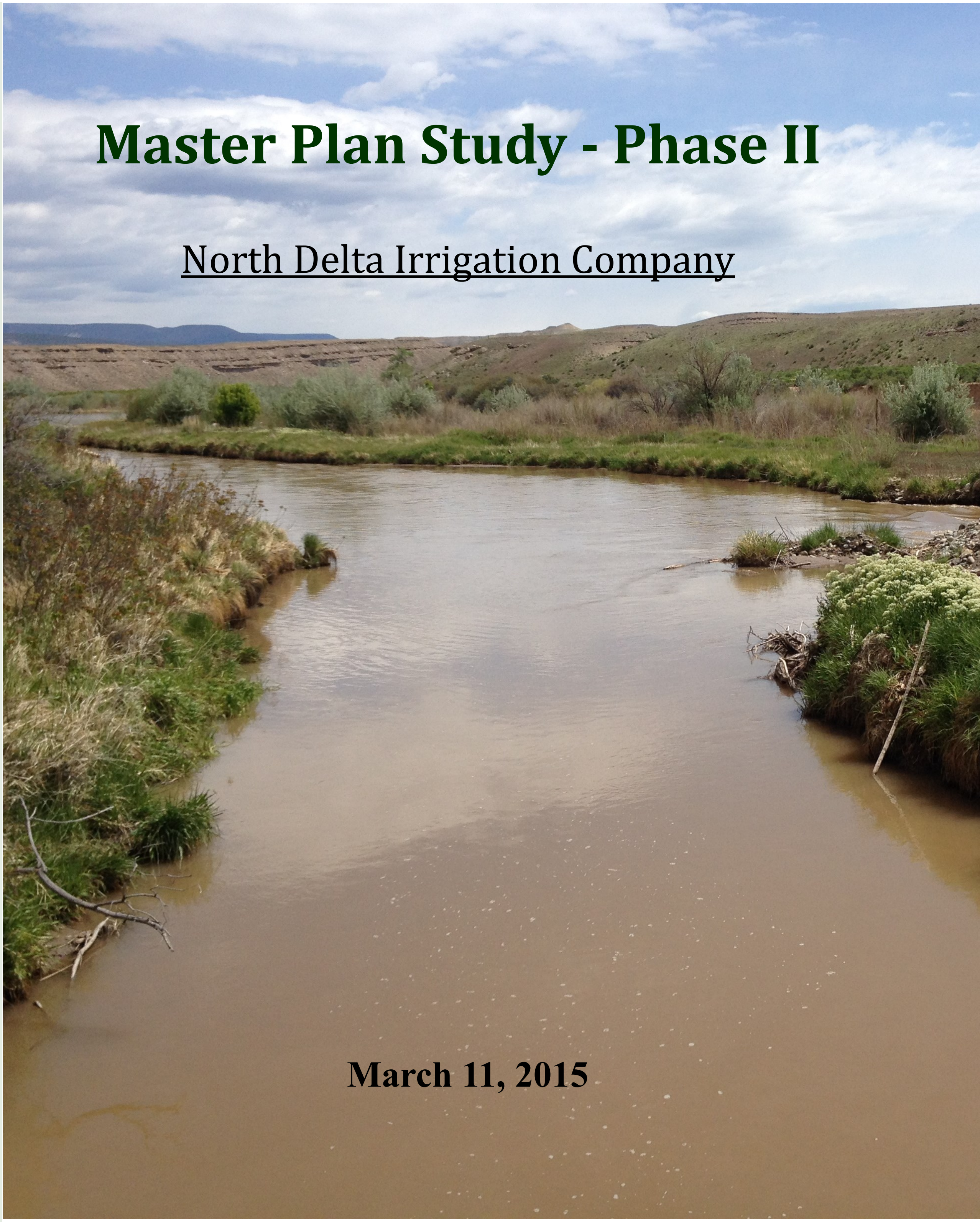
Master Plan - Phase II

Master Plan Study - Phase II

North Delta Irrigation Company



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INTRODUCTION

This report is the second part of a 2 phase study, the first of which evaluated issues concerning the recent tunnel collapse and subsequent piping project. The North Delta Irrigation District (NDIC) commissioned this study to evaluate numerous options for improving the future operations of their system. Funding for this study was provided by the Colorado Water Conservation Board (CWCB) through remaining funds from the tunnel piping project.

NDIC currently operates two river diversions to supply their system. The main headgate is located on the Gunnison River and the other is located on Tongue Creek. Water rights held by NDIC allow for diversion rates of 50 cfs off the Gunnison River and 30 cfs off Tongue Creek but the combined amount between the two points cannot exceed 50 cfs. Historically the Gunnison River has been the most reliable source of water for the system as flows on Tongue Creek are highly dependent on tailwater return flows from irrigation which are unreliable particularly in drought years. With the tunnel collapse in 2011 and subsequent problems with the installed tunnel pipe NDIC is interested in evaluating options to allow them to provide a reliable water supply to their shareholders in the future. An overview map of the NDIC system is located in Appendix A.

DATA GATHERING

TUNNEL PIPE INSPECTION

On March 9, 2014 a visual inspection of the interior of the tunnel pipe was performed to assess the integrity and general condition of the pipeline. One short section of the tunnel was flooded with over 2 feet of water and not walked but over 90 percent of the tunnel was visited. Measurements taken during this site visit indicate that the pipe has not experienced a significant amount of deflection due to backfilling of the large excavation hole or any tunnel collapsing that has taken place since the pipe was installed. Holes drilled in the roof of the pipe by NDIC are primarily in one area near the downstream end and none are located in the large air pocket in the middle of the tunnel pipeline. As mentioned in the Phase 1 study these holes were subsequently plugged with liquid nails; however, this does not appear to have sealed the holes as indicated by mineral deposits inside the pipe. In addition, one hole appears to have been cut in the pipe measuring approximately 4 inches by 4 inches. NDIC stated that this was done to observe the water flow in the pipeline at the location of the large excavation hole near the downstream end of the tunnel prior to backfilling the hole. Observations of pooled water in the tunnel also leads us to conclude that there is either an error in one of the survey points provided by Southwest Surveying or the pipe has settled nearly 2 feet in one location since the survey was performed in April 2014.

HOLES IN TUNNEL PIPE

CUT HOLE IN TUNNEL PIPE

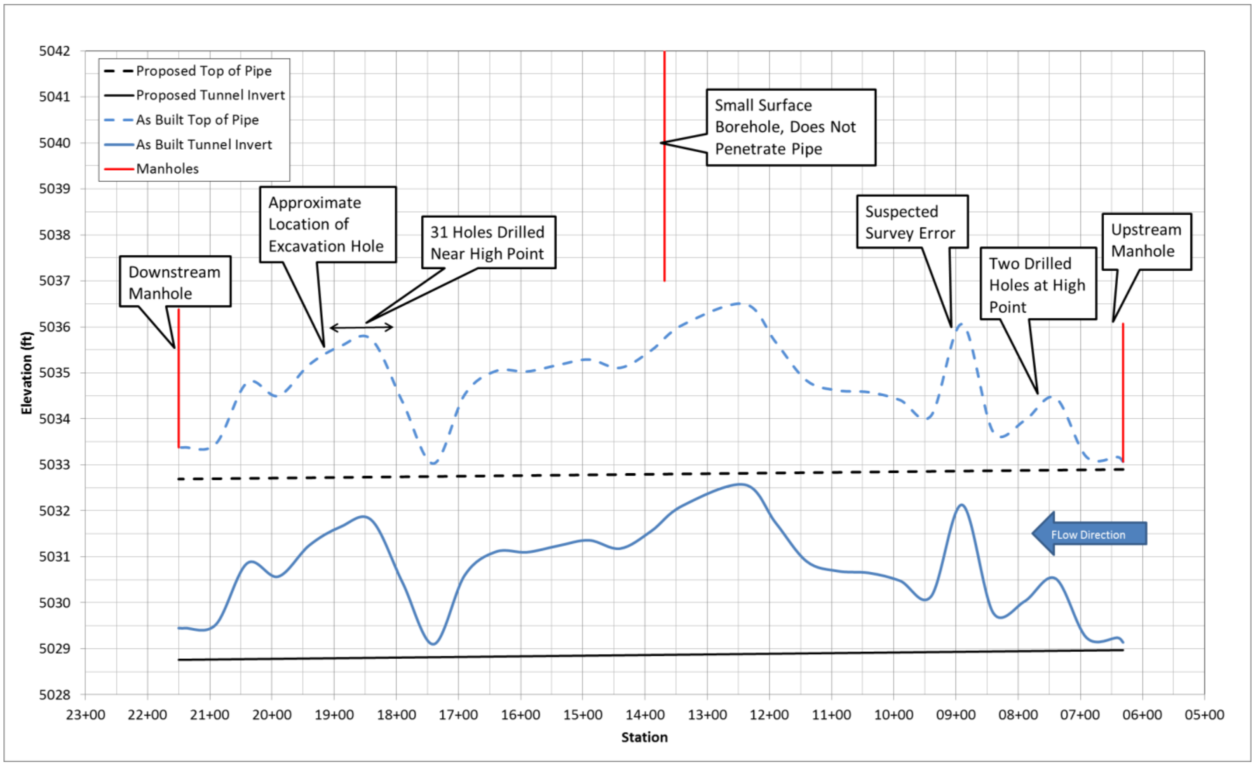


FIGURE 1 TUNNEL PIPE INSPECTION

FLOW MEASURING

Flow measuring at key locations along the NDIC system was carried out on October 13 and 14, 2014. The *Two-Point Method* was employed to gather velocity measurements and the *Midsection Method* was utilized to process measurements and compute actual flows. Both of these methods are recommended for stream gauging by the USBR, the procedures of which can be found in the USBR's *Water Measurement Manual*.

Velocity measurements were obtained using electromagnetic flow measuring equipment, specifically a Marsh-McBirney 2000 Flo-Mate. The unit offers +/- 2 percent accuracies on each velocity measurement. Considering user error and the nature of the computation, it is reasonable to assume a +/- 5 percent accuracy on each flow measurement. It is important to note the submerged condition of measuring flumes observed while flow measurements were being taken. Parshall Flumes at Tongue Creek and the Adobes were submerged beyond the point of using correction factors. Interestingly, however, the gage reading at the Adobes flume indicated a discharge of 38.3 cfs which is very close to the measured flowmeter value of 38.9 cfs.

SUBMERGED ADOBES FLUME

Figure 2 shows flow measurement locations, computed flow values, and estimated flow paths. See Appendix B for raw data and tabulated computations. Based on the results of the measuring, a couple of observations and conclusion can be drawn:

- The canal losses approximately 10 percent to seepage between the headgate flume and the current creek trestle crossing.

- The NDIC system receives significant amount of drainage from irrigated crops situated above the system.
- The seepage volume on the rest of the system is relatively low compared to other ditch systems in Colorado.

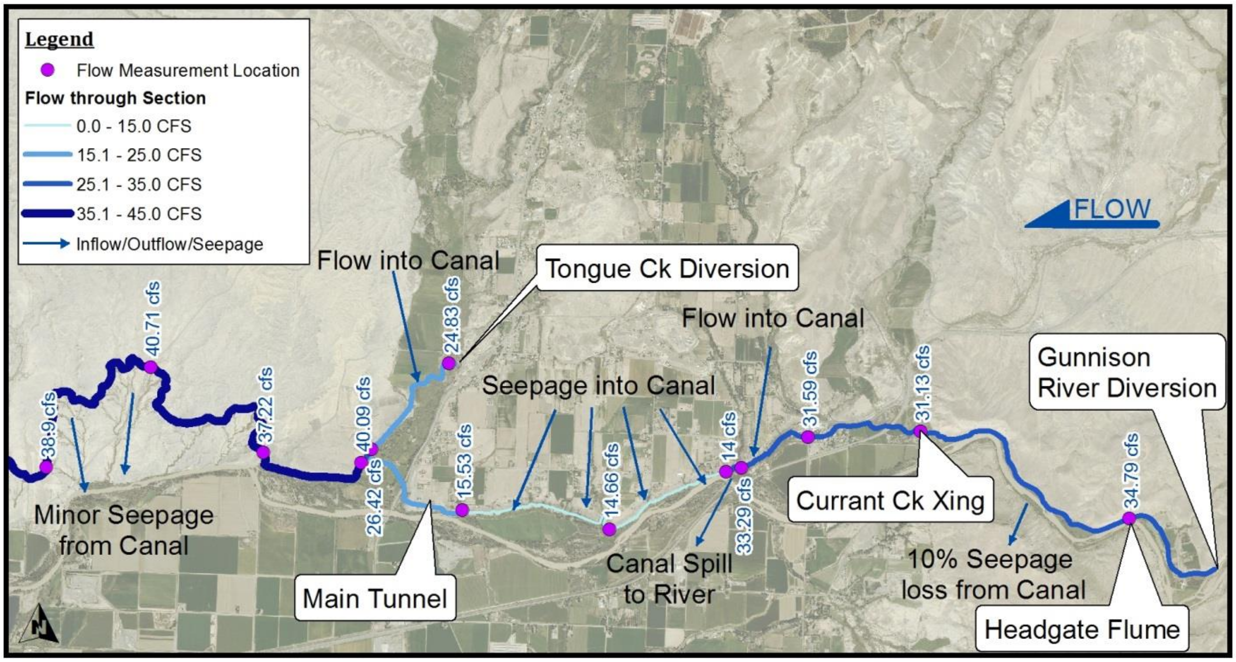


FIGURE 2 NDIC FLOW MEASUREMENT MAP

The tunnel capacity has been measured with a flowmeter by various people during the past 2 years. According to NDIC the water level upstream of the tunnel is very steady with only small fluctuations. Tunnel flowrate readings shown below and in Figure 3 indicate that the tunnel capacity may be decreasing over time:

- 23 cfs - July 17th 2012 (Steve Tuck - Water Commissioner, immediately after tunnel was turned on)
- 17.68 cfs - August 8, 2014 (Steve Tuck with Applegate Group present)
- 13.67 cfs - October 13, 2014 (Applegate Group)

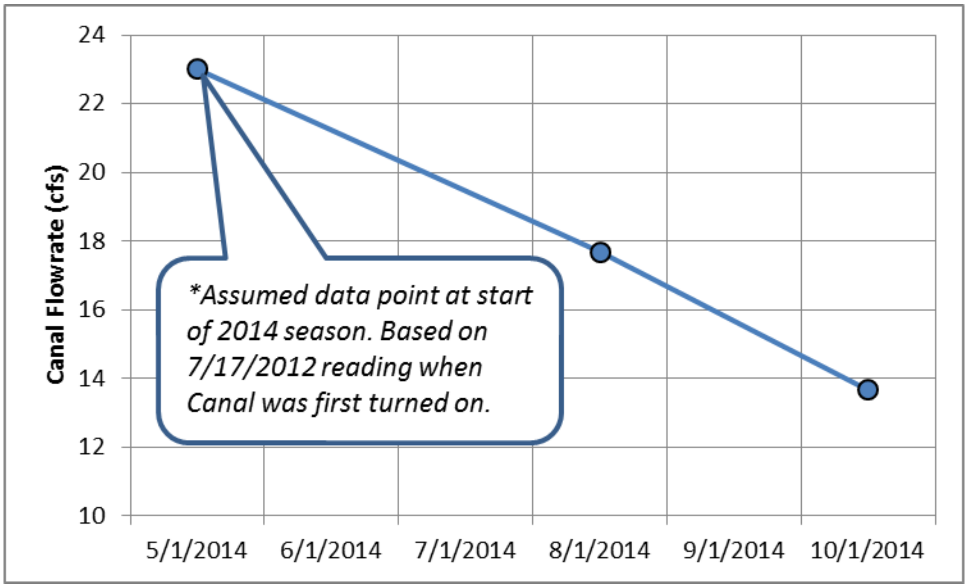


FIGURE 3 TUNNEL FLOWRATE READINGS

One possible explanation is that during operation air is being added to the large air pocket in the middle of the tunnel pipe. Such a situation would cause an air lock in that area and reduce the pipe capacity. This would need verified by further flowrate readings; however one simple recommendation is to drill one ¾ inch hole in the roof of the HDPE pipe at each high point. We recommend that this be performed prior to turning the tunnel on in 2015. Once the Tunnel is turned on in 2015 a flowmeter should be used to estimate the flowrate once again. One other explanation for the decreasing capacity is that the pipe invert could be shifting. We feel that this is less likely since the weight of the water in the pipe during the irrigation season would weigh the pipe down and limit any upward movement of the pipe that could cause a decrease in capacity.

SURVEY AND SITE VISIT

Survey grade GPS equipment was used to survey critical elevations to establish pumping heads, hydropower heads, siphon head differentials, and average canal slopes for piping and lining purposes. See Appendix B for the survey file.

A site visit was also done in order to verify information not readily obvious from aerial imagery. This aided in determining the following:

- Irrigation techniques common on the system
- Condition and layout of laterals, especially those located on 1525 Rd, 1550 Rd, and 1575 Rd
- Location and nature of tail water drainage and associated infrastructure
- Identifying potential areas suitable for buffer storage
- Establishing normal operating water levels within the canal

WATER DEMAND AND SUPPLY

Analyzing water demand and supply is important to establishing reasonable flows that equate to cost effective designs that can adequately supply the amount of water needed in the system. It is important to note that the irrigation season was assumed to start mid-April and continue to the end of October.

WATER DEMAND

This analysis uses historic evapotranspiration data to estimate the water demand of crops grown under the NDIC system. Local evapotranspiration and climate data was collected at the Delta CoAgMet Station, which is part of the Colorado AGricultral Meteorological nETwork (CoAgMet).CoAgMet climate and evapotranspiration data is reported daily and spans from 1995 to the present. Years with impartial data were ignored in the demand analysis, this includes years 2002, 2005, 2006, 2007, and 2009. For this analysis, the data was initially processed by taking daily evapotranspiration rates and subtracting any precipitation that occurred on that day. The resulting 'net evapotranspiration' represents the amount of water needed by means of irrigation to satisfy the crops requirement at the plant. Daily averages were developed for each month of the irrigation season.

The data was further processed to convert evapotranspiration requirements to a flow, assuming continuous application. This was done by applying the total evapotranspiration demand (on a monthly basis) to the irrigated acreage at 50 percent efficiency. In other words, if the crop irrigation demand was calculated as 1 cfs, this analysis assumed that 2 cfs would be diverted to meet that demand. This efficiency is a reasonable value for flood irrigated and gated pipe, which are very common on the NDIC system.

Irrigated acreage was estimated based on observations from site visits and aerial imagery. Subdivision areas were reduced by 50 percent to account for structures, driveways, and other non-irrigated areas. Based on this analysis a total of 1,669 acres are currently served by the NDIC system, see map below. It appears that large areas of historically irrigated acreage are not currently irrigated near the western end of the system.

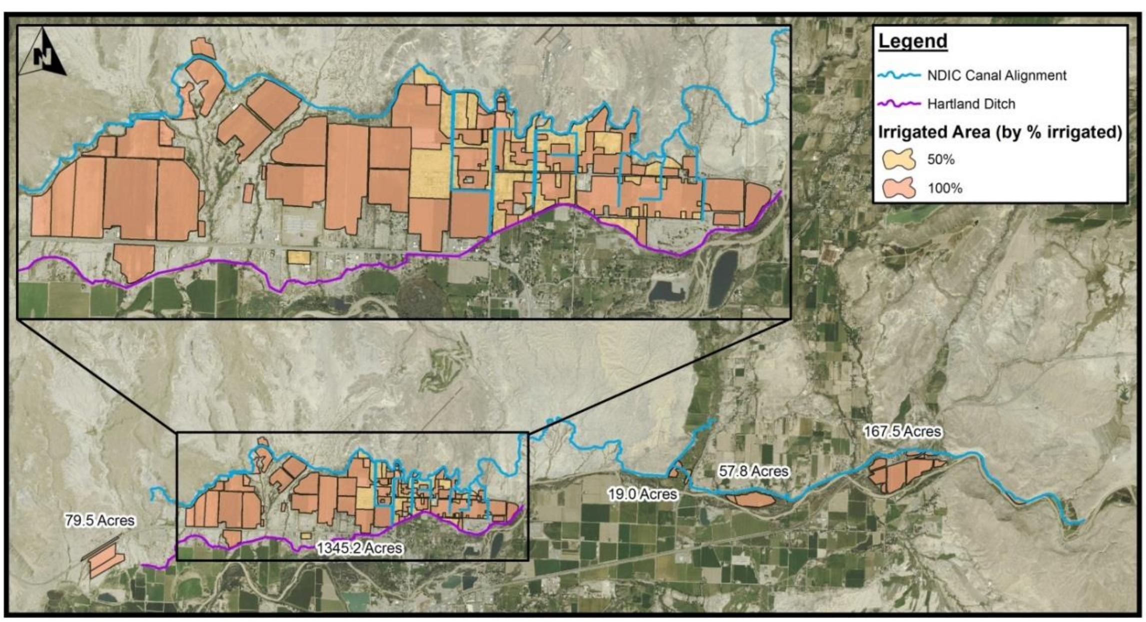
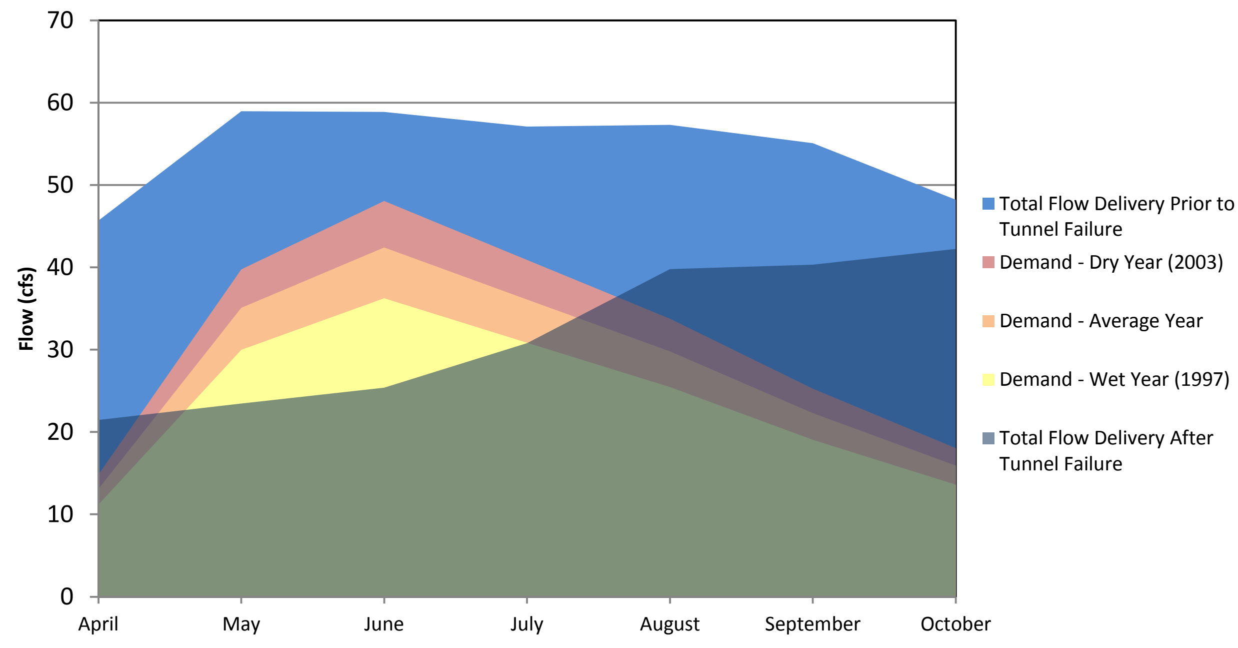


FIGURE 4 CURRENT IRRIGATED ACREAGE SERVED BY NDIC

WATER SUPPLY

Historic diversion data for NDIC diversions off the Gunnison River and Tongue Creek were obtained from the Colorado Division of Water Resources. The data spans from 1970 to the present and large portions of reported flow values seem to be rounded and may not be completely accurate. Although some of the data is questionable, it is the only historic flow data available and Applegate Group believes it provides a general idea of historic NDIC water diversions.

The diversions from the Gunnison River and Tongue Creek were combined to obtain monthly average flows prior to the tunnel failure and after the tunnel failure (2011). This data was then compared with the system demand requirements discussed above. The graph below shows the comparison of water supply and demand on the NDIC system. The reader is reminded that the demands shown below assume a system efficiency of 50 percent.



- Dry year and Wet year crop demand were determined by summation of total crop demand for the irrigation season from records dating from 1995 to 2014

FIGURE 5 NDIC WATER SUPPLY & DEMAND COMPARISON

Based on the results of the water demand and supply analysis, a couple of observations and conclusion can be drawn:

- Prior to the tunnel failure NDIC diverted ample amounts of water to serve irrigation needs, even for dry years
- After the tunnel failure NDIC cannot keep up with water demands during the summer months
- System efficiencies could be improved in order to reduce the difference between supply and demand but would need to be nearly 100 percent in order for the supple to equal the demand on an average year.
- Diversions after the tunnel failure are very dependent on what is available in Tongue Creek. As mentioned previously this water source is highly dependent on irrigation practices in the Tongue Creek basin and during severe drought years there is little water available at this

location and the water supply shown in Figure 3 would be further reduced to the tunnel capacity.

SYSTEM IMPROVEMENTS

The NDIC system was analyzed to identify infrastructure improvements that would improve the efficiency and reliability of the system. See below for a detailed discussion and cost estimates of the specific improvements considered.

FLOW MEASUREMENT STRUCTURES

It would be Applegate Group's recommendation to install more reliable means of flow measuring on the system. Ramp flumes are much more suitable to the types of conditions encountered on this system since they are capable of making accurate measurements under submerged conditions without the use of correction factors. Ramp flumes are increasingly being used for flow measurement because of their ease of installation, flexible construction tolerances, and accuracy. The rating curve for a ramp flume can also be adjusted after construction to account for as-built conditions.

Installing better flow measurement devices would allow for more efficient management of the system. The Adobes flume could be simply modified into a Ramp Flume by installing a concrete ramp in the bottom of the existing Parshall Flume and the existing staff gage could continue to be used with a new rating curve. A temporary ramp flume constructed of painted plywood could be installed in the existing 60 inch pipe between the Tunnel Outlet and the inverted siphon inlet. This flume could be installed through the existing manhole and a small hole would need to be cut in the top of the pipe near the flume to allow depth readings to be taken. Since there are low seepage losses in the reach between the Adobe flume and the inverted siphon outlet these two readings could allow the diverted flows off of Tongue Creek to be estimated. The last flume that should be evaluated further is the headgate flume. This flume should be checked for submergence and levelness to determine if any correction factors are needed. Trout Unlimited (TU) has indicated that they have money available to assist with constructing better flumes prior to the next irrigation season. If this is of interest to NDIC this potential should be pursued immediately.

PIPING/LINING MAINLINE CANAL

This improvement includes piping or lining the NDIC canal from the Adobes flume to the end of the Hawkins Lateral. Based on the survey discussed above, the NDIC canal was found to have a very flat slope of about 0.0006 feet per foot, thus a gravity pressurized system was not considered. A large diameter pipe would be necessary to overcome head losses, even so significant pressure would not be available at the turnouts. Applegate Group concluded pressure pipe would be very costly compared to gravity pipe and would provide the system with little increased benefit. The main benefit of lining or piping the canal with gravity pipe would be to reduce seepage losses from the system which would also reduce the risk of a canal failure.

The gravity pipe was sized for an initial flow at the headgate and then downsized based on turnouts as the pipe line progressed downstream. In this study, pipe was sized to never be more than 75 percent full at a slope of 0.0006 feet per foot. Significant cost savings can be realized by sizing the pipe based on system demands as discussed earlier in this report as opposed to the full decree. The estimated cost of a gravity pipe system sized for the demand flow and for the full decree flow were $8.4 million and $9.5 million respectively. The cost includes the installation of the pipe itself as well as an inlet structure, turnout structures, and a flow measuring structures. Although there are saving of about $1 million using the demand flow as the design basis, ultimately these options were deemed unfeasible due to the large capital investment.

Another option that has been used on very flat canal systems involves lining the canal with a liner system consisting of an impermeable membrane covered by shotcrete. Based on costs of similar projects completed in the Grand Junction area we estimate that lining this section of canal to be $4.7 and $5.0 million for the demand flow and decree flow respectively. This appears to be significantly cheaper than piping the canal; however, obtaining a USBR Salinity Control Grant to perform this work would be questionable due to the cost benefit ratio discussed later in this report.

PIPING LATERALS

Lateral improvements were focused on those located on 1525 Rd, 1550 Rd, and 1575 Rd, which serve small subdivisions and lots with a significant proportion of lawn irrigation. Those laterals tend to be problematic for NDIC when shareholders water their lawns at the same time, causing shortages in the NDIC canal. In many areas there is a lateral on both sides of the street in order to supply water to all shareholders. Many shareholders have installed small pumps that draw water from the flowing lateral for lawn irrigation. At times when the water demand is lower the headgate is not typically adjusted in order to ensure water is available for those shareholders at any given time. Based on site observations it was found that the laterals discharge unused water into the Hartland Ditch. In their current state the laterals are intermittently piped and lined. See map below for a general layout of the laterals.

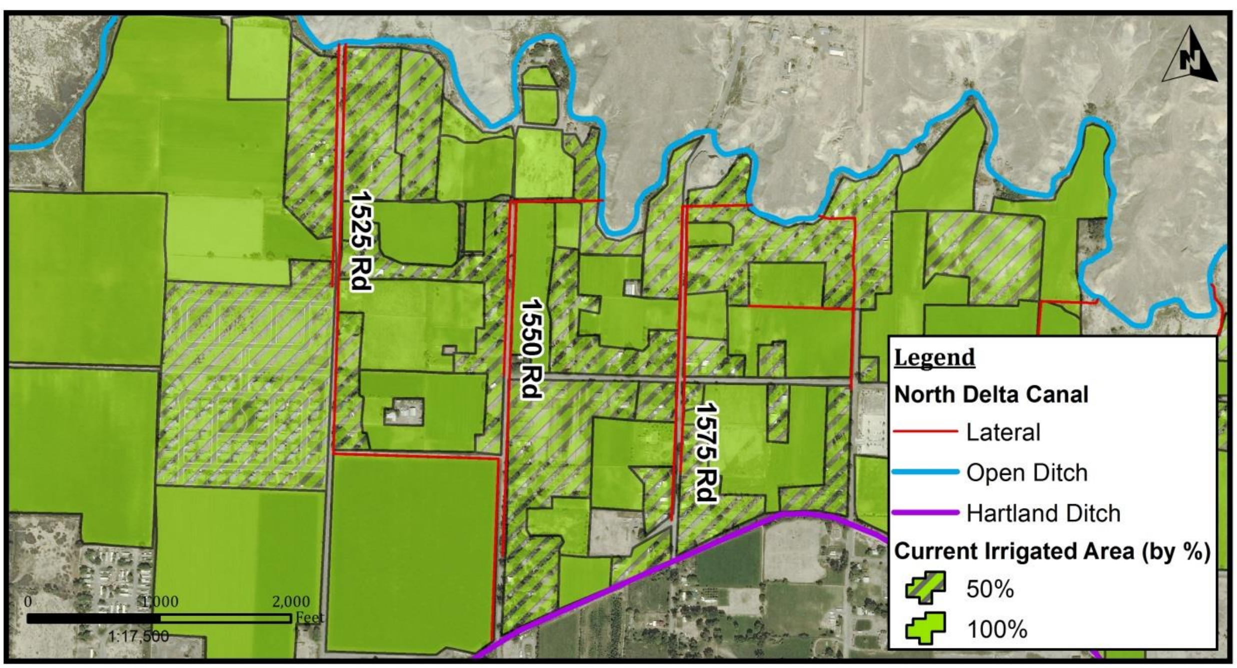


FIGURE 6 LATERAL IMPROVEMENT LOCATIONS

Piping the laterals located on 1525 Rd, 1550 Rd, and 1575 Rd with pressure pipe would provide significant efficiency improvements that would alleviate the stress on the NDIC canal during times of high demand. Installing pressure pipe on the laterals allows for irrigation water to only be diverted when it is needed, thus completely eliminating waste water discharging to the Hartland Ditch during times of low water use. Pressure pipes were sized such that pipe velocities would not exceed 5 feet per second.

Cost estimates were developed for a complete replacement of each lateral with one PVC pipe alignment. Estimates include removal of the existing carrier system and installation of new PVC pipe, an inlet structure, an outlet structure for flushing, 'large' turnout structures, and 'small' turnout structures. The estimate also includes costs for boring across county roads to supply shareholders on the opposite side of the street. The cost for lateral improvements on 1525 Rd, 1550 Rd, and 1575 Rd are $164,000, $160,000, and $172,000 respectively. Detailed cost estimates can be found in Appendix D.

BUFFER STORAGE

Buffer storage was another means to address water shortage issues associated with the laterals mentioned above. This involves the storing of water during times of low demand that can be drawn upon in times of high demand. For this study, adequate buffer storage volume was determined to be 7 acre-feet, this represents the amount of water to satisfy the average demand of the laterals mentioned above for a 24 hour period.

EQUALIZER RESERVOIR

An equalizer reservoir was considered for providing buffer storage to the canal. This would involve constructing a non-jurisdictional reservoir and a pump to fill the reservoir. Upon a site visit, it was concluded that this option would be expensive due to limited reservoir sites, land ownership, and pumping costs.

CHECK STRUCTURES

A more feasible means of buffer storage considered was in-canal check structures. Check structures create 'wedge storage' by backing up water within their reach which can be drawn on in times of high demand. For this study, it was assumed that a check structures could hold an additional 2 feet of depth, Applegate felt this was a reasonable assumption that would not exceed the freeboard capacity of the canal along most sections. A few sections with low freeboard may need to be filled to provide the additional freeboard. It was determined that 9 check structures spaced around 3,000 feet apart could hold 6.9 acre-feet of storage.

Check structures can be 'passive' and operate on fixed weirs, or they can be 'active' and operate on manual or automated gates and may incorporate remote monitoring and control. A 'passive' check structure was estimated to cost $20,000 per structure and an 'active' check structure was estimated to cost $50,000 per structure. These costs are based on costs of similar structures on other canal systems. Although 'passive' check structures are considerably cheaper, 'active' check structures offer more fined tuned and efficient water management. Water measurement capabilities can also be built into check structures.

A complete 'passive' check structure system consisting of 9 checks was estimated to cost $251,000 while a complete 'active' check structure system was estimated to cost $439,000.

NEW TUNNEL BORE

At the request of NDIC the feasibility of a new tunnel bore was considered to completely replace the failed tunnel. Contractors were contacted for construction estimates for three boring methods, discussed below.

TUNNEL BORING MACHINE

A tunnel alignment adjacent to the existing would be possible with a boring machine as it is able to tunnel curved alignments. This method was estimated to cost $4.25 million and includes boring a 1530 foot long tunnel and the installation of 54 inch pipe.

PIPE JACKING

It is only possible to tunnel straight alignments with this method, thus a completely new alignment is necessary in order to avoid the old curved tunnel. The new alignment would start upstream of the current tunnel and continue straight 2000 feet before joining back with the canal on the east side of Highway 65. This method was estimated to cost $2.89 million and includes boring a 2000 foot tunnel with steel casing that will be lined off site with polyuria coating. Lining the steel casings proved to be more economically feasible than dragging new pipe.

DIRECTIONAL DRILLING

This method allows for curved alignments but it is not capable of reliably following the flat slope of the tunnel. Typically a minimum slope of 1 percent is required. This slope would result in the tunnel pipe daylighting on the west side of Highway 65 significantly lower than the existing canal. Replacing the aging inverted siphon across Tongue Creek would be required at the same time as a new directional drilled tunnel and would fall along a new alignment across the Tongue Creek valley. Also the diameter required for this project is pushing the current limit of this technology. Talking with one contractor we estimate that this option would likely cost approximately $2.5 million not including the cost of a new siphon which is discussed later in this report.

Below is a map displaying the proposed tunnel alignments.

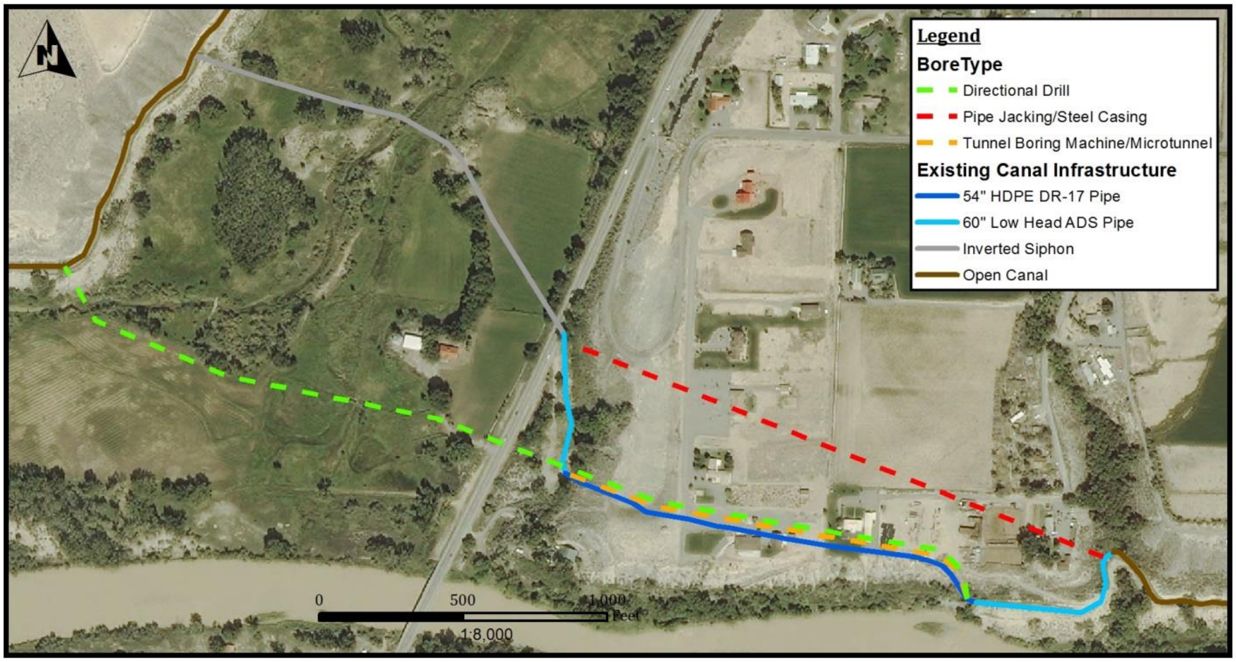


FIGURE 7 PROPOSED TUNNEL BORE ALIGNMENTS

SIPHONS

A previous study carried out by King Engineering in 2014 suggested a potential siphon alignment to bypass the adobes, that alignment was further analyzed in this study. The adobe bypass siphon would require 7,500 feet of 48 inch pipe. The alignment contains three high spots that would need a combination air valve at each, as well as four low spots that would require a drain valve at each. The siphon would reduce seepage losses in the adobe hills and reduce the liability and risk associated with two tunnels currently in that reach. The cost of installing the siphon was estimated to be $2.16 million.

In addition to the siphon mentioned above, updating and replacing the current tongue creek siphon was assessed. It is unknown the exact condition of the siphon but based on conversations with NDIC Board Members Applegate Group gathered that it is aging and consists of a mix of concrete and metal pipe. The cost a replacing the tongue creek siphon with 48 inch HDPE pipe, a new inlet structure, and a new outlet structure was estimated to be $529,000. Please note that this option would leave the existing siphon in the ground.

The map below displays the proposed siphon alignments and associated infrastructure.

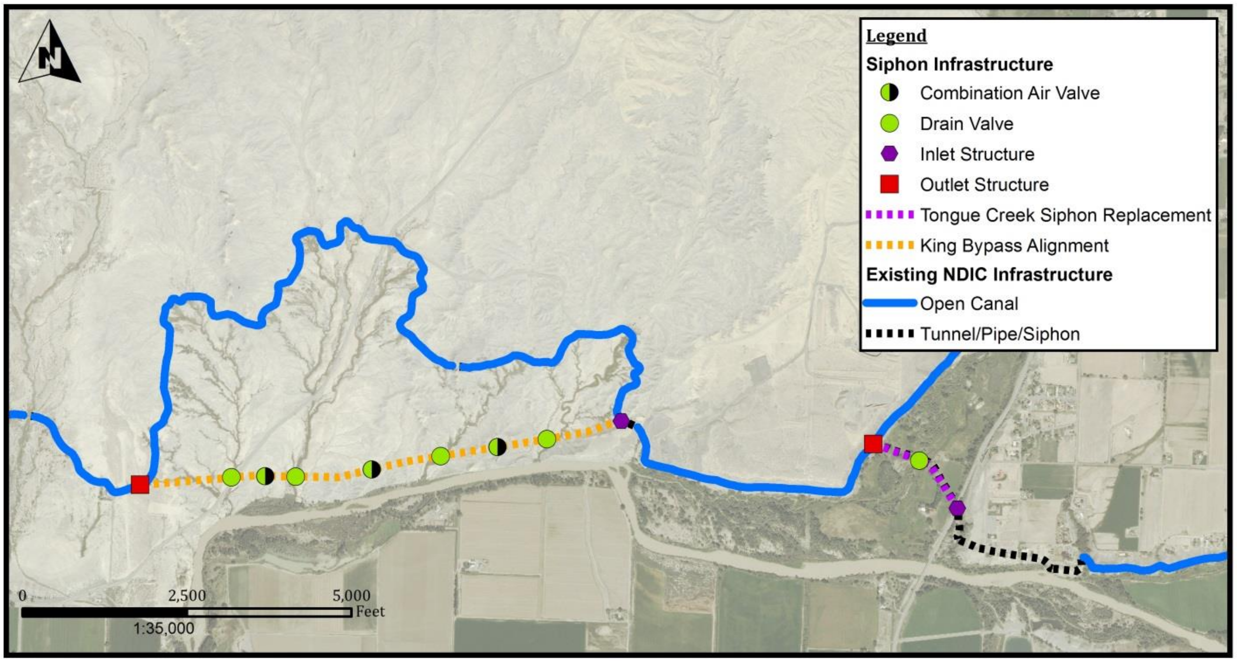


FIGURE 8 SIPHON LAYOUT AND INFRASTRUCTURE

RECONFIGURED SYSTEM

The King study evaluated an option that would relocate the main canal diversion on the Gunnison River downstream to a point near the Hartland Ditch diversion. Doing so would eliminate the need to modify/fix the tunnel pipe and replace other aging infrastructure, such as the Tongue Creek siphon. This study expanded on that idea by considering options that would abandon the reach of canal from the West side of Austin to the end of the adobes with an alternate point of diversion for a pump station on the Gunnison River located near the Hartland Ditch diversion.

This would require a filing in water court to specify the new location as an alternate point of diversion for both the Tongue Creek and Gunnison River diversions. A discussion with the Colorado Department of Water Resources and our own knowledge of this area indicates that there should not be a significant amount of opposition to such a filing. This option would essentially leave a significant portion of NDIC's water in the reach between the existing diversions and the proposed pump station location. There are few intervening water rights in this stretch of river and no instream flow right. The only call historically administered in this reach was from the Redlands Power Canal in 2002, however, recent changes with the operation of the Aspinall Unit reservoirs and changes in the Redlands system itself significantly reduces the likelihood of this call being placed in the future. Even if a call was made it would impact the existing diversion points in the same manner as a new point of diversion.

The map below shows the section of canal that is proposed to be abandoned in this option.

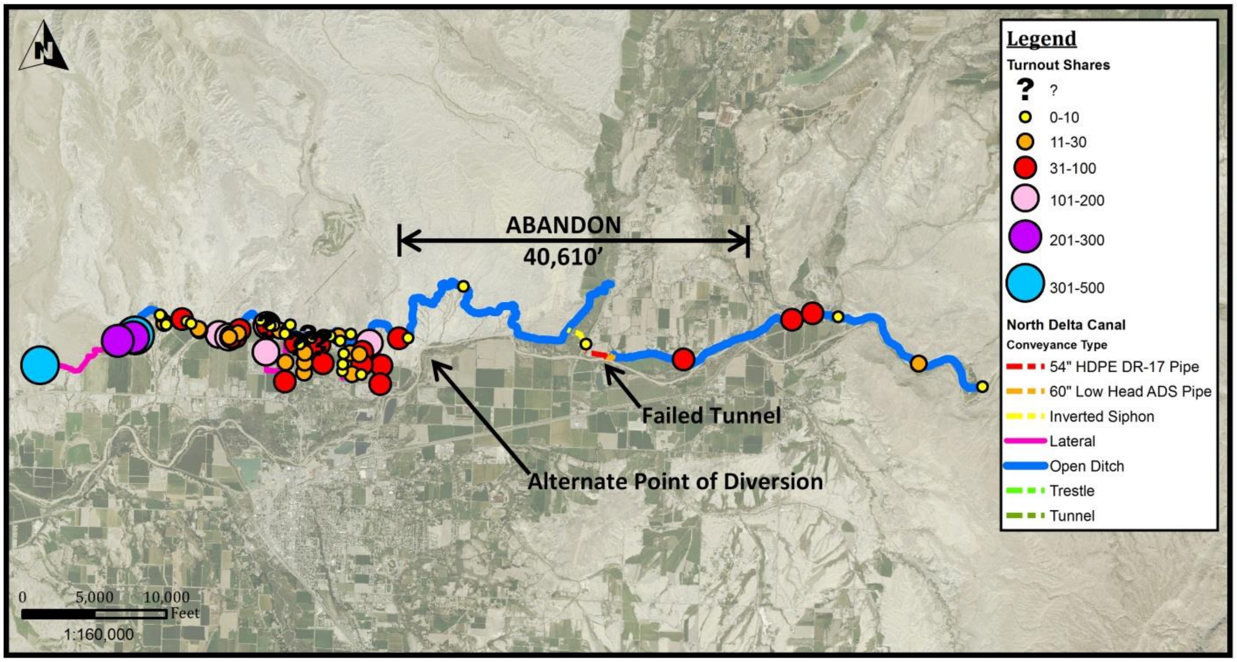


FIGURE 9 PROPOSED NDIC ABANDONMENT MAP

The proposed abandonment section eliminates the failed tunnel altogether as well as the Tongue Creek siphon and two tunnels within the adobe reach and thus the associated risk and liability. The abandonment section also falls within a section of canal in which there are few shareholders. By keeping the main diversion intact the system will still be able to serve shareholders near Austin, while adding an alternate point of diversion would serve the majority of shareholders downstream of the adobes. Solutions for the two shareholders in the abandoned reach will need to be addressed.

PUMP STATION

To carry water from the alternate point of diversion to the canal system a pump station is needed. The survey previously mentioned in this study measured a required pumping lift of 60 feet from the river to the canal.

The pump could be sized to carry a percentage of the full decree based on the number of shares served by the pump, but significant savings could be realized by sizing the pump to satisfy the demand flow. The table below shows the difference in pump size and energy requirements for a pump sized to carry the decree flow constantly through the irrigation season compared with a pump that will mimic the demand curve presented in the 'Water Demand' section of this report.

TABLE 1 PUMP SIZING COMPARISON

Sizing Flow	Pump Size (HP)	Electricity Requirement (kWh/yr)	Annual Operating Cost ($/yr)*
Full-Decree	400	1,574,000	$126,000 - $173,000
Demand	300	753,000	$60,000 - $83,000

* Usage rates & other costing information will be discussed in greater detail in later sections of this report

Sizing the pump for the full-decree was not further considered due to the extremely high operating costs. The pipeline for the pump station could be located within an existing pipeline easement held by NDIC and the pump station would be located entirely on a land parcel owned by NDIC. The pump station would contain several pumps to allow for some redundancy and for increased flexibility. The initial installation cost of a pump station to meet the demand flow was estimated to be $1.05 million and includes:

- 1,350 feet of 36 inch HDPE pressure pipe
- Inlet structure with 1mm screen for fish screening purposes
- 300 HP total pump power
- Pumphouse Building
- 3-Phase electric materials and hookup
- Outlet Structure

In addition to the initial and operating cost reported above, an additional $9,000 a year is estimated for maintenance.

POWER GENERATION

The annual costs associated with operating a pump station are cost prohibitive for NDIC and would need to be offset somehow in order for this option to be feasible. This study evaluated the feasibility of using either a hydropower plant or solar array to offset the annual costs of running the pump. The Delta-Montrose Electric Association was contacted to discuss the idea of 'net metering' the pump usage with some sort of off-site power generating facility. Although the pump cannot technically be 'net metered' without the generating facility being behind the same meter, DMEA has a policy for 'net metering' for qualifying grid tied generation, meaning that renewable energy generation can be used to offset power usage elsewhere on their grid.

The specifics of conversations with DMEA and their grid tied generation policy as it relates to the NDIC system will be discussed in greater detail in the 'Cost Estimates' section of this report.

HYDROPOWER POTENTIAL

A hydropower turbine located on the NDIC canal West of Austin, directly upstream of the abandoned section, is an ideal location. A survey concluded a total drop of 35 feet could be utilized by a turbine at that location. The hydropower option would divert excess water at the main headgate and flow not utilized by shareholders within that reach would be put through the turbine before discharging back to the Gunnison. A new easement would be required for the penstock pipe and turbine facility as well as a new three phase power line.

To estimate the potential months of operation, flow data from the Redland Power Canal in Grand Junction was referenced. The Redland Power Canal diverts water to supply a hydropower turbine and on average they operate 11 months out of the year. This study assumed the same operating period for calculating potential energy generation. The headgate diversion flow would need to be increased from the historical 50 cfs to 67 cfs in order to satisfy upper end shareholders as well as fully offset operation and maintenance costs for the pump and turbine. If the upper end of the NDIC system is lined with shotcrete the hydraulic capacity would be more than enough to handle the increased flow while also reducing the seepage loss in that reach.

A cost estimate was developed for a completely reconfigured system focused around a pump station and hydropower plant as well as some of the system improvements mentioned in the previous section, the estimate includes the following:

- Pump Station, same as the one mentioned above
- Screen structure on existing Gunnison River Diversion
- Hydropower Plant ($1.13 million)
- Lining canal upstream of turbine
- Solutions for 'stranded' shareholder on Tongue Creek – 8" Pipe from Tongue Creek headgate to turnout. A pump on Tongue Creek may be more cost effective but would require coordination with that shareholder.
- Backfill of abandoned canal
- Four active and five passive check structures at lower end of system
- Currant Creek Trestle Replacement
- Piping Laterals

The system described above would result in improved system efficiency and reliability while continuing to provide adequate water for shareholders. The cost totals $6 million and is expected to generate $2,000 of revenue each year of operation to cover unforeseen costs. Please note that the generation of the turbine is enough to cover the entirety of operating and maintenance costs of the pump and turbine on an average year.

See below for a map showing the general layout of the pump station and hydropower plant.

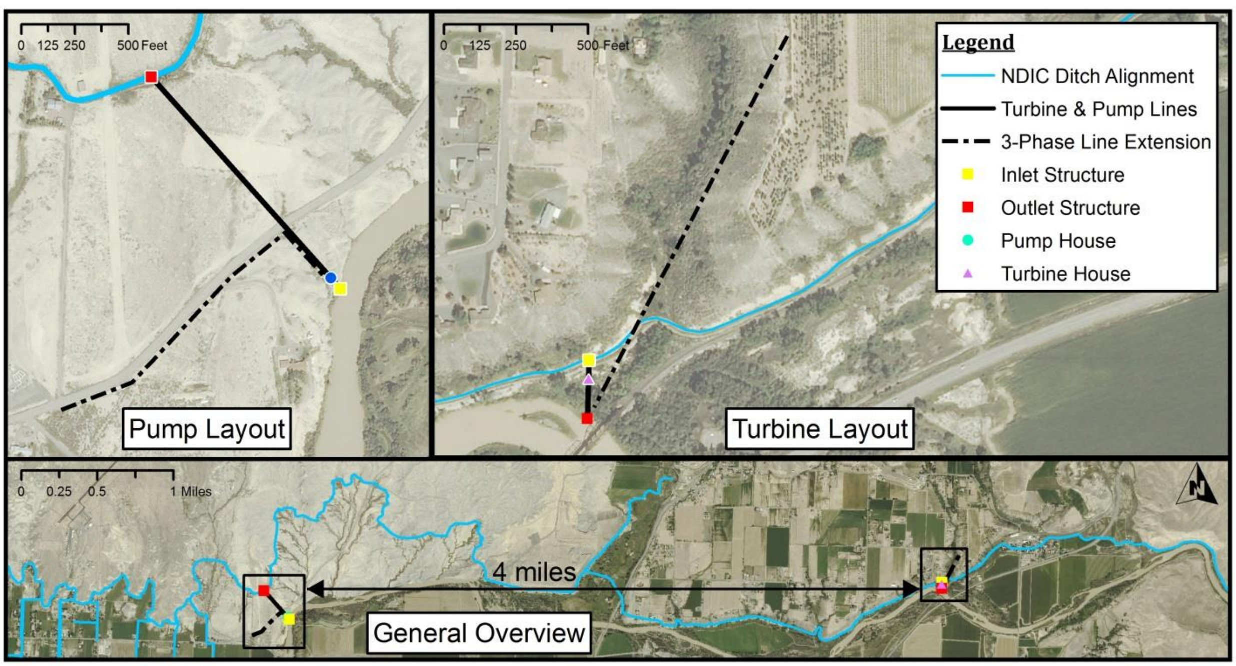


FIGURE 10 PUMP STATION AND HYDROPOWER HOUSE CONFIGURATION

The hydropower option is contingent on two import aspects: the ability to obtain a water right and a Federal Energy Regulatory Commission (FERC) license. As mentioned earlier, a regular call has not historically been placed on this section of the Gunnison River and therefore filing a new non-consumptive water right for hydropower would not likely be rejected by the water court. A much more significant unknown would be the possibility of obtaining a license from FERC for the operation of the plant. Since the plant would be using a new water right to generate hydropower it is likely that a full permit would be required rather than an exemption for small plants using existing conduits and water rights. Obtaining a FERC license would require that the project be reviewed by numerous consulting agencies including the Federal Fish and Wildlife Service and the Colorado Parks and Wildlife. While the existing Programmatic Biological Opinion for the four endangered fish species states that habitat for them does not extend above the Hartland diversion there are still a couple species of concern located in this reach that could impact their view of such a project.

SOLAR ARRAY

Similar to the hydropower option discussed above, a solar array was considered as a means of generating power to offset the operating costs of a pump. Besides the obvious, a solar option differs from the hydropower option in that the flow at the main headgate would only need to be enough to satisfy the irrigation needs of the shareholders upstream of the abandoned section, which is about 4 cfs.

It is important to stress that solar panels are relatively new technology and there are many unknowns related their life span. Typically solar panels are warrantied for 25 years but beyond that is unknown. It is understood that solar panels energy production degrades year by year, for this study a degradation rate of 0.8 percent was assumed. That value represents an average rate for modern solar panels as determined by a study conducted/compiled by the National Renewable Energy Laboratory (NREL). NREL's PVWatts Calculator was utilized to determine solar production per year. The uncertain lifespan of the solar panels would need to be investigated further. Preliminary estimates show that it may be possible to oversize the system further and use excess revenues to replace panels on a regular basis and maintain relatively constant levels of generation.

For this study the solar plant was designed to last 50 years. The solar plant was sized to generate more revenue than the pump usage and pump maintenance at the start of its life and thus produce revenue. At some point, due to degradation, the production of the solar plant would fall below the pumping costs. The excess revenue, if rolled into a saving account, at the start of the plants life would be enough to cover energy costs of the pump when the plant can't fully offset it. To satisfy these requirements, a 495 kW capacity solar array taking up 1.5-2 acres would be necessary. One shareholder has offered up to 3 acres of his land to be used for a solar plant and this site has three phase power adjacent to it; however, the location would need to be investigated further to determine potential objections from nearby neighbors and other potential issues. Another idea with potential would be working with the County to purchase or lease some of their land near the airport. A similar project for a community solar array was recently completed in Garfield County and has been very successful.

A cost estimate was developed for a completely reconfigured system focused around a pump station and solar array as well as some of the system improvements mentioned in the previous section. This option is almost identical to the previous except for the solar plant and the treatment of the upper canal, the estimate includes the following:

- Pump Station
- Screen structure on existing Gunnison River Diversion
- Solar-Power Plant ($1.55 million)
- Piping upstream canal reach
- Solutions for 'stranded' shareholder on Tongue Creek – 8" Pipe from Tongue Creek headgate to turnout. A pump on Tongue Creek may be more cost effective but would require coordination with that shareholder.
- Backfill of abandoned canal
- Four active and five passive check structures at lower end of system
- Currant Creek Trestle Replacement
- Piping Laterals

The cost totals $5.5 million and will generate enough to cover the entirety of operating and maintenance costs of the pump. Costing details will be discussed in the following section.

COST ESTIMATES

Cost estimates were developed from experience in past projects and, when necessary, contractors were contacted to aid in cost estimating. Detailed tabulated cost estimates for every project and option presented in this report can be found in Appendix D. Generally, every estimate contains a construction cost with engineering, construction observation, mobilization, and contingency added on as a percentage of the construction cost. These cost estimates are based off of conceptual designs and not off of any detailed design work. The follow sections describe how specific costs were estimated.

GENERAL INFRASTRUCTURE

General infrastructure cost such as earth work, pipe, pumps, concrete structures (checks, inlets, outets, flow measuring), shotcrete lining, inlet screens, etc were estimated based on previous projects. Whenever possible, costs were taken from projects completed near the Delta area.

HYDROPOWER TURBINE

Canyon Hydro was contacted and was willing to provide budgetary numbers on a site specific turbine (34 feet of head at 67 cfs) complete with a powerhouse, which totaled $530,000. The cost for the complete hydropower station included Canyon Hydro's estimate as well as costs for penstock pipe, draft tube, intake structure, 3-Phase line extension, and associated electrical work.

ANNUAL MAINTENANCE COSTS

Budgetary annual maintenance costs were simply assumed to be 1 percent of the construction costs per year. Maintenance would include such as greasing & replacing bearings and replacing seals. In actuality the pump and turbine won't need to be maintained every single year, but planning for 1 percent every year is assumed to cover the cost of major maintenance when necessary.

SOLAR-POWER PLANT

A local and trusted company, SunSense Solar, was contacted to aid in developing budgetary costs for a solar array and also to check our key assumptions. SunSense suggested budgetary cost of

$2.15 per watt which was used in this study, and they were able to confirm that the land area requirement assumed was adequate for the proposed system. The remainder of the estimate includes land purchase, 3-phase power line extension, and electric grid hookup. Our estimate was compared with solar projects of similar size recently completed in western Colorado and found to be reasonable.

DMEA Reimbursement and Usage Rates

Electric usage rates were assumed to range from $0.08/kWh to $0.10/kWh which represents DMEA's agriculture irrigation and commercial rates respectively. DMEA was contacted for their reimbursement rates for power generation, which are currently $0.07/kWh. Their rates are subject to change every year. When analyzing the solar power option over a 50 year design life, rates were escalated 2 percent per year to account for inflation.

DMEA 'Net Metering' Policy

As previously mentioned, DMEA was contacted in regards to their net metering policy for usage and generation not behind the same meter. In situations like this, a user's kWh generation is credited to their account and used against their usage at a 1 to 1 rate, meaning 1 kWh generated offsets 1 kWh used. The accounting of credits and usage happens at the end of the billing year around March/April. If at the end of the year the user generates excess credits they will be compensated at the reimbursement rate mentioned above, conversely if more is used than generated then they are expected to pay the difference at the rate mentioned above. Credits are reset each billing year once a payment or payout made, and the next year starts anew. Please note that if at any time an account holder's usage is in excess of their generation they will be expected to pay that difference during the normal billing cycle. The options presented in this report avoid the previously mentioned condition.

FUNDING OPTIONS

USBR Salinity Control Program

The salinity control program directed by the USBR is the most likely source of funding for one of the projects discussed above. Grants are awarded about every 3 years through a competitive application process. Ditch companies submit potential projects for the lining or piping of off farm delivery canals and the USBR awards grants to the most cost effective projects. Typically individual grants range from $1 to $6 million with up to $35 million in grants allocated each cycle. There are two parts of the program, the Basin States is for projects with salt loads from 300 to 1,000 tons per year and the Basinwide program for projects over 1,000 tons. There is no cost match required for this program which makes it highly desirable.

The amount of money available from this source depends on the amount of salt the USBR salinity model associates with each ditch. Salt loads associated with different sections of the NDIC system were obtained from the USBR based on a 2012 salt model. These numbers are subject to change when the new model is released later this year but the USBR has stated that they don't anticipate them changing significantly.

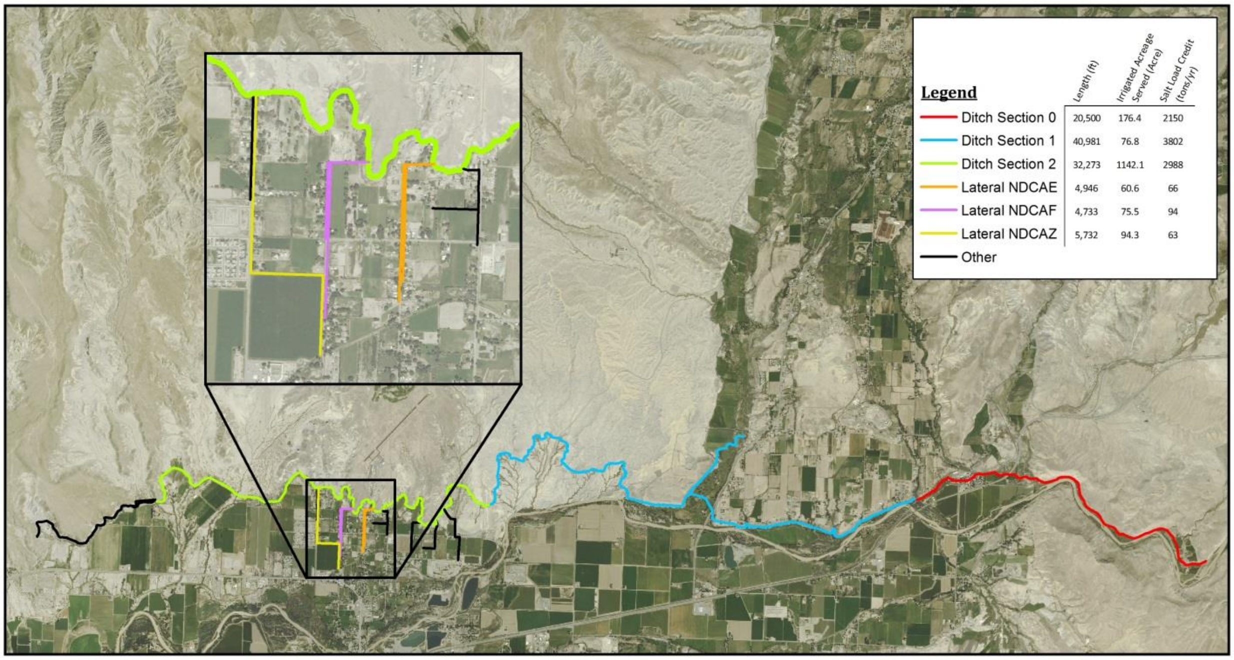


FIGURE 11 NDIC SALINITY MAP

The USBR has also indicated that applicants proposing a gravity flow system on a ditch that could potentially be pressurized may be penalized for not providing pressure. The USBR encourages pressure systems since they would hopefully encourage shareholders under those systems to install sprinklers which would further reduce salt loading from flood irrigation. For this reason the funding available for a particular system could potentially be lower if a gravity pipeline was proposed rather than a pressurized system.

In order to rank grant submittals against one another the project cost is amortized at a USBR selected interest rate (4% +/-) over the project life (typically 50 years for pipe) and divided by the annual salt load associated with the improvements. Projects awarded during past grant cycles has ranged from $30-$100 per ton of salt removed per year depending on the Basin States vs Basinwide program and the application cycle. The average cost efficiency during past grant cycles is shown below in Table 2.

TABLE 2 USBR SALINITY GRANT CYCLE AWARD HISTORY

Year	Average $/Ton Awarded
2008	$38
2009	$64 (ARRA Funded)
2010	$47
2012	$58

Using these assumptions, the amount of money that could be obtained from these sources is shown in Table 7 assuming a funding level of $50 per ton of salt removed per year.

TABLE 3 SALT LOAD ESTIMATES/POTENTIAL SALINITY GRANT AMOUNT

Ditch System	Salt Load Estimate (tons)	Grant Funding Amount @ $50 per ton
Section 1	2150	$ 2,200,000
Section 2	3802	$ 3,900,000
Section 3	2988	$ 3,000,000
Laterals	67	$ 67,000
Total	**1,868**	**$ 9,167,000**

The major system reconfigurations envisioned in this report would cover sections 1, 2, and the laterals and could obtain full funding based on the amounts awarded during past grant cycles.

USBR Water SMART

This is a Bureau of Reclamation program that covers the western United States. The program can provide up to 50% funding for projects that achieve one or more of the following goals:

- Conserve and use water more efficiently
- Increase renewable energy
- Improve energy efficiency
- Protect endangered and threatened species
- Facilitate water markets
- Address climate related impacts on water or prevent any water related crisis or conflict

According to this list piping these canals could meet several of these goals, however, this program could not be used in conjunction with any federal dollars and the maximum award ceiling per project is $1,000,000. This would imply that the Salinity control program is a better option for this type of project if the salt load estimates stated earlier verify with numbers from the USBR model during a future grant cycle.

COLORADO WATER CONSERVATION BOARD –GRANTS AND PROJECT LOAN PROGRAM

According to the CWCB website the Water Supply Reserve Account (WSRA) “provides grants and loans to assist Colorado water users in addressing their critical water supply issues and interests.” Grants are made available from either the Basin Account (Gunnison River) or the Statewide Account. Basin Account grants have not required a cost match in the past while Statewide Account grants require a minimum match of 25%. This match can come in part from a Basin Account grant but a minimum of 5% must come from the applicant or a 3rd party source. Projects seeking funding through the Statewide Account will typically have multiple benefits and provide a positive impact one or more basins in the state. Obtaining any additional funds from a roundtable grant is not likely due to the large grant amount received by NDIC for the tunnel project.

The CWCB also offers low interest loans for the construction of water projects. These loans can be used in conjunction with other state and federal grants listed above. Assuming a 30 year loan period with an interest rate of 1.75%, the annual payment on a $1,000,000 loan would be $43,000. The minimum loan recommended by the CWCB is $100,000 in order to justify going through the loan process and paperwork. In order to receive a loan the recipient must show how the loan will be repaid, typically through shareholder assessments and water sales. An additional loan by NDIC for any project will be heavily scrutinized by the CWCB due to problems with the recent tunnel piping and the existing loan for that project.

These programs could be used in conjunction with a salinity grant to bring the cost effectiveness of the project within the range typically funded by the salinity program.

Colorado River Water Conservation District – Annual Grant Program

The CRWCD has an annual grant program that funds a wide variety of water projects. Grants are typically awarded for the implementation of projects rather than studies. This is a fairly competitive process and the maximum grant amount is $150,000 per project with a total grant pool of $250,000 annually. This program could be used to provide a match required by another grant program or could help reduce the overall amount required by a salinity program grant, thereby improving the cost efficiency of that grant but is not likely to provide a large percentage of the required funding for a project of this magnitude. In addition, this program typically only funds shovel ready projects or completed projects so it would be difficult to use it until a design was completed.

Environmental Groups

Recent partnerships have been formed locally with various environmental groups such as Trout Unlimited (TU) where a particular project, such as a headgate reconstruction, will benefit shareholders as well as the surrounding environment. Participation of any particular entity would be on a project by project basis and the amount of funding available would depend on the environmental benefits resulting from a proposed project. Reconfiguring the system and allowing a significant portion of NDIC's water to remain in the Gunnison River would be a significant benefit and would likely draw some support from these groups. Furthermore, allowing Tongue Creek flows to pass the current headgate and reconnect that stream with the Gunnison River would have significant environmental benefits and therefore increase the likelihood of obtaining additional funding.

PROJECT FUNDING PLAN

As discussed above the funding source with the most potential is the USBR salinity control program. Comparing the overall project costs to the estimated grant amount through this program shows that a significant amount of additional funding would need to be provided from other sources in order to compete for the Salinity funds.

USDA Rural Energy For America (REAP)

This Rural Energy for America Program (REAP) "provides guaranteed loan financing and grant funding to agricultural producers and rural small businesses to purchase or install renewable energy systems or make energy efficiency improvements." There are also grants available and a combination of grants and loans can be used to finance a project. This funding source would apply to the construction of a Hydropower or Solar facility if constructed as part of a system reconfiguration plan. A grant could potentially fund 25% of the cost of a power plant which would improve the cost efficiency of a salinity grant applied for through the USBR.

CONCLUSIONS & RECOMMENDATIONS

The recent collapse of the tunnel and problems with the tunnel piping project has put NDIC in a difficult position. Diverted flows are not typically sufficient to meet the full system demand and NDIC is now highly dependent on Tongue Creek which is not a reliable water source during drought years. Modifying the tunnel into a siphon carries some risk and additional costs while boring a new tunnel is very expensive. Grant money for either of these options will be difficult to obtain due to the past history of the project and the current CWCB loan involved and the cost of such a project may fall on NDIC and its shareholders. Even if the tunnel was repaired NDIC would still need to plan to replace the Tongue Creek inverted siphon and Currant Creek Crossing soon, which will cost $529,000, and $129,000 respectively, in addition to standard maintenance. Obtaining grant funding for either of these options will also be challenging since the main benefit would be limited to the NDIC system.

In order to reduce the possibility of an air lock reducing the tunnel capacity a ¾ inch hole should be drilled in the ceiling of the tunnel pipe at each existing high point, 3 total. This will likely allow the tunnel flowrate to remain constant throughout the summer.

The best option evaluated in this study would be to take advantage of grant money from the USBR Salinity Control Program to significantly change the current system. Other grants are likely available in smaller amounts and could be used to compliment USBR funding, however, no program is capable of providing such a large grant without matching funds from NDIC. Abandoning over 7 miles of canal in the middle of the system and installing a pump station near Delta would likely be able to secure enough grant money to fully pay for the project without any financial contribution by NDIC. As discussed above, a hydropower or solar power plant would be included in the project in order to offset the annual cost of power for the pump as well as annual maintenance of the system. The proposed system would also include piping three key laterals, installing 9 check structures, improvements to existing canal infrastructure, as well as other items listed earlier in the report.

This study sized the pump to supply currently irrigated areas under NDIC with sufficient water assuming a 50 percent application efficiency. If shareholders on the system improve efficiency and lessen the demand on the pump, NDIC increase annual revenues from either the hydropower or solar-power options. With all the improvements shown above it is feasible that the system efficiency could improve to 60 or 70 percent. This would in turn decrease the annual pumping costs while the power generation remained the same, thereby significantly increasing the revenue for NDIC. If a system efficiency of 70 percent was achieved then there could be over $12,000 of annual revenue generated by the power plants.

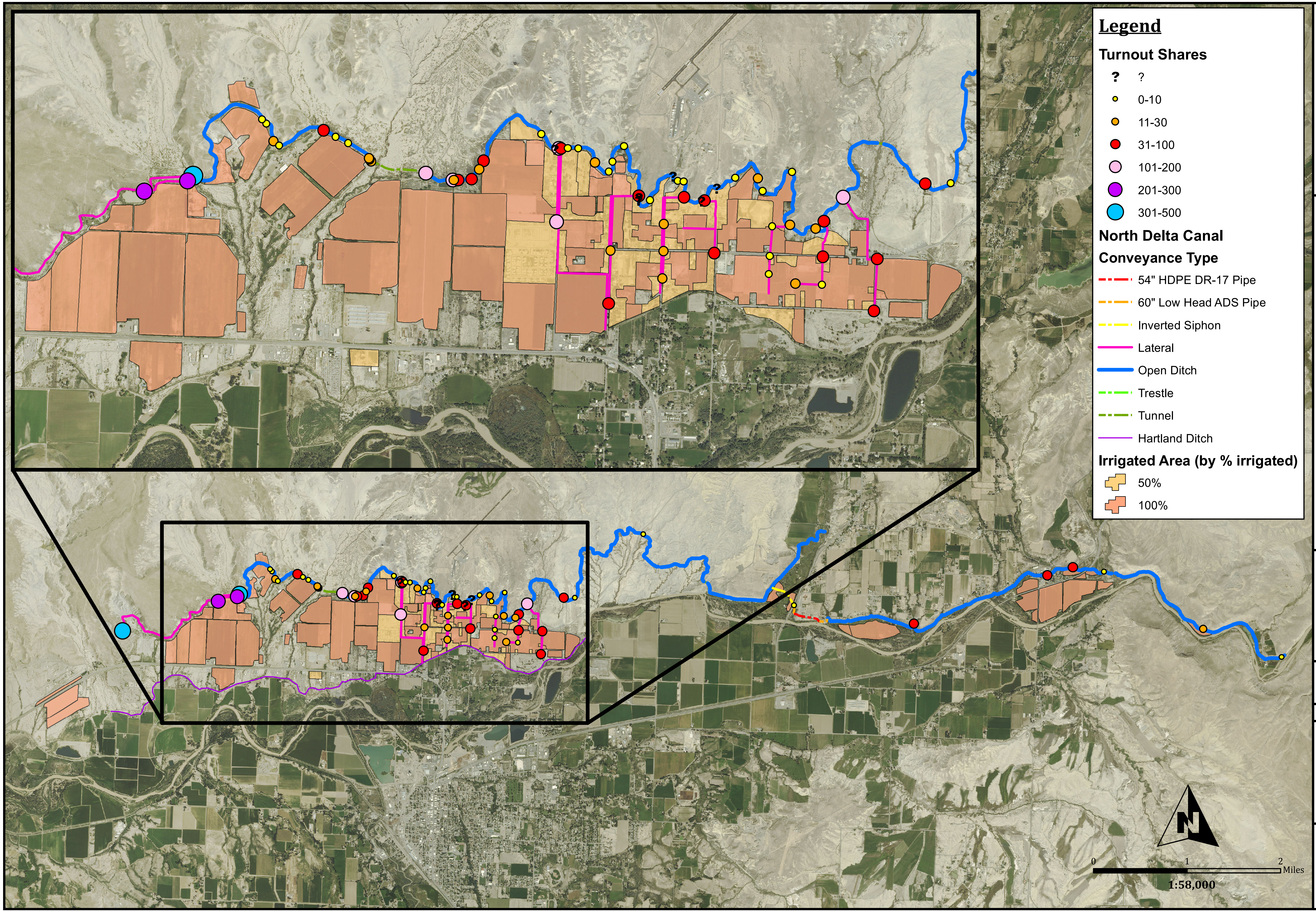
If NDIC is interested in pursuing a USBR Salinity Control Program Grant some logical next steps are listed below. The next grant cycle for these grants opens on May 1, 2015 and NDIC will need to move quickly in order to determine the final details of a potential grant application. A final grant for the USBR would need to be submitted by July 17th, 2015.

- Further assess the potential risks of Solar generation versus Hydropower
    - Hold preliminary conversations with US Fish and Wildlife Service and Colorado Parks and Wildlife to determine their concerns with a hydropower plant
    - Identify a potential solar plant site

        - Discuss potential with City and County on public land
        - Discuss project with DMEA
        - Identify landowners willing to sell or donate land
    - Seek additional input from experts on how to best plan for the eventual replacement of a solar power system
- Modify the Adoble flume near Delta prior to the 2015 irrigation season in order to better monitor water flows reaching the main service area. This flume could also be used if the system was reconfigured since it lies immediately downstream of the proposed pump discharge point. Trout Unlimited may be willing to financially support this effort.
- Construct a temporary measuring flume inside the 60 inch pipe downstream of the tunnel in order to monitor flows during 2015. Trout Unlimited may be willing to financially support this effort.

APPENDIX A

SITE OVERVIEW MAP



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NDIC Master Plan

Site Map

No.	Rev. Date	Revision Description

Date: 16 Dec 2014
Job #: 14-121
Drawn By: TJD

Figure: 1
Of: 1

Date Saved: 3/10/2015 12:25:09 PM
Path: P:\14121 N Delta Irrigation-NDIC Master Plan\Drawings\GIS\SiteMap11x17.mxd

APPENDIX B

DATA GATHERING

Stationing: 13300		XS Inbetween Flume and TO. 3				Simple Averaging Method	Midsection Method	
Length	Depth	$V_{.2D}$	$V_{.8D}$	$V_{.6D}$	V_{avg}	$q_{n-(n+1)}$	$q_{n+/-}$	Flow Area
0	0	e			0		0	
						0.09		0.5
0.5	2	-	-	0.34	0.34		0.51	
						1.47		2.1
1.5	2.2	-	-	1.06	1.06		2.332	
						2.45		2.325
2.5	2.45	-	-	1.05	1.05		2.5725	
						2.82		2.6
3.5	2.75	1.4	0.84	-	1.12		3.08	
						3.36		2.875
4.5	3	1.38	1.05	-	1.22		3.645	
						3.57		3.075
5.5	3.15	1.41	0.81	-	1.11		3.4965	
						4.38		3.15
6.5	3.15	1.44	1.9	-	1.67		5.2605	
						4.23		3.125
7.5	3.1	1.38	0.7	-	1.04		3.224	
						2.74		2.9
8.5	2.7	1.27	0.43	-	0.85		2.295	
						2.06		2.575
9.5	2.45	-	-	0.75	0.75		1.8375	
						1.25		2.275
10.5	2.1	-	-	0.35	0.35		0.735	
						0.89		1.95
11.5	1.8	-	-	0.56	0.56		1.008	
						1.02		1.625
12.5	1.45	-	-	0.69	0.69		0.7504	
						0.44		0.675
13	1.25	-	-	0.62	0.62		0.3875	
						0.10		0.3125
13.5	0	e			0		0	
					Total	**30.87**	**31.13**	**32.06**

Stationing: 4100		XS DS of Headgate Parshall Flume				Simple Averaging Method	Midsection Method	
Length	Depth	$V_{.2D}$	$V_{.8D}$	$V_{.6D}$	V_{avg}	$q_{n-(n+1)}$	$q_{n+/-}$	Flow Area
0	0	e			0		0	
						0.01		0.3375
0.5	1.35	-	-	0.04	0.04		0.0405	
						0.52		1.65
1.5	1.95	-	-	0.59	0.59		1.1505	
						1.86		2.175
2.5	2.4	-	-	1.12	1.12		2.688	
						2.87		2.525
3.5	2.65	1.4	0.9	-	1.15		3.0475	
						3.35		2.525
4.5	2.4	-	-	1.5	1.5		3.6	
						3.75		2.425
5.5	2.45	-	-	1.59	1.59		3.8955	
						3.82		2.425
6.5	2.4	-	-	1.56	1.56		3.744	
						4.03		2.4
7.5	2.4	-	-	1.8	1.8		4.32	
						4.30		2.45
8.5	2.5	-	-	1.71	1.71		4.275	
						3.94		2.475
9.5	2.45	-	-	1.47	1.47		3.6015	
						3.32		2.4
10.5	2.35	-	-	1.3	1.3		3.055	
						2.17		2.2
11.5	2.05	-	-	0.67	0.67		1.3735	
						0.34		1.025
12.5	0	e			0		0	
					Total	**34.27**	**34.79**	**27.01**

Stationing: 17450		XS US of Austin Road				Simple Averaging Method	Midsection Method	
Length	Depth	$V_{.2D}$	$V_{.8D}$	$V_{.6D}$	V_{avg}	$q_{n-(n+1)}$	$q_{n+/-}$	Flow Area
0	0	e			0		0	
						0.07		0.2375
0.5	0.95	-	-	0.55	0.55		0.3919	
						1.26		1.675
1.5	2.4	-	-	0.95	0.95		2.28	
						2.43		2.525
2.5	2.65	1.11	0.84	-	0.98		2.5838	
						2.86		2.725
3.5	2.8	1.17	1.08	-	1.13		3.15	
						3.31		2.8
4.5	2.8	1.3	1.18	-	1.24		3.472	
						3.79		2.95
5.5	3.1	1.5	1.16	-	1.33		4.123	
						4.13		3.125
6.5	3.15	1.43	1.2	-	1.32		4.1423	
						3.80		2.975
7.5	2.8	1.29	1.19	-	1.24		3.472	
						3.29		2.875
8.5	2.95	1.17	0.93	-	1.05		3.0975	
						2.73		2.9
9.5	2.85	0.95	0.71	-	0.83		2.3655	
						2.14		2.775
10.5	2.7	0.77	0.65	-	0.71		1.917	
						1.30		2.35
11.5	2	-	-	0.4	0.4		0.6	
						0.10		0.5
12	0	e			0		0	
					Total	**31.21**	**31.59**	**30.41**

Stationing: 20300		XS US of Check (W. of Austin)				Simple Averaging Method	Midsection Method	
Length	Depth	$V_{.2D}$	$V_{.8D}$	$V_{.6D}$	V_{avg}	$q_{n-(n+1)}$	$q_{n+/-}$	Flow Area
0	0	e			0		0	
						0.08		0.3
1	0.6	-	-	0.55	0.55		0.2475	
						0.28		0.4375
1.5	1.15	-	-	0.75	0.75		0.6469	
						1.04		1.525
2.5	1.9	-	-	0.61	0.61		1.159	
						1.91		2.2
3.5	2.5	-	-	1.13	1.13		2.825	
						2.75		2.525
4.5	2.55	1.49	0.6	-	1.05		2.6648	
						3.04		2.65
5.5	2.75	1.58	0.92	-	1.25		3.4375	
						3.79		2.775
6.5	2.8	1.72	1.24	-	1.48		4.144	
						4.10		2.8
7.5	2.8	1.75	1.15	-	1.45		4.06	
						3.98		2.825
8.5	2.85	1.65	1.09	-	1.37		3.9045	
						3.73		2.8
9.5	2.75	1.4	1.19	-	1.3		3.5613	
						3.18		2.775
10.5	2.8	1.25	0.74	-	1		2.786	
						2.42		2.8
11.5	2.8	0.91	0.56	-	0.74		2.058	
						1.72		2.6
12.5	2.4	-	-	0.59	0.59		1.416	
						0.91		1.8
13.5	1.2	-	-	0.42	0.42		0.378	
						0.06		0.3
14	0	e			0		0	
					Total	**33.00**	**33.29**	**31.11**

Stationing: 20900	XS DS of Check (W. of Austin)					Simple Averaging Method	Midsection Method	
Length	Depth	$V_{.2D}$	$V_{.8D}$	$V_{.6D}$	V_{avg}	$q_{n-(n+1)}$	$q_{n+/-}$	Flow Area
0	0	e			0		0	
						0.00		0.25
1	0.5	-	-	0	0		0	
						0.06		0.85
2	1.2	-	-	0.13	0.13		0.117	
						0.10		0.6375
2.5	1.35	-	-	0.18	0.18		0.1823	
						0.30		1.6
3.5	1.85	-	-	0.2	0.2		0.37	
						0.55		2.05
4.5	2.25	-	-	0.34	0.34		0.765	
						0.99		2.3
5.5	2.35	-	-	0.52	0.52		1.222	
						1.35		2.55
6.5	2.75	0.89	0.18	-	0.54		1.4713	
						1.60		2.75
7.5	2.75	1	0.25	-	0.63		1.7188	
						1.57		2.675
8.5	2.6	0.95	0.15	-	0.55		1.43	
						1.35		2.5
9.5	2.4	-	-	0.53	0.53		1.272	
						1.34		2.25
10.5	2.1	-	-	0.66	0.66		1.386	
						1.51		1.95
11.5	1.8	-	-	0.89	0.89		1.602	
						1.50		1.7
12.5	1.6	-	-	0.87	0.87		1.392	
						1.05		1.375
13.5	1.15	-	-	0.66	0.66		0.5693	
						0.36		0.525
14	0.95	-	-	0.7	0.7		0.4988	
						0.17		0.475
15	0	e			0		0	
					Total	13.78	14.00	26.44

Stationing: 25150	XS US TO. 6					Simple Averaging Method	Midsection Method
Length	Depth	$V_{.2D}$	$V_{.8D}$	$V_{.6D}$	V_{avg}	$q_{n-(n+1)}$	$q_{n+/-}$
0	0	e			0		0
						0.05	
1	0.85	-	-	0.23	0.23		0.146625
						0.09	
1.5	1.1	-	-	0.13	0.13		0.10725
						0.31	
2.5	2.05	-	-	0.26	0.26		0.533
						0.66	
3.5	2.7	0.44	0.15	-	0.3		0.7965
						0.91	
4.5	3.15	0.53	0.12	-	0.33		1.02375
						1.27	
5.5	3.2	0.65	0.3	-	0.48		1.52
						1.59	
6.5	3.2	0.75	0.29	-	0.52		1.664
						1.80	
7.5	3.3	0.8	0.37	-	0.59		1.9305
						1.92	
8.5	3.35	0.79	0.35	-	0.57		1.9095
						1.78	
9.5	3.35	0.64	0.34	-	0.49		1.6415
						1.41	
10.5	3.1	0.5	0.27	-	0.39		1.1935
						1.08	
11.5	2.9	0.43	0.24	-	0.34		0.9715
						0.91	
12.5	2.75	0.48	0.14	-	0.31		0.8525
						0.59	
13.5	2.3	-	-	0.16	0.16		0.368
						0.10	
14.5	0.17	-	-	0	0		0
						0.00	
15	0	e			0		0
					Total	14.46	14.66

Stationing: 31150		XS US Tunnel Check Structure				Simple Averaging Method	Midsection Method
Length	Depth	$V_{.2D}$	$V_{.8D}$	$V_{.6D}$	V_{avg}	$q_{n-(n+1)}$	$q_{n+/-}$
0	0	e			0		0
						0.00	
1	1	-	-	0	0		0
						0.01	
1.5	1.85	-	-	0.02	0.02		0.02775
						0.26	
2.5	2.3	-	-	0.23	0.23		0.529
						0.83	
3.5	2.95	0.39	0.42	-	0.41		1.19475
						1.28	
4.5	3.2	0.41	0.44	-	0.43		1.36
						1.43	
5.5	3.4	0.45	0.43	-	0.44		1.496
						1.52	
6.5	3.5	0.44	0.44	-	0.44		1.54
						1.58	
7.5	3.5	0.47	0.46	-	0.47		1.6275
						1.71	
8.5	3.65	0.48	0.5	-	0.49		1.7885
						1.67	
9.5	3.55	0.49	0.38	-	0.44		1.54425
						1.51	
10.5	3.45	0.45	0.4	-	0.43		1.46625
						1.33	
11.5	3.2	0.36	0.39	-	0.38		1.2
						1.04	
12.5	3.1	0.28	0.29	-	0.29		0.8835
						0.66	
13.5	2.6	0.15	0.21	-	0.18		0.468
						0.44	
14.5	2.15	-	-	0.19	0.19		0.4085
						0.10	
15.5	0	e			0		0
					Total	**15.36**	**15.53**

Stationing:		XS DS Tongue Creek Headgate				Simple Averaging Method	Midsection Method
Length	Depth	$V_{.2D}$	$V_{.8D}$	$V_{.6D}$	V_{avg}	$q_{n-(n+1)}$	$q_{n+/-}$
0	0	e			0		0
						0.00	
1	0.4	-	-	0	0		0
						0.06	
2.5	1.2	-	-	0.1	0.1		0.15
						0.39	
3.5	2.2	-	-	0.36	0.36		0.792
						1.51	
4.5	2.7	1.04	0.71	-	0.88		2.3625
						2.94	
5.5	3.1	1.39	0.92	-	1.16		3.5805
						4.05	
6.5	3.4	1.32	1.35	-	1.34		4.539
						4.17	
7.5	3.5	0.92	1.25	-	1.09		3.7975
						3.72	
8.5	3.4	0.59	1.55	-	1.07		3.638
						3.18	
9.5	2.95	0.63	1.23	-	0.93		2.7435
						2.40	
10.5	2.3	-	-	0.9	0.9		2.07
						1.49	
11.5	1.55	-	-	0.65	0.65		1.0075
						0.54	
12.5	1	-	-	0.2	0.2		0.15
						0.03	
13	0	e			0		0
					Total	**24.48**	**24.83**

Stationing:		XS US Siphon Outlet					
						Simple Averaging Method	Midsection Method
Length	Depth	$V_{.2D}$	$V_{.8D}$	$V_{.6D}$	V_{avg}	$q_{n-(n+1)}$	$q_{n+/-}$
0	0	e			0		0
						0.04	
0.5	0.95	-	-	0.31	0.31		0.220875
						0.81	
1.5	1.4	-	-	1.07	1.07		1.498
						1.95	
2.5	1.9	-	-	1.29	1.29		2.451
						2.67	
3.5	2.05	-	-	1.41	1.41		2.8905
						3.15	
4.5	2.2	-	-	1.55	1.55		3.41
						3.58	
5.5	2.35	-	-	1.6	1.6		3.76
						3.82	
6.5	2.45	-	-	1.58	1.58		3.871
						3.62	
7.5	2.3	-	-	1.47	1.47		3.381
						3.12	
8.5	2.1	-	-	1.37	1.37		2.877
						2.53	
9.5	1.85	-	-	1.19	1.19		1.651125
						0.73	
10	1.5	-	-	0.55	0.55		0.4125
						0.10	
10.5	0	e			0		0
					Total	**26.11**	**26.42**

Stationing: 36100		XS DS Siphon Outlet					
						Simple Averaging Method	Midsection Method
Length	Depth	$V_{.2D}$	$V_{.8D}$	$V_{.6D}$	V_{avg}	$q_{n-(n+1)}$	$q_{n+/-}$
0	0	e			0		0
						0.24	
1	1.65	-	-	0.57	0.57		0.705375
						0.63	
1.5	2	-	-	0.8	0.8		1.2
						1.74	
2.5	2.65	0.82	0.57	-	0.7		1.84175
						2.41	
3.5	3.05	1.31	0.68	-	1		3.03475
						3.45	
4.5	3.2	1.64	0.78	-	1.21		3.872
						4.10	
5.5	3.3	1.78	0.85	-	1.32		4.3395
						4.54	
6.5	3.25	1.82	1.1	-	1.46		4.745
						4.96	
7.5	3.15	1.79	1.49	-	1.64		5.166
						4.98	
8.5	3.15	1.62	1.42	-	1.52		4.788
						4.52	
9.5	3	1.55	1.29	-	1.42		4.26
						3.72	
10.5	2.9	1.35	0.86	-	1.11		3.2045
						2.80	
11.5	2.5	-	-	0.97	0.97		2.425
						1.36	
12.5	1.9	-	-	0.27	0.27		0.513
						0.13	
13.5	0	e			0		0
					Total	**39.57**	**40.09**

Stationing:	40100	XS US Working Tunnel				Simple Averaging Method	Midsection Method
Length	Depth	$V_{.2D}$	$V_{.8D}$	$V_{.6D}$	V_{avg}	$q_{n-(n+1)}$	$q_{n+/-}$
0	0	e			0		0
						0.49	
0.5	3	1.32	1.3	-	1.31		2.9475
						4.17	
1.5	3.05	1.52	1.38	-	1.45		4.4225
						4.53	
2.5	3.05	1.63	1.41	-	1.52		4.636
						4.82	
3.5	3.05	1.66	1.62	-	1.64		5.002
						5.03	
4.5	2.9	1.69	1.79	-	1.74		5.046
						4.97	
5.5	2.7	1.78	1.84	-	1.81		4.887
						4.67	
6.5	2.75	1.74	1.49	-	1.62		4.44125
						3.96	
7.5	2.75	1.42	1.11	-	1.27		3.47875
						3.31	
8.5	2.5	-	-	1.26	1.26		2.3625
						0.39	
9	0	e			0		0
					Total	**36.35**	**37.22**

Stationing:	48150	XS DS Trapclub Road				Simple Averaging Method	Midsection Method
Length	Depth	$V_{.2D}$	$V_{.8D}$	$V_{.6D}$	V_{avg}	$q_{n-(n+1)}$	$q_{n+/-}$
0	0	e			0		0
						0.00	
0.5	1	-	-	0	0		0
						0.11	
1.5	2.05	-	-	0.14	0.14		0.287
						1.13	
2.5	2.4	-	-	0.88	0.88		2.112
						2.96	
3.5	2.5	-	-	1.54	1.54		3.85
						4.07	
4.5	2.6	1.75	1.55	-	1.65		4.29
						4.38	
5.5	2.55	1.84	1.66	-	1.75		4.4625
						4.43	
6.5	2.45	-	-	1.79	1.79		4.3855
						4.49	
7.5	2.55	2.01	1.59	-	1.8		4.59
						4.65	
8.5	2.5	-	-	1.88	1.88		4.7
						4.62	
9.5	2.45	-	-	1.85	1.85		4.5325
						3.98	
10.5	2.25	-	-	1.54	1.54		3.465
						3.07	
11.5	1.8	-	-	1.49	1.49		2.682
						1.94	
12.5	1.2	-	-	1.1	1.1		0.99
						0.43	
13	0.85	-	-	0.57	0.57		0.363375
						0.12	
14	0	e			0		0
					Total	**40.37**	**40.71**

Stationing:	55600	XS US Flow Control Structure					
						Simple Averaging Method	Midsection Method
Length	Depth	$V_{.2D}$	$V_{.8D}$	$V_{.6D}$	V_{avg}	$q_{n-(n+1)}$	$q_{n+/-}$
0	0	e			0		0
						0.42	
0.5	2.3	-	-	1.47	1.47		2.53575
						4.09	
1.5	2.6	2.09	1.65	-	1.87		4.862
						4.88	
2.5	2.55	2.16	1.68	-	1.92		4.896
						5.11	
3.5	2.55	2.27	1.91	-	2.09		5.3295
						5.46	
4.5	2.55	2.33	2.05	-	2.19		5.5845
						5.37	
5.5	2.4	-	-	2.15	2.15		5.16
						4.62	
6.5	2.2	-	-	1.87	1.87		4.114
						3.58	
7.5	2	-	-	1.54	1.54		3.08
						3.14	
8.5	2.1	-	-	1.52	1.52		2.394
						1.25	
9	1.85	-	-	1.02	1.02		0.9435
						0.24	
9.5	0	e			0		0
					Total	**38.16**	**38.90**

Survey File

Point Code	Easting	Northing	Elevation	Description
PRS614636738309	1340429.242	2266196.481	4996.054	
2001	1352394.461	2287131.329	5037.831	mh_inv
2002	1352421.635	2287130.59	5034.325	pipe_top
2003	1352394.484	2287131.285	5037.866	mh_rim
2004	1353842.309	2285853.774	5031.743	toc
2005	1353846.105	2285846.686	5028.723	hws
2006	1353790.116	2285832.174	5031.073	tob_1
2007	1353840.699	2285855.894	5030.524	hwl
2008	1353842.54	2285852.52	5030.512	hwl
2009	1353837.116	2285854.282	5030.578	hwl
2010	1353762.562	2285817.943	5031.076	tob_1
2011	1353764.226	2285815.344	5026.26	inv_1
2012	1353763.744	2285815.82	5028.614	hws_1
2013	1353705.993	2285765.708	5031.842	tob_2
2014	1353707.923	2285763.83	5027.072	inv_2
2015	1353706.946	2285763.87	5028.615	hws_2
2016	1353654.791	2285695.819	5032.137	tob_3
2017	1353654.658	2285695.435	5032.113	tob_3
2018	1353654.681	2285695.448	5032.053	tob_3
2019	1353656.337	2285692.657	5026.7	inv_3
2020	1353656.245	2285693.172	5028.406	hws_3
PRS614636738309	1340428.302	2266199.112	4996.054	
1001	1352147.004	2275562.219	4954.925	river
1002	1353138.043	2274676.301	5015.274	flume_inv
1003	1353037.624	2268916.482	5008.076	inv
1004	1353033.836	2268915.135	5011.059	wse
1005	1354031.986	2265036.966	5004.504	inv
1006	1354027.602	2265035.93	5007.915	wse
1007	1354032.727	2265014.751	5004.426	inv
1008	1354026.331	2265013.909	5007.71	wse
1009	1353396.933	2261600.699	5002.149	inv_pipe
1010	1353390.892	2261604.842	5005.708	check_board
1011	1353395.777	2261609.464	5006.403	wse
1012	1353179.302	2255962.046	4997.215	inv
1013	1353176.938	2255960.413	5000.467	wse
1014	1349981.222	2249563.779	4984.368	inv
1015	1351220.479	2249220.304	4987.969	inv
1016	1351219.354	2249223.093	4989.501	check_board
1017	1357027.711	2288792.312	5030.527	inv
1018	1357024.419	2288788.132	5033.53	wse
1019	1357048.48	2288892.943	5034.882	wse
1020	1354202.923	2281980.555	5023.895	inv
1021	1354206.845	2281983.94	5026.482	wse
1022	1353557.82	2298497.918	5037.171	wse
1023	1353261.346	2298157.92	5002.272	wse

APPENDIX C

DEMAND AND SUPPLY ANALYSIS

Crop Demand Data Summary

Month	Crop Demand (in) Wet Year	Crop Demand (in) Average	Crop Demand (in) Dry Year	Crop Demand (cfs) Base Flow	Crop Demand (cfs) @ 50% Efficiency
April	2.42	2.83	3.21	13.08	26.16
May	6.70	7.84	8.88	17.54	35.08
June	7.84	9.17	10.39	21.21	42.41
July	6.89	8.06	9.14	18.04	36.09
August	5.69	6.66	7.54	14.90	29.80
September	4.12	4.82	5.46	11.15	22.30
October	3.04	3.56	4.03	7.96	15.93
Total	**36.70**	**42.94**	**48.66**		

Monthly Total Evapotranspiration Average (inch)

Month	1995	1996	1997	1998	1999	2000	2001	2003	2004	2008	2010	2011	2012	2013	2014
(mid)April	2.65	3.22	2.07	2.30	1.88	3.60	2.82	3.53	1.76	3.42	3.07	2.61	3.63	2.88	3.00
May	4.69	9.72	6.69	8.58	7.68	8.98	8.25	7.34	8.91	6.96	8.25	7.14	9.61	7.54	7.27
June	6.77	8.22	8.32	9.46	8.34	9.30	9.83	9.70	9.48	9.08	8.56	9.81	10.73	10.35	9.61
July	8.42	8.48	8.47	7.94	6.43	8.91	7.82	10.78	9.12	7.64	7.86	6.71	7.41	6.57	8.40
August	7.64	8.75	5.26	8.07	4.35	6.49	6.13	7.94	8.43	8.28	5.03	6.45	6.18	5.83	5.04
September	5.05	4.36	2.75	5.67	4.89	5.83	6.19	4.57	3.94	6.34	5.66	4.70	5.10	3.56	3.69
October	4.49	3.32	3.14	2.69	5.22	3.08	3.80	4.79	2.82	4.44	2.79	2.73	4.17	2.50	3.41
Total	**39.71**	**46.06**	**36.70**	**44.72**	**38.79**	**46.18**	**44.84**	**48.66**	**44.46**	**46.15**	**41.22**	**40.15**	**46.84**	**39.24**	**40.42**

Crop Demand Data Summary

NDIC Diversion off Gunnison

Monthly Average Flow

Month	*1995*	*1996*	*1997*	*1998*	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*
April	29.2	40.0	17.8	0.0	48.6	37.8	23.2	54.4	55.3	28.6	28.2	39.1	44.7	50.0	50.0	23.3	50.0	4.8	21.9
May	38.6	43.4	37.6	36.3	50.2	54.3	52.5	64.6	53.0	49.2	46.1	47.9	55.0	50.0	50.0	50.0	50.0	6.5	24.5
June	39.0	45.0	45.0	39.2	35.9	64.8	54.3	42.2	59.4	54.3	46.0	54.5	55.0	50.0	50.0	50.0	50.0	13.6	23.9
July	43.7	45.0	45.6	42.7	41.3	58.1	44.6	55.4	52.5	55.9	34.5	49.0	48.0	50.0	50.0	50.0	42.3	23.5	24.7
August	40.8	45.0	39.2	42.0	49.7	57.9	54.1	57.0	59.8	53.8	35.5	47.0	55.0	50.0	50.0	50.0	19.7	25.2	26.6
September	40.0	40.3	39.9	40.6	46.8	55.9	49.5	43.7	53.1	52.4	30.0	50.0	55.0	50.0	50.0	50.0	25.0	22.1	26.6
October	38.1	36.4	35.2	35.6	40.7	62.3	31.3	36.3	39.8	38.6	30.0	41.6	52.4	50.0	46.8	50.0	21.6	17.4	25.5

NDIC Diversion off Forked Tongue

Monthly Average Flow

Month	*1995*	*1996*	*1997*	*1998*	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*
April	20.0		16.8	10.0	0.0		3.8	3.5	2.0	11.7	6.0	9.2	12.7	10.0	13.4	0.0	18.7	10.3	6.0
May	3.2	12.4	31.9	17.7	0.0	6.5	4.9	2.5	3.4	14.5	9.1	7.8	10.6	10.5	8.4	10.0	20.0	8.8	7.0
June	10.1	10.4	18.4	24.1	8.3	2.5	6.7	1.4	3.0	9.1	4.6	4.6	8.0	15.0	11.3	8.9	20.0	6.0	7.2
July	14.7	5.4	28.0	16.6	12.4	0.0	3.7	1.0	2.1	6.1	5.3	2.5	5.9	12.3	13.9		22.6	10.6	2.8
August	7.3	7.8	27.0	10.0	15.0	0.0	4.6	1.0	2.0	4.4	8.2	0.0	9.6	15.1	10.0		36.1	9.1	2.7
September	15.0	10.0	13.3	10.0	6.3	0.0	5.0	2.3	2.0	10.8	13.2	8.4	8.7	13.3	7.4		37.5	6.8	3.0
October	10.0	5.7	0.0	9.2	3.3	0.0	4.8	3.4	2.0	16.6	13.7	7.7		9.7	6.8		39.7	19.6	2.9

APPENDIX D

COST ESTIMATES

Engineers Opinion of Probable Construction Cost

Applegate Group, Inc.
1490 W. 121st Ave.
Suite 100
Denver, CO 80234
Phone: (303) 452-6611
Fax: (303) 452-2759

NDIC Phase II

Gravity Pipe - Full Decree

Job No. : 14-121
By: TJD
Date: 2/27/2015
Client: NDIC

Description of Work	Item	Units	Quantity	Unit Cost	Total Cost
	60" Duromax	LF	5,495	$ 200	$ 1,099,000
	54" Duromax	LF	16,942	$ 170	$ 2,880,140
	48" Duromax	LF	4110	$ 143	$ 587,730
	42" Duromax	LF	5829	$ 117	$ 681,993
	36" Duromax	LF	9756	$ 93	$ 907,308
	Turnout Structure (complete with vents and slide gates)	EA	38	$ 15,000	$ 570,000
	Inlet Structure (complete with screen)	EA	1	$ 50,000	$ 50,000
	Flow Measuring Structure	EA	1	$ 20,000	$ 20,000
	Construction Subtotal				**$ 6,796,171**
	Mobilization	%		8%	$ 544,000
	Contingency/Missing Items	%		10%	$ 680,000
	Construction Total				**$ 8,020,171**
	Engineering	%		10%	$ 803,000
	Construction Observation	%		8%	$ 642,000
	Total				**$ 9,465,171**

Engineers Opinion of Probable Construction Cost

Applegate Group, Inc.
1490 W. 121st Ave.
Suite 100
Denver, CO 80234
Phone: (303) 452-6611
Fax: (303) 452-2759

NDIC Phase II

Gravity Pipe - Demand Flow

Job No. : 14-121
By: TJD
Date: 2/27/2015
Client: NDIC

Description of Work	Item	Units	Quantity	Unit Cost	Total Cost
	54" Duromax	LF	12,071	$ 170	$ 2,052,070
	48" Duromax	LF	10,849	$ 143	$ 1,551,407
	42" Duromax	LF	9456	$ 117	$ 1,106,352
	30" Duromax	LF	9756	$ 70	$ 682,920
	Turnout Structure (complete with vents and slide gates)	EA	38	$ 15,000	$ 570,000
	Inlet Structure (complete with screen)	EA	1	$ 50,000	$ 50,000
	Flow Measuring Structure	EA	1	$ 20,000	$ 20,000
	Construction Subtotal				**$ 6,032,749**
	Mobilization	%		8%	$ 483,000
	Contingency/Missing Items	%		10%	$ 604,000
	Construction Total				**$ 7,119,749**
	Engineering	%		10%	$ 712,000
	Construction Observation	%		8%	$ 570,000
	Total				**$ 8,401,749**

Engineers Opinion of Probable Construction Cost					
Applegate Group, Inc.					
1490 W. 121st Ave. Suite 100 Denver, CO 80234 Phone: (303) 452-6611 Fax: (303) 452-2759	**NDIC Phase II** **Lateral Improvements**			Job No. : 14-121 By: TJD Date: 2/27/2015 Client: NDIC	
Description of Work	Item	Units	Quantity	Unit Cost	Total Cost
Lateral NDCAE	8" PVC PIP	LF	1,845	$ 7.16	$ 13,210.20
	6" PVC PIP	LF	690	$ 5.65	$ 3,898.50
	Inlet Structure	EA	1	$ 20,000.00	$ 20,000.00
	8" Small User Turnout Structure	EA	10	$ 950.00	$ 9,500.00
	8" Large User Turnout Structure	EA	3	$ 10,000.00	$ 30,000.00
	6" Small User Turnout Structure	EA	8	$ 950.00	$ 7,600.00
	6" Large User Turnout Structure	EA	3	$ 10,000.00	$ 30,000.00
	County Road Crossing Bore	EA	4	$ 4,000.00	$ 16,000.00
	Outlet Structure	EA	1	$ 1,000.00	$ 1,000.00
Lateral NDCAF	8" PVC PIP	LF	2,040	$ 7.16	$ 14,606.40
	6" PVC PIP	LF	1,350	$ 5.65	$ 7,627.50
	Inlet structure	EA	1	$ 20,000.00	$ 20,000.00
	8" Small User Turnout Structure	EA	5	$ 950.00	$ 4,750.00
	8" Large User Turnout Structure	EA	5	$ 10,000.00	$ 50,000.00
	6" Small User Turnout Structure	EA	9	$ 950.00	$ 8,550.00
	6" Large User Turnout Structure	EA	1	$ 10,000.00	$ 10,000.00
	County Road Crossing	EA	1	$ 4,000.00	$ 4,000.00
	Outlet Structure	EA	1	$ 1,000.00	$ 1,000.00
Lateral NDCAG	8" PVC PIP	LF	5,735	$ 7.16	$ 41,062.60
	Inlet Structure	EA	1	$ 20,000.00	$ 20,000.00
	8" Small User Turnout Structure	EA	3	$ 950.00	$ 2,850.00
	8" Large User Turnout Structure	EA	6	$ 10,000.00	$ 60,000.00
	Outlet Structure	EA	1	$ 1,000.00	$ 1,000.00
	Construction Subtotal				**$ 376,655.20**
	Mobilization	%		8%	$ 31,000.00
	Contingency/Missing Items	%		15%	$ 57,000.00
	Construction Total				**$ 464,655.20**
	Engineering	%		3%	$ 14,000.00
	Construction Observation	%		3%	$ 14,000.00
	Total				**$ 492,655.20**

Engineers Opinion of Probable Construction Cost

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NDIC Phase II

Tunnel Boring Machine

Job No. : 14-121
By: TJD
Date: 2/27/2015
Client: NDIC

Description of Work	Item	Units	Quantity	Unit Cost	Total Cost
	Tunneling, complete w/ 54" Pipe	LF	1,530	$ 2,000	$ 3,060,000
	Inlet Structure	EA	1	$ 50,000	$ 50,000
	Outlet Strcuture	EA	1	$ 50,000	$ 50,000
	Construction Subtotal				**$ 3,160,000**
	Mobilization	%		8%	$ 253,000
	Contingency/Missing Items	%		10%	$ 316,000
	Construction Total				**$ 3,729,000**
	Engineering	%		8%	$ 299,000
	Construction Observation	%		6%	$ 224,000
	Total				**$ 4,252,000**

Engineers Opinion of Probable Construction Cost

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NDIC Phase II

Steel Casing Boring

Job No. : 14-121
By: TJD
Date: 2/27/2015
Client: NDIC

Description of Work	Item	Units	Quantity	Unit Cost	Total Cost
	CL911 Polyurea Pipe Lining	LF	2,000	$ 150.00	$ 300,000
	Steel Casing Boring	LF	2,000	$ 900.00	$ 1,800,000
	Inlet Structure	EA	1	$ 50,000.00	$ 50,000
	Outlet Strcuture	EA	1	$ 50,000.00	$ 50,000.00
	Construction Subtotal				**$ 2,150,000**
	Mobilization	%		8%	$ 172,000
	Contingency/Missing Items	%		10%	$ 215,000
	Construction Total				**$ 2,537,000**
	Engineering	%		8%	$ 203,000
	Construction Observation	%		6%	$ 153,000
	Total				**$ 2,893,000**

Engineers Opinion of Probable Construction Cost

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NDIC Phase II

Kings By-Pass Siphon

Job No. : 14-121
By: TJD
Date: 2/27/2015
Client: NDIC

Description of Work	Item	Units	Quantity	Unit Cost	Total Cost
	48" HDPE DR 41	LF	7,500	$ 205	$ 1,537,500
	Inlet/Outlet Structure	EA	2	$ 10,000	$ 20,000
	Combination Air Valve w/ branch saddle	EA	4	$ 1,200	$ 4,800
	Drain Valve	EA	4	$ 10,000	$ 40,000
	Construction Subtotal				**$ 1,602,300**
	Mobilization	%		8%	$ 129,000
	Contingency/Missing Items	%		10%	$ 161,000
	Construction Total				**$ 1,892,300**
	Engineering	%		6%	$ 114,000
	Construction Observation	%		8%	$ 152,000
	Total				**$ 2,158,300**

Engineers Opinion of Probable Construction Cost

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NDIC Phase II

Tongue Creek Siphon Upgrade

Job No. : 14-121
By: TJD
Date: 2/27/2015
Client: NDIC

Description of Work	Item	Units	Quantity	Unit Cost	Total Cost
	48" HDPE DR 41	LF	1,760	$ 205	$ 360,800
	Inlet/Outlet Structure	EA	2	$ 10,000	$ 20,000
	Drain Valve	EA	1	$ 10,000	$ 10,000
	Construction Subtotal				**$ 390,800**
	Mobilization	%		8%	$ 32,000
	Contingency/Missing Items	%		10%	$ 40,000
	Construction Total				**$ 462,800**
	Engineering	%		6%	$ 28,000
	Construction Observation	%		8%	$ 38,000
	Total				**$ 528,800**

Engineers Opinion of Probable Construction Cost

Applegate Group, Inc.
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NDIC Phase II

Pumping Station

Job No. : 14-121
By: TJD
Date: 2/27/2015
Client: NDIC

Description of Work	Item	Units	Quantity	Unit Cost	Total Cost
	HDPE SDR 32.5 Pipe 36" Dia	LF	1,350	$ 150	$ 202,500
	Inlet Structure (concrete structure and excavation)	LS	1	$ 150,000	$ 150,000
	Intake Screen (Cylinder VEE wire intake, with air burst system)	LS	1	$ 65,000	$ 65,000
	Pumphouse Building	LS	1	$ 40,000	$ 40,000
	300 HP Pump w/ VFD	LS	1	$ 150,000	$ 150,000
	Outlet Structure	LS	1	$ 20,000	$ 20,000
	3-Phase Line Extension	LF	1700	$ 14	$ 23,800
	Electrical Hook-Up (includes meters, transformers, connection, labor, etc)	LS	1	$ 25,000	$ 25,000
	Construction Subtotal				**$ 676,300**
	Mobilization	%		8%	$ 55,000
	Contingency/Missing Items	%		20%	$ 136,000
	Construction Total				**$ 867,300**
	Engineering	%		10%	$ 87,000
	Permitting (Army Corps, Floodplain, Water Rights Filing)	LS	1	$ 30,000	$ 30,000
	Construction Observation	%		8%	$ 70,000
	Total				**$ 1,054,300**

Engineers Opinion of Probable Construction Cost

Applegate Group, Inc.
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NDIC Phase II

Hydropower Station

Job No. : 14-121
By: TJD
Date: 2/27/2015
Client: NDIC

Description of Work	Item	Units	Quantity	Unit Cost	Total Cost
	Penstock/Draft Tube (48")	LF	210	$ 150	$ 31,500
	Intake Structure	LS	1	$ 70,000	$ 70,000
	Powerhouse Structure (including 110 KW turbine)	LS	1	$ 530,000	$ 530,000
	3-Phase Line Extension	LS	1650	$ 14	$ 23,100
	Electrical	LS	1	$ 40,000	$ 40,000
	Construction Subtotal				**$ 694,600**
	Mobilization	%		8%	$ 56,000
	Contingency/Missing Items	%		20%	$ 139,000
	Construction Total				**$ 889,600**
	Engineering	%		8%	$ 72,000
	Permitting (Water Rights Filing)(FERC)	LS	1	$ 100,000	$ 100,000
	Construction Observation	%		8%	$ 72,000
	Total				**$ 1,133,600**

Engineers Opinion of Probable Construction Cost					
Applegate Group, Inc. 1490 W. 121st Ave. Suite 100 Denver, CO 80234 Phone: (303) 452-6611 Fax: (303) 452-2759	**NDIC Phase II** **Solar-Power Plant Estimate**			Job No. : 14-121 By: TJD Date: 2/27/2015 Client: NDIC	
Description of Work	Item	Units	Quantity	Unit Cost	Total Cost
	PV Panels	Watts	495,000	$ 2.15	$ 1,064,250
	land	Ac	2	$ 15,000.00	$ 30,000
	3-Phase Power line Extension	LF	1,500	$ 14.00	$ 21,000
	Electric Grid Hookup (includes transformers, power house, controllers, etc)	LS	1	$ 50,000	$ 50,000
	Construction Subtotal				**$ 1,165,250**
	Mobilization	%		8%	$ 94,000
	Contingency/Missing Items	%		10%	$ 117,000
	Construction Total				**$ 1,376,250**
	Engineering	%		10%	$ 138,000
	Permitting	%		10%	$ 138,000
	Construction Observation	%		8%	$ 12,000
	Total				**$ 1,664,250**

Engineers Opinion of Probable Construction Cost					
Applegate Group, Inc. 1490 W. 121st Ave. Suite 100 Denver, CO 80234 Phone: (303) 452-6611 Fax: (303) 452-2759	**NDIC Phase II** **Miscellaneous Items for Reconfigured Systems Estimate**			Job No. : 14-121 By: TJD Date: 2/27/2015 Client: NDIC	
Description of Work	Item	Units	Quantity	Unit Cost	Total Cost
	Pipeline to Isolated User on Gunnison (material & placement)	LF	5,675	$ 7	$ 39,725
	Solution for Tongue Creek User	LS	1	$ 50,000	$ 50,000
	Backfill of Abandoned Canal	LF	36,602	$ 4	$ 146,408
	Check Structures Passive	EA	5	$ 20,000	$ 100,000
	Check Structure Active	EA	4	$ 50,000	$ 200,000
	Currant Creek Trestle Replacement	LF	200	$ 600	$ 120,000
	Canal lining Turbine to P Flume(16772 LF, 16.7 ft wide)	SF	280092.4	8	$ 2,240,739
	Screen on Canal Diversion, flow measurement, new gate	LS	1	$ 250,000	$ 250,000

Engineers Opinion of Probable Construction Cost

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NDIC Phase II

Job No. : 14-121
By: TJD
Date: 2/27/2015
Client: NDIC

Piping Upstream Canal

Description of Work	Item	Units	Quantity	Unit Cost	Total Cost
	24" PVC PIP Pipe	LF	14,100	$ 50	$ 708,525
	12" PVC PIP Pipe	LF	8,400	$ 13	$ 109,200
	Turn Out Structure	EA	6	$ 10,000	$ 60,000
	Inlet Structure	EA	1	$ 100,000	$ 100,000
	Solution for Tongue Creek User	LS	1	$ 50,000	$ 50,000
	Construction Subtotal				**$ 1,027,725**
	Mobilization	%		8%	$ 83,000
	Contingency/Missing Items	%		10%	$ 103,000
	Construction Total				**$ 1,213,725**
	Engineering	%		8%	$ 98,000
	Construction Observation	%		8%	$ 98,000
	Total				**$ 1,409,725**

Engineers Opinion of Probable Construction Cost

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NDIC Phase II

b No. : 14-121
By: TJD
Date: 2/27/2015
Client: NDIC

Reconfigured System - Hydropower

Description of Work	Item	Unit Cost
	Pump Station	$ 1,054,300
	Hydropower Plant	$ 1,133,600
	Pipeline to Isolated User on Gunnison	$ 39,725
	Solution for Tongue Creek User	$ 50,000
	Backfill of Abandoned Canal	$ 146,408
	Piping Laterals	$ 492,655
	Check Structures Active	$ 200,000
	Check Structure Passive	$ 100,000
	Lining Ditch Upstream of Turbrine	$ 2,240,739
	Currant Creek Trestle Replacement	$ 120,000
	Screen on Canal Diversion	$ 250,000
	Habitat Mitigation	$ 200,000
	Total	**$ 6,027,427**

Engineers Opinion of Probable Construction Cost

Applegate Group, Inc.

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NDIC Phase II

Reconfigured System - Solar-Power

b No. : 14-121
By: TJD
Date: 2/27/2015
Client: NDIC

Description of Work	Item		Unit Cost
	Pump Station	$	1,054,300
	Solar-power Plant	$	1,664,250
	Backfill of Abandoned Canal	$	146,408
	Piping Laterals	$	492,655
	Check Structures Active	$	200,000
	Check Structure Passive	$	100,000
	Piping Upstream Ditch	$	1,409,725
	Currant Creek Trestle Replacement	$	120,000
	Habitat Mitigation	$	200,000
	Total	**$**	**5,387,338**