been rentals in the past. Five of these unoccupied houses have water taps and electrical hookups. Finally, there are eight abandoned houses that are not livable in their present condition.

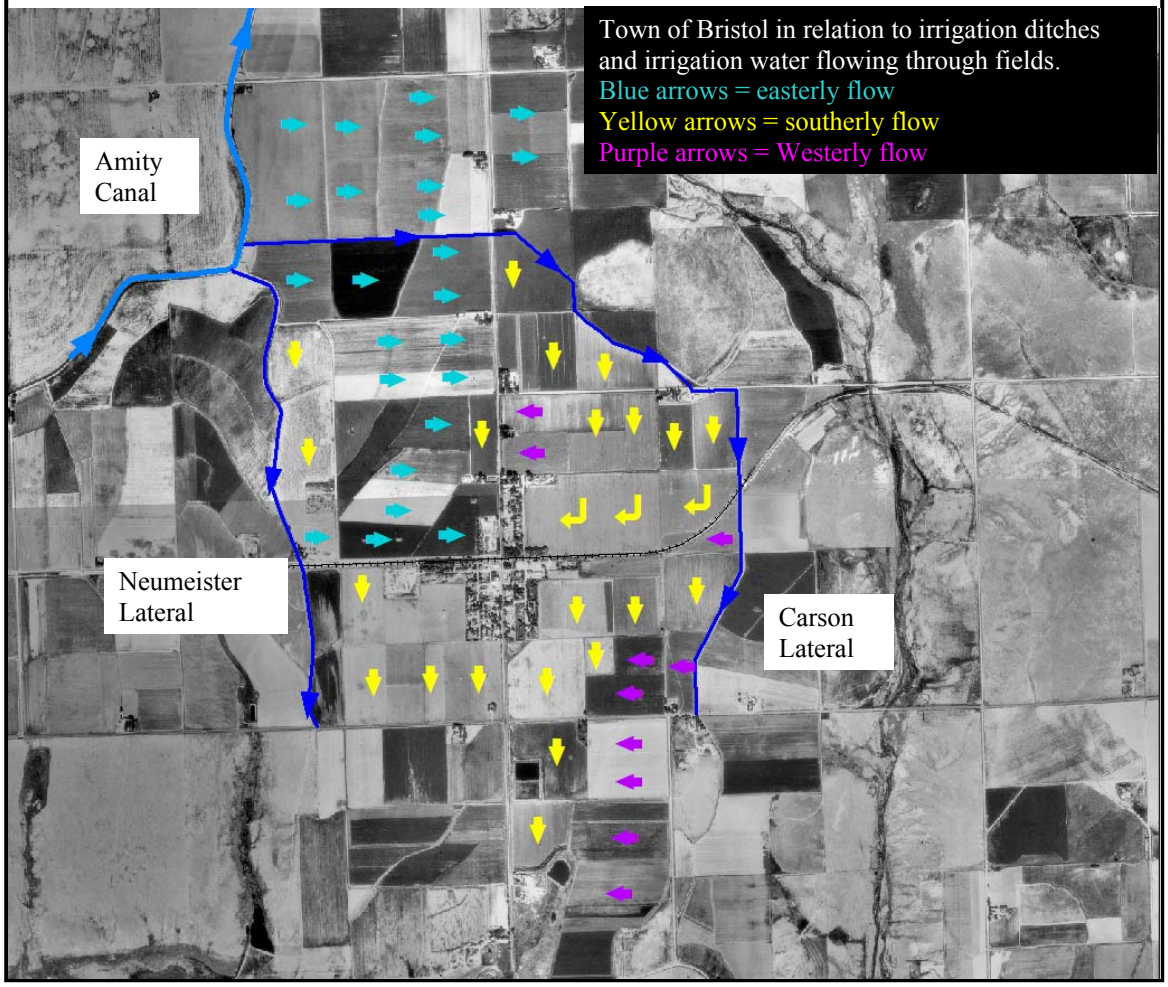
The town was originally platted with very small lots, generally 25' feet by 100' feet. Most residential dwellings have been built on two to four of these small lots joined together. Based on the present market for buildable lots in surrounding communities, it is estimated that there are about 26 lots in town (including the abandoned houses) that are large enough to build houses on. Some of these lots are covered with trees. These buildable lots really represent two or more smaller platted lots in town. Some of the original lot sizes could accommodate mobile homes.

Very few residents have landscaped front yards or gardens due to the stormwater problem. Informal conversations with residents indicate that about 25 percent of the residents would like to have lawns, while another 25 percent would like to have full gardens, if the stormwater problem was resolved.

Many dwellings, including those unoccupied, have been severely damaged by flooding in the past. Some retail properties on the east side of the highway have also been damaged by flooding. Photos in Appendix B show dwellings that have been damaged by flooding or are abandoned.

Community members estimate that Bristol has severe stormwater problems two to three times a year on the average, particularly when the lower Arkansas Valley region is experiencing a wet cycle. There have been five severe floods in the town since 1960, including 1965; the year of very severe and region-wide flooding in eastern Colorado.

Figure 2 – Watershed and Water Flows Surrounding Bristol



Source of Flooding

Bristol is located near the Arkansas River, but does not experience any flooding from the river itself. Rather, the town is situated in the middle of a small watershed (Figure 2) clearly defined by the Amity Mutual Irrigation Company's main canal, and two incorporated laterals. The Neumeister Lateral and the Carson Lateral both have headgates on the Amity Canal directly above Bristol.

The well-maintained Amity Mutual Irrigation Company provides water to irrigators surrounding the town, via the two incorporated laterals. The two laterals convey irrigation water to the fields surrounding Bristol. They are regularly maintained and closely

supervised. However, irrigation water tends to move in the direction of the town via sublaterals (farm ditches). A rapidly occurring intense rainstorm event, along with an occasional condition of saturated soils from irrigation, can lead to stormwater flows that exceed the capabilities of the town's stormwater system. There have been repeated episodes of flooding in the community as a result of intense rainstorm events occurring during the irrigation season.

Figure 3 –Residents Reporting Flooding in Past

Figure 3 shows the location of residences that have experienced residential lot and basement flooding in the past, most recently in the fall of 2004. This anecdotal information from town residents shows an estimated 60 homes (both occupied and presently unoccupied) experiencing some basement flooding in the past. However, most of the flooding occurs on the east side of the highway passing through town. Figure 3 also shows areas in town where

there is severe ponding of floodwaters that back up into yards and basements, overtop field ditches near the town, and silt up stormwater ditches bordering several of the unpaved roads in town.

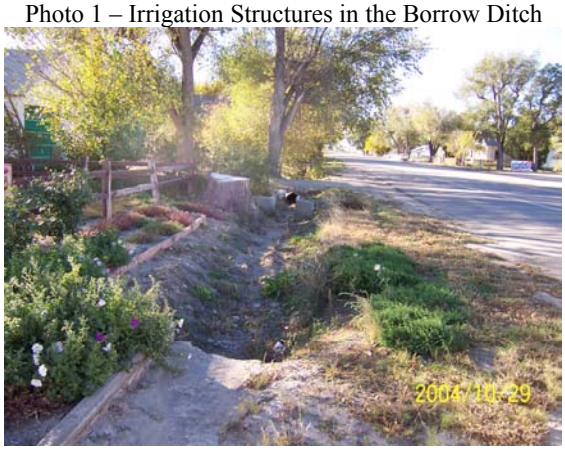
Figure 4 –Location of Borrow Ditches

Other Structural Considerations

There are borrow ditches bordering both sides of Highway 385 as it passes through town (Figure 4). Along with culverts under the streets accessing the community from the highway, many residents have built driveways across these highway borrow ditches, installing culverts underneath their driveways to convey stormwater as it passes through town. Likewise, commercial properties along the highway have diverted stormwater in the past through box culverts in an attempt to protect the front of their properties. Most of these

commercial properties have been permanently damaged from flooding and are not currently occupied.

Photo 1 – Irrigation Structures in the Borrow Ditch



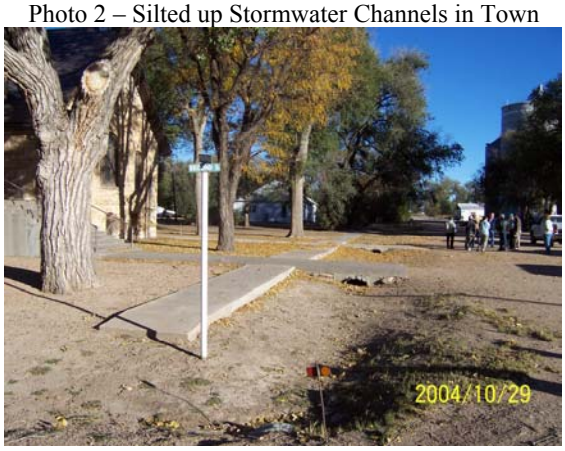
For some time, residents whose homes border the highway have irrigated their lawns and gardens from the borrow ditches. Residents irrigate mainly from the borrow ditch bordering the east side of the highway. There are several irrigation structures along the borrow ditches that are adjusted to check and divert water through pipe inlets onto residential lawns and gardens bordering the highway (Photo 1).

These combined activities and existing stormwater management structures have resulted in a large number of localities (maintenance points) along the borrow ditches that are difficult for the town to maintain on a regular basis. Since the town is unincorporated, there are often insufficient means to manage the annual maintenance of stormwater ditches in other parts of the town as well.

The Colorado Department of Transportation (CDOT) has expressed concern about the use of the borrow ditches bordering the highway for irrigation. The use of borrow ditches for irrigation is a potential safety hazard to highway traffic and is a practice that may need to be discontinued. At the very least, any new stormwater design should preclude the need to irrigate directly from these borrow ditches.

The remainder of the community's stormwater ditch system passes through town, located on one side of several (but not all) unpaved streets. There are no detention ponds or other structures to abate flooding. These stormwater ditches are mostly silted up, collapsed and/or have damaged culverts (Photo 2). They have lost virtually all of their capacity to convey stormwater.

Photo 2 – Silted up Stormwater Channels in Town



Residents have reported that flood waters enter town primarily from the north and then begin to pass through town via the unpaved roads and alleys. Floodwaters then begin to accumulate in the north side of town along an abandoned railroad bed which acts as a natural dike in the middle of the town. In the past, culverts under the railroad bed have conveyed stormwater along the open ditch system into the southern part of the town, where it then ponds. These abandoned railroad bed culverts have apparently been blocked in an effort to prevent flooding in the south end of town.

In summary, although surrounding irrigation canals are well-maintained, the potential for continued flooding in the community is great because of severe thunderstorms in the summer and fall, the town's proximity to irrigation canals and irrigated land, and primarily because of an inadequate stormwater system. Due to the unincorporated status of the town, it would appear that any effort to improve the design of the stormwater system must take into consideration the financial ability of the community to meet future annual operation and maintenance costs. At the very minimum, improvements should make it possible for designated county agencies to maintain the system without excessive cost to the rest of the county residents.

The issue of the capability of the town or county to keep up with the maintenance of any proposed structural solution to managing stormwater in the future is relevant to all three of the stormwater management options the community selected for study. Future operation and maintenance costs should be carefully considered in any effort to improve the stormwater system.

Condition and Value of Housing Stock

Interviews with county agencies and local realtors indicate that the current estimated actual value of the housing stock (commercial and residential) in Bristol is $1,933,721. This is the taxable value of the property used by the county as well. Four recent examples of houses sold in Bristol are indicative of the market value of the current housing stock (Table 1). Presumably, this market value would be somewhat higher if property, including currently vacant but buildable lots in the community, were not exposed to routine flooding. Photos in Appendix B show: (1) an occupied house flooded in the past; (2) an abandoned house; (3) a vacant but buildable residential lot in the community, and; (4) commercial property damaged by flooding.

Table 1 – Recent Housing Stock Sold in Bristol

Year Built	Price
1912	7,000
1912	18,000
1919	20,000
1919	22,500

There are estimated to be 26 vacant but buildable lots in the community at the present time. This represents potential for property infill and an improved tax base for the community in the future if these properties were developed. It is assumed that these lots are unlikely to be developed as long as the community continues to experience flooding from an outdated stormwater system. A conservative value has been given to this potential development in the benefit/cost analysis conducted on the three stormwater improvement options selected by the community for study (Table 2, page 14).

Benefits to the community from improved stormwater management can occur not only through avoidance of damage to property, but also from the community's increased capabilities of fully realizing its unique market position. Satellite communities like Bristol are desirable for people in the region because they represent affordable housing. Since housing costs in Colorado are already above the national average, those unable to afford housing in the larger regional communities (i.e., Lamar, La Junta, Las Animas, etc.) can more easily afford housing prices in these satellite communities. The regional impact of limiting the affordable housing market due to flooding in these small communities may therefore be considerable.

In addition, the loss of traditional wood frame housing stock from flooding invites more dependence on manufactured housing in the future which is suitable but may lack longevity. Manufactured housing may range from $60,000 to $90,000 for a metal frame structure, but may only have a thirty year life expectancy. Modular housing is another option, but the current market for housing still appears to favor traditional wood frame stock.

Continued failure to invest in these communities because of the danger of flooding, due primarily to ineffective stormwater systems rather than because of river flooding, limits a lifestyle that is very desirable to many residents in the lower Arkansas Valley. Based on contacts with local realtors, it is estimated that the market value of housing stock in these satellite communities, represented by Bristol, is comparable to the less expensive housing stock in the larger trade centers of the area such as Lamar, Las Animas and La Junta; that is to say, in the $20,000 to $35,000 price range. This estimate of the price of housing in the satellite communities was made from a quick survey of the recent sale of houses in the nearby communities of Hasty, McClave, and Hartman.

The preliminary benefit/cost analysis (Table 2) used in this study accounts for the following: (1) estimated avoidance of potential loss from protecting the current value of housing in Bristol; (2) estimated reduced long-term effects of flood damage to personal property in basements from moisture and mold; (3) estimated damage to community landscaping; (4) estimated damage to community historical properties, utilities and the potable well system and water supply, and; (5) estimated anticipated improvements in the use of property in the community through better stormwater management.

Residents report that flood water flows through the yards, around houses, and floods the basements of houses. About one-half of the occupied houses in town are in danger of being routinely flooded. The benefits from eliminating flooding of yards and basements will enhance the quality of life of the residences. A flooded basement can damage the furnace and water heater that are typically located in this area. If the washing machine and clothes dryer are located in the basement, flooding can prevent their use as well.

Table 2 - ESTIMATED BENEFITS FROM IMPROVED STORMWATER MANAGEMENT IN BRISTOL

Total Value of Property Protected - Preliminary Estimates		
Actual Value of Property (buildings and land improvements)		$1,933,721.00
Actual Value of Taxable Land		$189,708.00
Bristol Water and Sanitation (two wells valued at $12,000 each)		$24,000.00
	SUBTOTAL	$2,147,429.00
Value Placed on Damage from Flooding - Preliminary Estimates		
Structural Damage (0.05 of actual value of buildings and land improvements)		$96,686.05
Damages Resulting from Flooded Basements (10 occupied dwellings in town - $500 per dwelling)		$5,000.00
(i.e., Furnaces, Water Heaters, Laundry Facilities, Personal Storage, Food Storage (canned goods, etc.)		
Damage to Residential Landscaping (10 occupied dwellings in town - $50 removal of mud, trash, etc.)		$500.00
Damage to Community Landscaping (parks, open space, etc.)		$0.00
Damage to City Streets (Prowers County Roads - 5 hours at $115/hr)		$575.00
Damage to Potential Historical Properties		
Unted Presbyterian Church		$1,000.00
Damage to Utilities (gas, potable water, electrical, sewer, cable, etc.)		$1,500.00
Estimated Increased Value of Vacant Residential Lots ($1500 per vacant lot for 26 vacant and buildable lots)		$39,000.00
Estimated Value of New Housing on Vacant Lots (10 percent of vacant lots x $40,000 for modular unit)		$104,000.00
Estimated Improvements to Existing Stock (remodeling - 1000 x one-third (21) of occupied dwellings in town)		$21,000.00
	SUBTOTAL	$269,261.05
	TOTAL	$2,416,690.05

Cost of Stormwater Improvement Option 1	$305,348.00
Preliminary Benefit/Cost Ratio	7.91
Cost of Stormwater Improvement Option 2	$66,750.00
Preliminary Benefit/Cost Ratio	36.21
Cost of Stormwater Improvement Option 3	$379,048.00
Preliminary Benefit/Cost Ratio	6.38

Basements are often used for storage of food supplies, canned goods, out-of-season clothing and other equipment. Offices and work rooms are frequently located in basements. These uses are precluded if flooding occurs periodically. The value of basement usage varies from house to house, but all households with basements would seemingly be precluded from using this space productively under current circumstances.

Photo 3 – Newer Subdivision in the town of Kornman, nearby Bristol

This photo shows a small newer subdivision in the nearby community of Kornman. A frontage road has been designed on the other side of the highway borrow ditch. This precludes the need to construct driveways across the borrow ditch, as has been done in Bristol over the years, while providing the free flow of stormwater coming off the highway.

There are concerns about the future potential for community development and/or improvements in Bristol. Many properties are believed capable of being built on or improved, but the risk of flooding prevents this investment from occurring. The potential of flooding is believed to be the main reason why this satellite community is not being considered for residency by many regional residents looking for more affordable homes. Unlike some of the other communities, such as the nearby Town of Kornman that has reasonably adequate stormwater protection in the form of a large interceptor drain, no new subdivisions can be planned for Bristol under these conditions. Kornman has several new subdivisions, including those with designs to improve stormwater management (Photo 3).

Such opportunities are precluded for Bristol due to its current stormwater management system.

Water Supply

The Town of Bristol has water rights in two wells. One well currently provides water for the community potable water system (Photo 4). The second well is expected to come on line to provide additional potable water as soon as a water quality test is completed. A description of these wells is as follows:

Photo 4 – North Well in Bristol

Well #1 – Designated as the north well (Photo 4). This well pumps about 80 GPM and is the current potable supply. The water table is at a depth of about 500' feet. This well is known to be tributary to the Arkansas River. It is registered with the Office of the State Engineer and has a pumping right dating prior to 1960. Therefore, it does not require an augmentation plan unless it was to be re-drilled. It pumps about 50 percent of the time in order to serve the community. The community pumps, on the average, 11,991,730 million gallons of water annually, or just under one million gallons a month. Average annual pumping costs for this well are about $3,700. Water is pumped from this well into a holding tank for chlorination and distribution through the potable water line.

Well #2 – Designated as the south well. This well is expected to pump about 80 GPM when it is placed on line sometime this summer. It is also registered with the Office of the State Engineer and does not require an augmentation plan. However, the water duty is limited to the 77 acres representing the Town of Bristol or about 7 acre feet per year. It has recently been refurbished at a cost of about $12,000. The water table is at a depth of about 800' feet. The well is known to draw from a confined aquifer. Although closer to the river than the north well, it is apparently not tributary to the Arkansas River. Pumping from this well, as with the north well, falls under compliance with the Colorado State Engineer's Office and state law pertaining to domestic wells.

Sewage Lagoon

The sewage lagoon is located about one-quarter mile south of town, out and away from any housing (Photo 5). The lagoon has two adjacent storage/aeration bays, the second one being used when the first one is filled. There is a drain (a standing open 6" inch pipe about 6' feet high) carrying stormwater and sewage overflow from the first bay to the second. There is also a division box with two screw headgates between the two bays that can be used to divert sewage water into either bay. The second bay has a headgate to discharge water to the Buffalo Mutual Irrigation Company canal if both bays become filled.

Photo 5 – The Bristol Sewage Lagoon (town in background)

The lagoon is filled primarily with stormwater whenever it is available and can be diverted into the lagoon. Stormwater leaves the south end of town and is conveyed along the borrow ditch bordering the east side of Highway 385. The stormwater then passes through an 18" culvert under Highway 196, at which point it is supplemented by irrigation return flows conveyed by a farm ditch entering from the east and on the south side of Highway 196. These combined flows are then divided, one portion entering a stormwater lateral that carries the stormwater an additional 200 yards south where it is then checked up and diverted by gravity through a 12" diameter headgate and pipe into the first bay of the lagoon. The remainder of the stormwater not diverted into the stormwater lateral continues southward and dumps into the Buffalo Mutual Irrigation Company canal.

The Buffalo Mutual Irrigation Company has a joint operating agreement with the Lower Arkansas Water Management Association (LAWMA). This association has drilled and equipped several irrigation wells along the Buffalo Canal for the purpose of providing augmentation for its members who have wells pumping from the alluvium of the river. Members of LAWMA include the City of Lamar. The wells are operated under a joint

agreement with the Buffalo Mutual Irrigation Company whereby LAWMA guarantees a certain number of cubic feet per second to the Buffalo Canal to meet the needs of its remaining irrigators. A certain portion of the Buffalo Canal water rights are left in the river for augmentation when there is a call on the river that would cause the wells to be regulated or shut down. Historically, this arrangement has worked to the benefit of all water users in the area.

Finally, it has been determined that the Town of Bristol does have additional water rights that were apparently deeded with the original plat of the town. However, these water rights need to be legally determined. It is estimated that this would cost about $20,000 and would probably be a worthwhile investment for the community. The community does not have any rights to return flows from the irrigated lands surrounding the community (i.e., the watershed bounded by the Amity Mutual Irrigation Company canal, Neumeister Lateral, and Carson Lateral).

Potable Water System

As stated earlier, the community pumps, on the average, 11,991,730 gallons of water annually, or just under one million gallons a month. Average annual pumping costs are about $3,700.

The Town of Bristol is presently investigating the installation of a new potable water line system that would be tied into both the north and south wells. The community would then abandon its existing water line. However, the existing potable water line could conceivably be converted to a pressurized irrigation line to irrigate town landscapes and gardens, once the new potable water system was in place and operational. This would provide irrigation water for lawns and gardens in town at minimal cost, provided that irrigation water could be purchased to run the system, possibly supplemented by water from one of the two town wells.

For planning purposes, the Town of Bristol is really somewhat comparable to a small subdivision in a larger community. Many new subdivisions in Colorado are being built with pressurized secondary systems (irrigation systems) for landscape use. These systems are

generally easier to operate and maintain than potable systems. These secondary water systems reduce the need to use valuable and often limited potable water supplies for outdoor use, thereby insuring that the current potable supply will be adequate into the future. Option #3 of this study actually evaluates the potential cost of a secondary water system for the Town of Bristol. Option #4 shows an estimated cost of installing a secondary system, if the existing potable line were utilized for this purpose, subject to the new potable water line being installed.

Opportunities to improve the housing and vacant lots in town with irrigation water for landscape could encourage more people to settle in the town. Again, this satellite community has housing stock and buildable lots that may be attractive to those looking for more affordable living, including the capability of doing a little landscaping and gardening.

The Community Decision-Making Process

The overall purpose of the workshops conducted for the community was to: (1) allow the community to see how other small rural towns in the West are addressing stormwater under comparable circumstances; and (2) decide on a community stormwater protection system that could be sustained in the future with local resources. A related purpose of the workshops was to show various ways in which an improved water and stormwater system could enhance opportunities to attract new residents and improve its tax base. Finally, it was felt that solutions to the Bristol stormwater problem could be informative to other communities in the area experiencing similar problems. Appendix A shows the chronology of workshops and related activities that CSU organized as part of the feasibility study.

The workshops fostered a highly interactive process of building ownership for the project among a full range of stakeholders. These included the town residents, surrounding agricultural landowners, Prowers County, the Colorado Department of Transportation, and various agencies of the U.S. Department of Agriculture. The workshops encouraged residents to discuss how the community could be impacted by various stormwater management options. The workshops provided full participation and emphasized open dialogue among stakeholders. Parties were encouraged to carefully consider possible options and short term and long term implications for addressing periodic flooding in the community.

The workshops provided a process designed to build a collective understanding of the primary factors surrounding the stormwater problem. Many community residents were uncertain or appeared to misunderstand why the flooding was occurring. The workshops clarified potential causes and sought input and active involvement from the county and other agencies regarding their possible future role. Finally, the process clarified the importance of community values and a realistic assessment of available resources.

Some of the observed constraints for the community identified during the workshops included:

- History of flooding in the area (other surrounding communities have the same problem and are dealing with it in various ways).
- Size and status of the community (approximately 150 residents and unincorporated).
- Average age of community 55 years of age and older.
- Potential issues between agricultural landowners and community residents over possible solutions (probably the main discussion issue that concerned long-standing irrigators around the community).
- Minimal opportunities for future commercial development, unless the flooding problem is resolved.
- CDOT is an important agency in the process the community is undertaking, due to the highway passing through the community.
- Potential local resources that might be applied to the project (land leasing for new stormwater infrastructure).
- Cost of the stormwater infrastructure.

Clear leadership within the Bristol community has emerged around this activity. The Bristol Water and Sanitation District (Water Board) has agreed to maintain sustained commitment to the project to the best of its ability, given its limited resources. It is anticipated that the process utilized by CSU could help other communities in the area. Hopefully, this activity will create future partnerships among local community entities and

thereby facilitate broader, systemic solutions to drainage issues and community development throughout the larger region.

Technical Support Provided to Bristol

Colorado State University provided assistance to the Town of Bristol in developing GIS maps and other workshop materials for the residents to review. These included several aerial photos of the community obtained from U.S.D.A. with the following superimposed data: (1) the location and direction of laterals surrounding the community; (2) the location of flooded basements and sites of ponding of flood water; (3) the direction of the flow of stormwater across and through town during a flood event; (4) the location of culverts along the borrow ditches bordering the highway, and; (5) additional GIS layers (shape files) of retail, commercial and agricultural industrial buildings, churches, sewage lagoon, soils, Bristol wells, groundwater contours, gas, sewer and water lines, service valves, and waypoints. This information was provided to the Bristol Water Board for their future use.

Stormwater Improvement Options Selected for Study

At the close of the last workshop with the community on January 8, 2005, the residents proposed and discussed several options to address their stormwater problem, based in part on materials presented at this and an earlier workshop (Photo 6). There were six options that were developed and discussed by the residents. The residents then ranked these six options on 3 X 5 cards. Pursuant to a previously agreed upon procedure, the three top ranked options were then selected for study.

Photo 6 – Initial Stormwater Workshop in Bristol

In addition, the residents requested that the three top ranked options studied attempt to ensure the following in all cases:

Table 3 - Cost of Three Options Selected by the Community for Study

Item	Amount		Cost ($/unit)	Cost ($)
Option 1- Underground Stormwater System				
Land Acquisition	1	AC	$2,500	$2,500
Detention Pond	7500	CY	$2.50	$18,750
Detention Pond Outlet Structure	1	LS	$1,700	$1,700
Pipe (24")	3350	LF	$60	$201,000
Inlet/Manhole	9	EA	$550.00	$4,950
Apron	3	EA	$533	$1,598
Open Ditch	3150	LF	$2	$6,300
Culvert (24")	410	LF	$25	$10,250
Engineering Design	1	LS	$20,000	$20,000
			Subtotal	**$267,048**
With Irrigation Capabilities along borrow ditch				
Pipe (6")	2500	LF	$15	$37,500
Valves/Risers	8	EA	$100	$800
			Total	**$305,348**
Option 2 – Clean Out Existing Stormwater System				
Land Acquisition	1	AC	$2,500	$2,500
Detention Pond	7500	CY	$2.50	$18,750
Open Ditch	6500	LF	$2	$13,000
Culvert (24")	1300	LF	$25	$32,500
			Total	**$66,750**
Option 3 - Option 1, plus a Secondary System				
Cost of Option 1 (without irrigation capabilities)	1	LS	$267,048	$267,048
Secondary System - Phase 1 (1/3 of homes provided with service)	22	EA	$5,000	$110,000
LAWMA water shares	1	AC-FT	$2,000	$2,000
			Total	**$379,048**
Option 4 - Option 1, plus a Secondary System (if new potable water system built)				
Cost of Option 1 (without irrigation capabilities)	1	LS	$267,048	$267,048
Secondary System (conversion of the abandoned potable water system) - all homes provided with service.	65	EA	$1,400	$91,000
LAWMA water shares	1	AC-FT	$2,000	$2,000
			Total	**$360,048**

Note: None of the above options include costs of fencing, annual mantainence or an updated legal determiniation of the community's water rights. All options include a detention pond at the north end of town.

1. That community property would be protected as much as possible and within an acceptable annual operation and maintenance cost.

2. That there would be a possibility of continuing to irrigate out of the borrow ditch bordering the east side of Highway 385 passing through town.

3. That there would be the possibility of diverting stormwater into the water treatment lagoon at the south end of town.

Table 3 shows the estimated cost of the three options, along with information on the preliminary engineering components. A fourth option is also indicated, based on the idea that if the new potable water system were to be installed as planned under a separate project, the old potable water line could conceivably be used for a secondary irrigation system for the community. Again, Table 3 does not show any cost for a study of the community's water rights originally deeded with the platting of town lots on irrigated land.

Option #1 - The option ranked highest by those residents active in the workshops involved constructing an underground storm drain system for the community.

This underground storm drain system would be anchored by a detention pond protected by a chain link fence. The detention pond would be located immediately adjacent to Highway 385 (La Belle Avenue) and on the east side of the highway where it enters town from the north.

The detention pond would have a capacity of 1.6 acre feet. It would collect and hold for slow release stormwater entering town from the north during major storm events. It would be designed with a headgate that would release the stormwater into a 24" inch underground storm drain running south along the east side of the highway. This 24" inch storm drain would continue south to the end of town below Third Street South.

This drain would then surface and discharge stormwater into the existing open borrow ditch on the east side of the highway below Third Street South. It would have a concrete apron at this point to protect against erosion. Stormwater would then continue

southward in the borrow ditch. If legally permitted through a water right or a water exchange, part of the stormwater could be diverted into the lateral taking it to the headgate of the lagoon. The remaining stormwater would continue onward in the borrow ditch to the Arkansas River.

There would be a similar 24" inch underground storm drain on the west side of the highway (LaBelle Avenue). This 24" inch drain would begin at the intersection of First Street North and surface at the south end of town. Stormwater would then continue southward out of town toward the river via the west side borrow ditch.

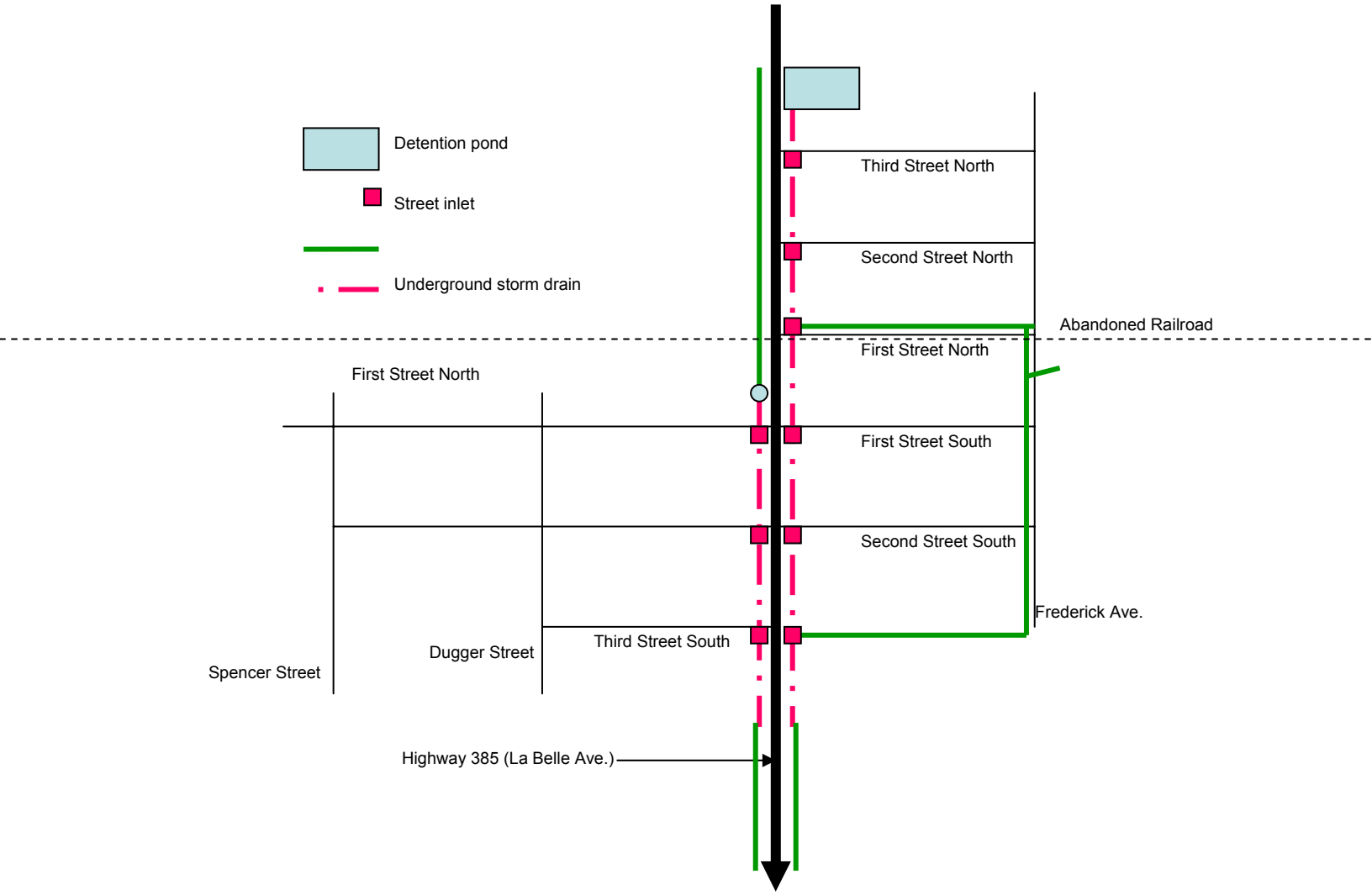
The existing open borrow ditch that runs on the west side of the highway from the north end of town to the railroad bed just south of First Street North would be cleaned out and serviced with a grated inlet at First Street North. The two culverts currently passing eastward under the highway from the west borrow ditch, located just north of First Street North, would be closed.

Collector inlets on the south side of each highway intersection in town, on both sides of the highway, would convey stormwater coming off the highway or accumulating at these intersections from other directions. This stormwater would go directly into the underground drains instead of ponding at the intersections and migrating down the unpaved streets.

The current open ditches along the north side of First Street North from Frederick Avenue to the highway, along the west side of Frederick Avenue from First Street North to the end of town, would be cleaned out. The Frederick Avenue ditch would be extended to the most southern end of town. It would then connect to a new ditch that would convey stormwater into the east side borrow ditch along the highway, just south of the apron of the 24" underground drain.

Additionally, to allow a few individuals living along the east side of the highway (LaBelle Avenue) to continue to irrigate their lawns and gardens as they have done in the past, a 6" inch pipe with risers for irrigating could be installed running parallel to and on the

Figure 5 – Option #1, Underground Stormwater System



east side of the underground storm drain. However, the water rights for this irrigating have not been clarified.

In summary, in Option #1 stormwater is conveyed out of town through 24" inch storm drains along both sides of the highway with inlets at all intersections along both sides of the highway (but from only North First Street, south, on the west side of the highway). The detention pond could also provide controlled releases for irrigation along the east side of the highway if water rights can be clarified.

Anticipated annual maintenance of the Option #1 stormwater system is expected to be minimal and well within the capabilities of the town to keep up with.

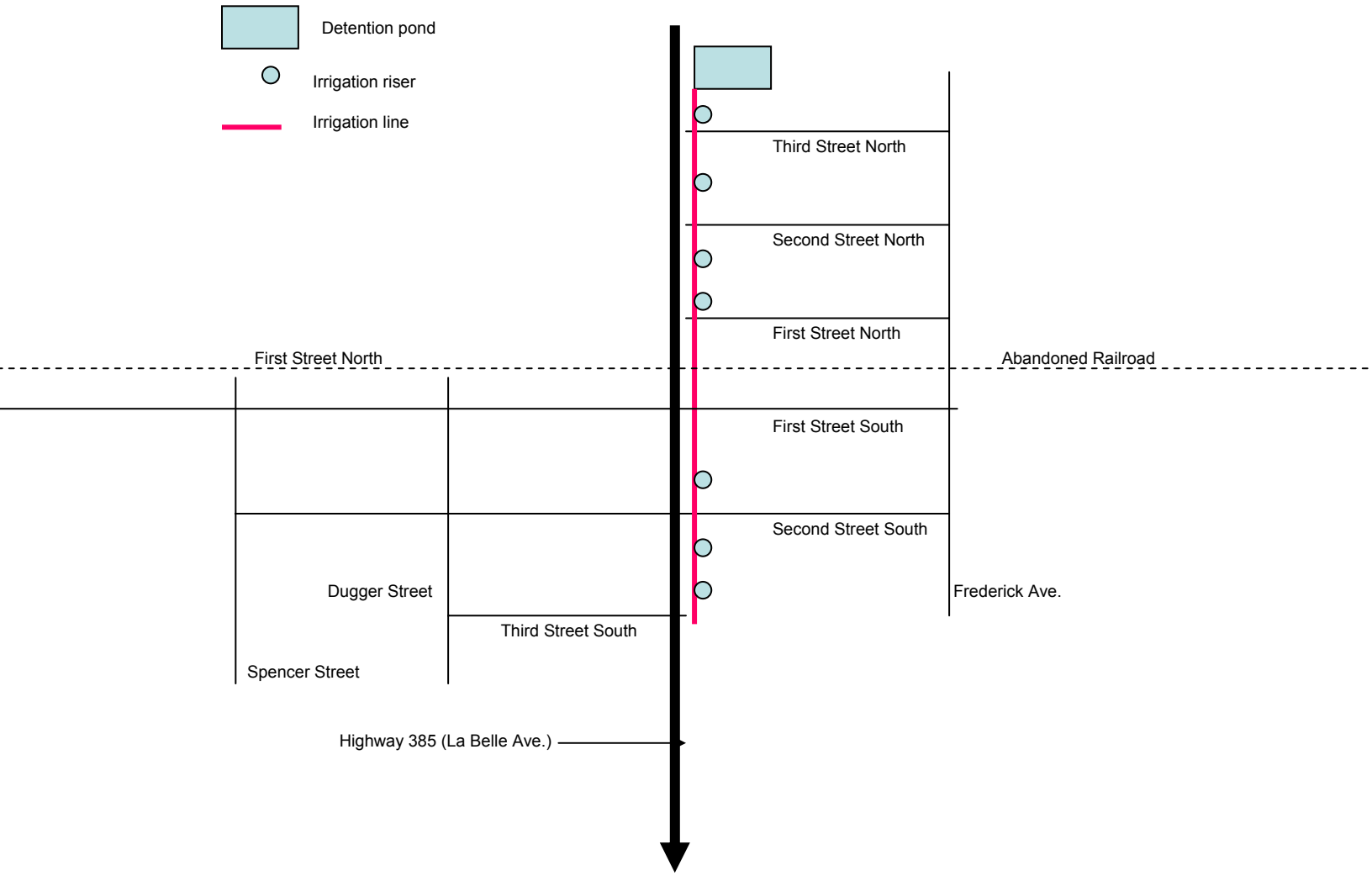
Option #2 – The second highest ranked option was to thoroughly clean out and repair the existing open ditch stormwater system in town.

This option also includes the same detention pond described on Option #1 that would collect stormwater entering the north end of town and release it at a lower controlled flow along the borrow ditch on the east side of the highway. Water stored in the detention pond could also be released to irrigate lawns and gardens along the highway's east side borrow ditch if water rights can be clarified.

The ditches and culverts along and under the highway (LaBelle Avenue) and First Street North would be cleaned out and repaired. The ditch along Frederick Avenue south of First Street North would be cleaned, deepened, and extended further south to the end of town. It would be connected to a new ditch that would be installed to convey the Frederick Avenue stormwater back to the borrow ditch along the east side of the highway and out of town. The two culverts currently passing under the highway just north of First Street North would remain open to divert water into the borrow ditch on the east side of the highway.

It is assumed that only the existing open drain system would need to be cleaned and repaired. There are presently no other open ditch storm drains in town, either on the east or west side of the highway, other than the borrow ditches along the highway and

Figure 6 – Option #2, Cleaning Existing Open Ditch System



the open ditches on the north side of First Street North and the west side of Frederick Avenue south of First Street North.

Anticipated maintenance of the Option #2 stormwater system is expected to be much greater than Option #1. There are estimated to be 1300' feet of culvert passing under 21 driveways and 11 street intersections. This includes 1000' feet of presently existing underground box culvert on the east side of the highway in front of largely abandoned commercial property and a church. Special care will be needed to ensure that all the open storm drains and culverts are cleaned out on an annual basis. Furthermore, during storm events, it will be important that all check structure along these open ditches be raised in order to prevent flooding from stormwater flows.

In addition, stormwater will be coming from the west borrow ditch, through the two culverts under the highway, then joining storm flows in the east borrow ditch. Thus, careful attention will need to be given to controlling releases from the proposed detention pond at the north end of town. This will require close, on site, supervision of the entire open drain system during storm events.

Option #3 – The third highest ranked option is to pursue Option #1, with the addition of a pressurized secondary irrigation line to serve the irrigation landscape and garden needs of the entire community. Water for the secondary system would come from water rights associated with the town wells, or the acquisition of supplemental water stock from one of the surrounding mutual irrigation companies.

This option could become more affordable, perhaps by about one-third or less of its current estimated cost, if the town converted the existing potable water line into a secondary irrigation system. This option would be possible if the community indeed goes forward with its current plan to build a new potable water line. This option would also preclude the need to build the proposed irrigation line parallel to the underground storm drain on the east side of the highway. Its purpose is to irrigate primarily those properties along the east side of the highway. However, the water rights are still not clarified.

Conclusion

This feasibility study has provided essential background information on the stormwater problem in Bristol, along with an analysis of possible solutions. An estimate of the costs of three options requested by the community for study is included. The community has participated actively in the study via workshops conducted by Colorado State University. Additionally, the Bristol Water and Sanitation District (Water Board) has assumed a strong community-based leadership role.

It is anticipated that the community will now select one of these options, or a version thereof, and apply for a grant to finance a full-scale engineering design on the selected option. Using the engineering design, an additional grant or loan would then be needed to construct or rehabilitate the stormwater system.

Several tradeoffs are apparent. Clearly, Option #2 is the least expensive, but will require considerably more annual maintenance than the other two options. This annual maintenance requirement may tax the ability of the community to keep up with essential maintenance requirements. In addition, although all options will require some on-site supervision of stormwater flows during storm events, Option #2 will probably require the most supervision.

Option #1 is more expensive, but offers an opportunity to eliminate most problems with flooding, ponded water and muddy streets throughout town. Maintenance is expected to be minimal for Option #1. The cost of designing and constructing Option #1 will have to be weighed against the cost of maintaining Option #2 on an annual basis. It is possible that, as with the lagoon, Bristol could enter into a long-term, low interest loan from a federal or state agency program to finance Option #1.

Option #3, although yet more expensive, provides an opportunity for the community to improve residential properties with landscaping and to provide the opportunity for more residents to have gardens. The current practice of irrigating from the borrow ditch along the east side of the highway, either with an open ditch system or using risers as under Option #1, will continue to be an issue for the Colorado Department of Transportation due to safety

concerns. The water rights issue for irrigation should be clarified. The installation of a secondary system for the community would eliminate most of these concerns. It could probably also be financed through a state agency, such as the Colorado Water Conservation Board.

Finally, the ability to divert some stormwater into the lagoon is of great concern to the community. However, this would require a thorough investigation of the town's water rights to determine if this is possible. The lagoon was constructed in 1967 and financed through USDA's Rural Development program. Information on the design and original cost of the project was not known at the time of the completion of this report. The project was paid off in 2001. There does not appear to be any water rights associated with the lagoon.

There appear to be several options for the community to finance the development of the stormwater system. These options are being investigated at present. Conversations with federal and state agencies suggest that low interest loans are available and there are some grant programs available as well.

For instance, USDA's Rural Development program has indicated that both this project and the current plan by the community to upgrade its potable water supply system would likely qualify under that program. The Rural Development program finances projects and issues grants for drinking water, stormwater, and sewer projects. However, they do not finance irrigation projects, such as the secondary system envisioned under Option #3. It might even be preferable for both the planned potable water project and the proposed stormwater project to be financed together as a single project, including the engineering design work.

It is possible that such a project could be financed through either a general obligation bond or a revenue bond. A revenue bond might be preferable. Interest rates for such projects tend to run between 4 percent and 5 percent for 40 year loans under the Rural Development program (see their website), including the engineering design work. Table 4 shows some preliminary calculations of the potential annual repayment costs on a revenue bond for Option #1 and Option #3, based on conversations with the Rural Development program and the Colorado Water Conservation Board.

Table 4 - Estimated Annual Cost to Residential Accounts in Bristol

Option #1 - Underground Stormwater System

Cost (without irrigation infrastructure)	$267,048.00
Estimated Annual Cost to Residential Lot (lots currently with a water tap)	$231.26
Estimated Monthly Cost to Residential Lot (lots currently with water tap)	$19.27

Option #2 - Clean Out Existing Stormwater System

Cost	$66,750.00
Estimated Annual Cost to Residential Lot (lots currently with a water tap)	$58.03
Estimated Monthly Cost to Residential Lot (lots currently with water tap)	$4.84

Option #3 - Option #1, plus a Secondary System

Cost	$379,048.00
Estimated Annual Cost to Residential Lot (lots currently with a water tap)	$328.27
Estimated Monthly Cost to Residential Lot (lots currently with water tap)	$27.36

Option #4 - Option #1 plus a Secondary System (if new potable water system built)

Cost	$360,048.00
Estimated Annual Cost to Residential Lot (lots currently with a water tap	$311.82
Estimated Monthly Cost to Residential Lot (lots currently with water tap)	$25.98

NOTE: The above estimates are based on the community paying for the full cost of a project, rather than relying on a grant to cover a portion of the cost.

APPENDIX A

Brief History of the Project

Town of Bristol determines need of help and approaches County Commissioners.

September 28 - Meeting held in Lamar at Scranton-Specht and Associates to discuss including Bristol in the Lower Arkansas Valley Agricultural Drainage System Study being organized by Colorado State University.

October 8 - Meeting with Prowers County Commissioners to formally include Bristol into the larger Lower Arkansas Valley Agricultural Drainage System Study.

October 29 - Meeting with Town of Bristol to discuss initial activities (mapping of drainage system features) and to conduct a community walkthrough of the drainage system.

December 12 – Overview of drainage issues in Bristol and presentation of "action plan" for addressing the problem.

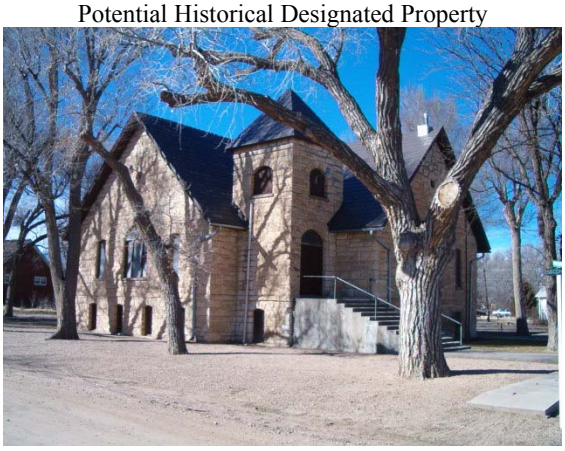
January 8, 2005 – Workshop on options explored by other small communities in the region. Selection of three options for the feasibility study.

March 5, 2005 – Feasibility study complete.

Workshop Activities

APPENDIX B

Potential Historical Designated Property



Flooded and Abandoned Commercial Property

Occupied House With Flood Damage

Abandoned House

Vacant Lot

Highway Running Through Town