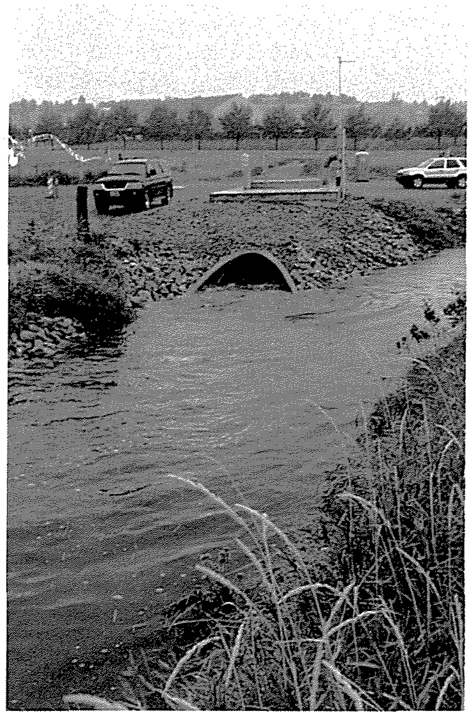

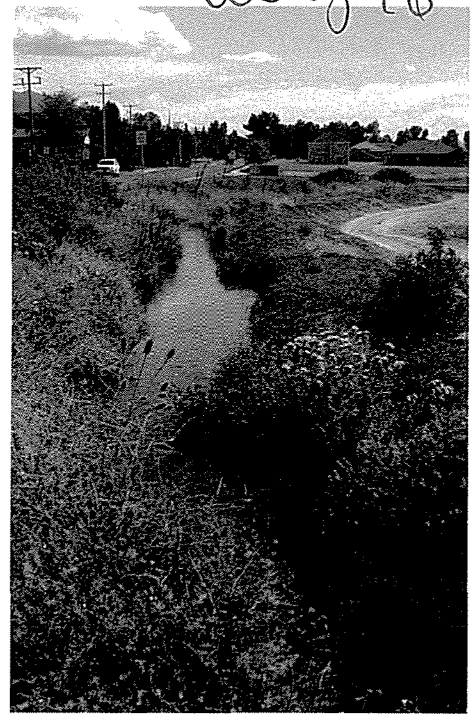

WaterSMART
Water & Energy Efficiency Grants

FY 2014
FOA No. R14AS00001

LOGAN & NORTHERN IRRIGATION COMPANY
Piping & Pressurization Project

Applicant

Logan & Northern Irrigation Company
Lyle Thornley, Treasurer
PO Box 100
Providence, Utah 84332

Project Manager

Zan Murray, SE
1047 South 100 West
Logan, Utah 84321
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Technical Proposal and Evaluation Criteria

Executive Summary

Date, Applicant Name, City, County and State

- Date: **January 21, 2014**
- Applicant name: **Logan and Northern Irrigation Company (LNIC)**
- City, County, State: **Logan, Cache, Utah**
- Project Manager
  - Name: **Zan Murray, SE**
  - Title: **Project Manager/Engineer**
  - Telephone: **(435) 713 9514**
  - E-mail: **zpm@jub.com**
- Project funding request: **$1,000,000**
- Total Project Cost: **$2,644,256**

Benefits at a Glance
4,998 acre-feet better managed
1,530 acre-feet conserved annually
125,500 kWh conserved annually
314,500 kWh generated with conserved water
Reduction of CO^2 by 1.03 metric tons per year

Project Summary and Task Areas

The Logan and Northern Irrigation Company Canal Piping and Pressurization Project will enclose, pressurize, and meter a 4.2 mile section of an existing open gravity-flow canal in Cache Valley. The canal begins at the Logan River in Logan City and proceeds north through North Logan, Hyde Park and Smithfield. North of Smithfield it extends to the southern boundary of Richmond. The project will include installing 22,090 feet of high-density polyethylene (HDPE) pipe ranging from 8-32 inches within the current canal easement. The project will install 46 Octave ultrasonic flowmeters; one at each turnout to better manage water in the system. This project will connect to 30 existing lateral piping systems that service agricultural and residential irrigation and municipal culinary water exchanges. In 2013 the NRCS Emergency Watershed Protection (EWP) Program funded the Cache Water Restoration Project (CWRP) which piped and pressurized 2.6 miles of the Logan and Northern Canal. The CWRP provided the infrastructure to permit the continuation of pressurizing the entire pipeline with this project. The project will better manage 4,998 acre-feet of water in the LNIC system. This project will conserve a total of 1,530 acre-feet of water annually. The conserved water includes 1,088 acre-feet that is currently being lost from seepage, 25 acre-feet from evaporative losses as well as 417 acre-feet of operational water lost at the end of the canal.

The project will be funded under Funding Group II and will be completed over two years, but has the flexibility to be extended over three years if needed by Reclamation.

Task A – Water Conservation and Improved Water Management

By enclosing the canal, 1,088 acre-feet of water lost to seepage and 25 acre-feet to evaporation will be conserved annually. Currently, extra operational water is required to be sent through the canal to serve users at the end of the canal. This 417 AF of water will be conserved by eliminating the need for operational water spilling at the end of the canal. Further conservation will be implemented as pressurization allows for more effective irrigation practices in residential and agricultural areas.

Task B – Energy Efficiency

The water conserved through the Logan and Northern Irrigation Piping and Pressurization Project will be available to be directed through the existing Logan City Light and Power Hydroelectric Facility. This facility is operational and permitted by FERC. By making this conserved water available to Logan City Power it is estimated that 314,500 kWh of power each year could be produced at an estimated annual revenue of $22,700. Currently many of the shareholders on the canal have to use pumps to pressurize their water for irrigation practices. These pumps will be removed as a result of this project because the system will be pressurized. **The associated energy consumption that would be eliminated is 285,000 kWh of power and the estimated yearly savings of $27,100 would be realized.**

Length of Time and Estimated Completion Date

The project will be completed over a three year period as outlined in the annual schedules below. LNIC is pursuing an aggressive schedule with all construction being completed between October 2015 and May 2016. However, if unforeseen delays occur, some construction may need to take place the following non-irrigation season putting project completion in May 2017.

Year 1: October 2014 to September 2015

The Year 1 funding request from Reclamation will be $500,000 and include the following:

- Preparation and approval of the environmental document for the entire project
- Preparation and submittal of necessary permits – Wetlands
- Preparation of construction easements
- Completion of Engineering design
- Bidding and Award
- Materials procurement
- Mobilization

Year 2: October 2015 to May 2016

The Year 2 funding request from Reclamation will be $500,000 and include the following:

- Installation of 22,090 feet of HDPE pipe and appurtenances within existing canal right-of-way.
- Installation of ultrasonic flow meters at each turnout; 46 total.

Year 3: Tentative

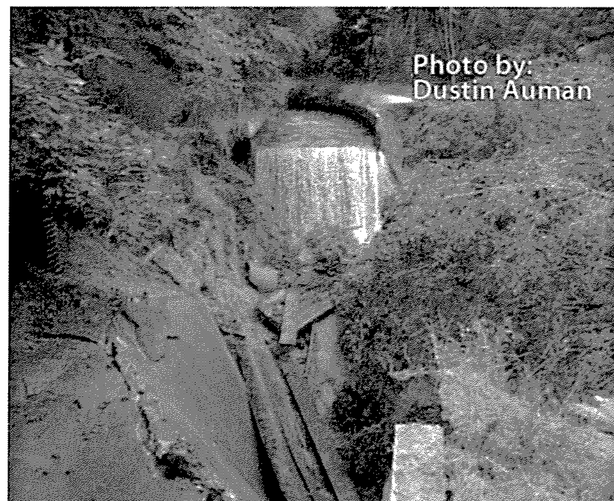
In the case of unforeseen delays, some construction activities may need to take place between October 2016 and May 2017. Construction may also extend into Year 3 if advantageous to Reclamation's budget constraints.

Federal Facilities

The Logan and Northern Canal Piping & Pressurization Project is not located on a Federal facility.

Background Data

Project Background



In July 2009 a landslide occurred in Logan City along a hillside where the Logan & Northern canal is located. As a result of the landslide, a section of canal broke away causing a breach. This resulted in the death of three people, severe damage to homes and other nearby properties, and discontinued all water distribution through the canal. The Logan and Northern Irrigation Company came together with other entities and municipalities in the Cache Water Restoration Project to make necessary repairs, improve safety, and provide water to users as soon as possible. The CWRP was funded through the NRCS Emergency Watershed Protection Program and the Utah Division of Water Resources. Due to the breach LNIC only received 50% of its water right through July 2009 to May 2013, The water was delivered through other canals owned by other canal companies during the reconstruction. The CWRP project enclosed six miles of open canal in box culvert and pipe and was completed in May 2013. The development of the CWRP Project has allowed LNIC to receive its full water right this past 2013 irrigation season. The Water and Energy Efficiency project will make possible the continuation of piping and pressurizing the canal extending the availability of pressurized water to 594 shareholders and 1,050 acres of land. The project will also result in metering 46 unmetered turnouts, reduce power consumption, conserve 1530 acre-feet of water that can now be directed to help produce power, and better manage 4,998 acre-feet of water. Logan and Northern Irrigation Company History

The Logan & Northern Canal was constructed in 1887, originally known as the Temple Ditch Canal. It was constructed under the direction of Brigham Young and was intended to provide water to the Logan LDS Temple and residents of the 'bench' area of Logan.

In the early 1900s farmers from Richmond, Smithfield and Hyde Park approached the Temple Canal group and proposed the expansion of the canal northward to include the farmlands surrounding those towns. The canal became known officially as the Logan & Northern Irrigation Company comprising a 13-mile waterway encompassing 3,279 acres of irrigated lands; one share of water is allocated to each acre of ground watered.

Over the years, the cities of Logan, North Logan, Hyde Park and Smithfield have also become shareholders in small quantities. Smithfield City uses many of its 80+ shares as an exchange for culinary water from the Smithfield Summit Creek.

Many of today's shareholders are now residents using the water for lawn and garden. There are presently 880 shareholders, about 75 of the users are farmers. The canal has a significant impact on the four-city area, providing secondary water for parks, golf courses and other municipal needs that reduce the strain on culinary water supplies.

Geographic Location

The Logan and Northern Canal service area included 3,279 acres of land and runs from the Logan River in Logan Canyon through Logan City and north to Richmond. It ends 13 miles north from its diversion point. The project is located from the north boundary of Logan City to the center of Smithfield City. **See Attachment A for a project location map.**

Source of Water Supply, Water Rights, Current Water Users

» Source of water supply.
The Logan River is the primary source of water for the Logan and Northern Canal. The river is fed primarily from runoff from mountains in Cache County, Utah and parts of Franklin County, Idaho. In summer and late fall when river flows drop, water for the canal is supplemented by two large wells.

» Water rights involved.
Currently Logan and Northern Irrigation Company has water rights of 133.2 cfs in the Logan River. However, the river flows drop as the irrigation season progresses since and there are no storage reservoirs on the River. The result is that there is never enough water to meet the flow needs of the users throughout the irrigation season. In order to address this concern, the Kimball Decree was established in 1922 to help resolve conflict of water use from the Logan River. This decree was the result of a lawsuit between Utah Power & Light and Richmond Irrigation Company.

» Current water uses.
LNIC provides water for both agricultural and municipal uses. Of its 880 shareholders, 75 are farmers producing alfalfa, barley and corn crops and the remaining shares are used for residential lawn and garden watering.

LNIC water is also used by local municipalities to irrigate city property like parks, cemeteries and golf courses. An interruption or shortage in the secondary water supply would have a very deep impact on these communities as expensive culinary water would then be used for these purposes and put a strain on the culinary system.

» Number of water users served.
LNIC has 880 shareholders and 115 connections.

» Current and projected water demand.

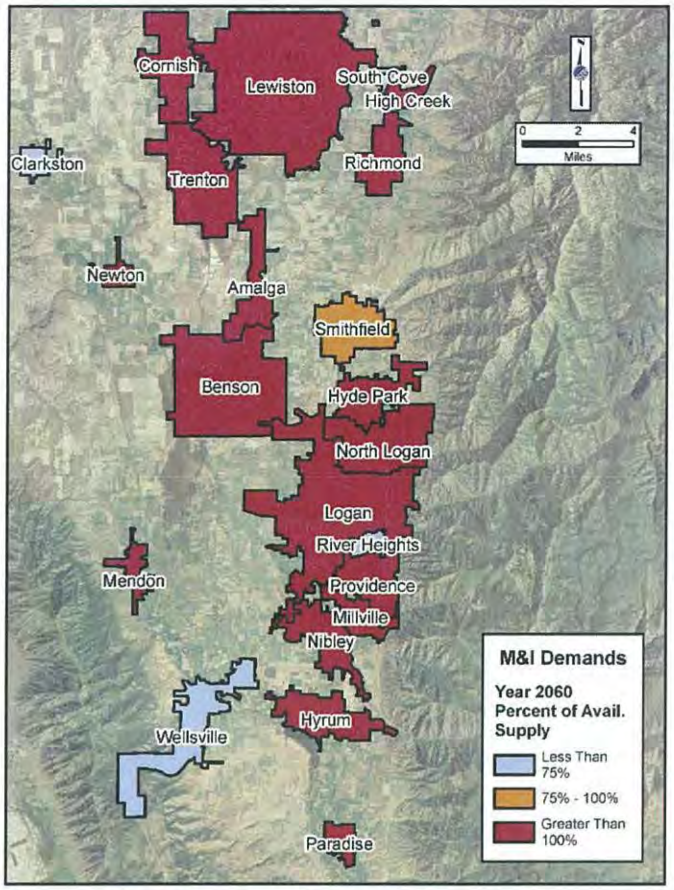


Figure 1 : Water Demands in Cache County

Utah has a growing economy and population. Cache Valley is no exception to this trend. Many businesses are locating there because of the quality of life and opportunity for growth. Population growth comes with new business. This creates further demand on municipal and irrigation water supply for industrial and residential purposes. While this demand increases, the agricultural water interests in the valley continue to remain high with three large dairy processing plants, multiple food processing plants, and manufacturing facilities located in the Logan Area. Since the Logan River does not have any irrigation storage on the river system, water available for use is dependent entirely on snowpack and climate conditions. Since 2012, snow pack has been light and runoff flows reduced. For years prior to 2011 there was a drought in the intermountain west that reduced flows significantly to the LNIC shareholders. These conditions create a significant impact on the available water supply. Trends in climatology indicate that there will not be a change in this pattern of a very wet year followed by a period of dry years. Without irrigation storage being constructed along the river, water users in the area will have to continue to improve water conservation and management practices to stretch the little water they have in reoccurring drought years

» Potential shortfalls in water supply.

In 2013, Cache County completed a water master plan outlining future water demands for the area. Through the technical study portion of the plan completed by the Utah Division of Water Resources, four Cache County communities are experiencing water supply challenges now, and by the year 2060, 16 communities or 80% will not have adequate supply. Projects including conservation and specifically rehabilitating canals and creating secondary water systems were identified as mechanisms to stretch supply to meet demand (See Attachment A for a larger M&I Demands Map).

As river flows drop in the summer and fall, conflict is create between the 16 water right holders of the Logan River. These water users have multiple competing interests, including culinary water exchanges, irrigation, power production, fish habitat and recreational uses. (See Water Rights Section above and Attachment B)

Water Delivery System

Miles of canals, laterals, existing irrigation improvements (i.e. type, miles and acres)

The Logan & Northern Canal Irrigation Company comprises a 13-mile waterway encompassing 3,279 acres of irrigated lands; one share of water is allocated to each acre watered. In 2010, a pressurized pipeline was installed from an upslope canal pressurizing approximately 700 Acres of agricultural land serviced by the LNC. Last year, a significant upgrade to the LNIC system was recently completed as part of the CWRP. That project repaired 2.6 miles of canal. The CWRP also made it possible to deliver pressurized water to existing users, but did not tap its full potential. This project will tap all of the benefits from the CWRP available to the LNC and impact 1,050 acres of land or 32 % of the total service area and 68% of the users of the LNC.

Storm water is carried in the Logan & Northern Canal along with the irrigation water. With the completion of this project, the irrigation water will be piped in the bank of the existing canal and delivered separately. Storm water will remain the canal. This will be an added benefit to the local government agencies dealing with storm water.

Renewable Energy and Energy Efficiency

Describe existing energy sources and current energy uses.

Since the current delivery system is an open-flow canal, shareholders must pump the water to increase pressure for irrigation. By using the available pressure provided by gravity, the shareholders can eliminate the need for pumps in their systems. Conserved water can then be leased to other interested parties including Logan Light and Power which has an existing hydropower facility on the Logan River. Not only can we reduce power consumption with this project by eliminating pumps, but we can also create power with that saved water at no additional capital cost. Based upon information from Logan Light and Power, 206 kWh of power can be produced for every additional one acre foot of water diverted through their power plant. The potential for benefit from this project for renewable energy is significant.

Relationship with Reclamation

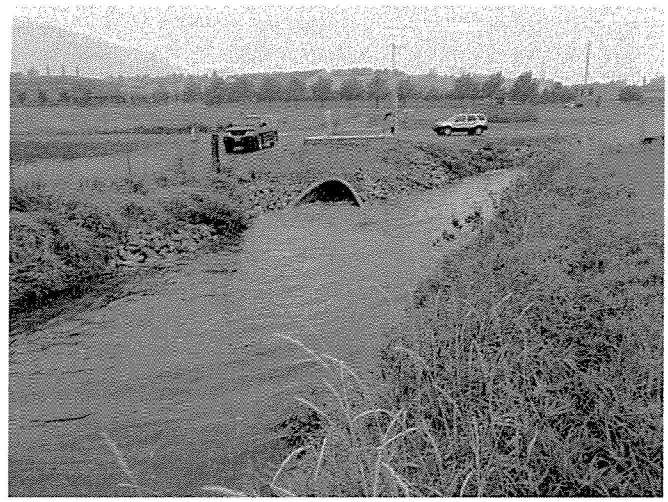
This project is focuses on the implementation plan of the Cache County Water Master Plan funded by the WaterSMART: System Optimization Review grant program. Projects that will rehabilitate canals for more efficient water usage and pressurized irrigation delivery are prioritized in the Plan in Section 6.2.1.8 and Appendix 5-A. This project will be the first to begin implementation of that part of the Plan. The Executive Summary of the plan is found in Attachment C, and a copy of the plan is found on the Cache County Website at: http://www.cachecounty.org/assets/department/water/water-master-plan/Cache_County_Water_Master_Plan_Report_Aug_2013.pdf

Two Reclamation projects exist within Cache Valley: the Newton Reservoir and Hyrum Reservoir Projects. These projects store irrigation water for agricultural and residential irrigation water uses on the southern and western portions of Cache Valley. By improving the water available in the project area, growth in the service area can continue and reduce the already high demand on irrigation water in the areas served by Newton and Hyrum Reservoirs.

Downstream of the Reclamation Projects and this LNIC project, all of the water is combined into Cutler Reservoir on the Bear River. With the reduced demand upstream, water can be conserved in the reservoir where there is significant need for water resources in the future. According to the Cache County Water Master Plan, within the next 20 years it is expected that a new storage reservoir will be needed and constructed to supply water to Northern Utah. Conserving water with projects such as this will make water available for that future demand while other water development projects are being completed.

Technical Project Description

The Logan and Northern Canal Pressurization Project will enclose and pressurize 4.2 miles of open gravity-flow canal along the east side of Cache Valley. Currently pressurized water is available through the Cache Water Restoration Project at 1500 North in Logan for use by the Logan and Northern Irrigation Company. This source piping has been sized to meet the demands of the Logan and Northern Canal as well as other irrigation companies downslope of the Logan and Northern Canal.



Location where the Piping & Pressurization Project will connect to the Cache Water Restoration Project

The Canal will be piped in a HDPE pipe inside of the existing irrigation canal bank. Pipe diameters will begin at 32 inches and reduce to 8 inches over the length of the project. At street crossings, the pipe will be open cut across the pavement, or bored beneath the road surface depending on existing conditions and potential impacts. As the pipeline is constructed, existing pumps will be disconnected and pressurized turnouts will be installed for use by water users. Gravity-flow turnouts will have pressurized water available for future connection. These connections will be metered and include an ultrasonic radio-read system to monitor usage, water distribution, and reduce conflict and usage questions that arise during the irrigation season.

Water that is conserved as the canal is enclosed will be available to meet the water demands of existing shareholders during times of drought. Water will also be available for lease by other future water users within the LNIC service area. The leasing system will be expanded as a result of this Project. Logan Light and Power will use their existing facilities to divert water and generate power from conserved water as available. Utah State University Facilities Management can also store conserved water in their facilities for power generation and research at the Utah Water Research Laboratory. The Agricultural College at USU will also be able to utilize pressurized irrigation at their research farm facilities located in the service area of the LNIC. Secondary to irrigation benefits, USU's research provides innovative methods of irrigation, crop production and genetic improvements that can help further reduce water consumption and improve production for agricultural purposes. We have included a letter of support for the Project from USU located in the "Letters of Support" section of the application.

Evaluation Criteria

Evaluation Criterion A - Water Conservation

A.1 Water Conservation

Subcriterion A.1 (a) - Quantifiable Water Savings

Describe the amount of water saved. Estimated amount of water to be conserved (acre feet/year) as a direct result of this project.

The LNIC Canal Piping & Pressurization Project will conserve an estimated 1,530 acre feet of water annually.

1,088 AF/year will be saved by eliminating seepage losses in the open canal.

25 AF/year will be saved by eliminating evaporative losses.

417 AF/year will be saved by eliminating spilling at the end of the ditch.

» What is the applicant's average annual acre-feet of water supply

The LNIC supplies 11,750 AF annually to its users.

» Where is that water currently going (e.g., back to the stream, spilled at the end of the ditch, seeping into the ground, etc.)?

Currently water is seeping into the ground, evaporating from open water surfaces and spilling over the end of the ditch.

» Where will the conserved water go?

Conserved water will provide first for the full allocation of water to existing shareholders. Then it will be available for lease to other water users including users needing to irrigate unserviced land, Logan Light & Power for hydroelectric power generation and Utah State University for research and power generation.

1. Canal Lining/Piping

» How has the estimated average annual water savings that will result from the project been determined? Please provide all relevant calculations, assumptions, and supporting data.

To determine seepage losses from the canal, a study from the American Society of Civil Engineers (ASCE) Journal of the Irrigation and Drainage Division (in Attachment D) provided the basis for calculations. The study consisted of 765 seepage measurements canals in 15 western United States over 40 years. Measurements were made from ponding or seepage meters. From the study, seepage losses for various soil types was determined as well as a methodology to determine seepage losses. Following the procedure outlined in the study, the soil type along the project area were determined using the NRCS Web Soil Survey. From the soils survey, the soil types in the canal were determined and the seepage loss rates from the study were applied for each soil type and length of that type along the project reach. The lengths and seepage rates were then multiplied by the water surface width and duration of the irrigation season to calculate the seepage loss. The following table contains the seepage calculations.

Figure 2: Seepage Loss Calculations

General Soil Classification	Soil Type	Length of Canal in Soil Type (FT)	Canal Width (FT)	Seepage Rate (FT/day)	Total Seepage Loss (FT^3/Day)	Volume Loss/Season (AF)
GrA	GREEN CANYON GRAVELLY LOAM, 0-3% SLOPES	1,105	12	0.94	12,464	60
GrB	GREEN CANYON GRAVELLY LOAM, 3-7% SLOPES	1,061	12	0.94	11,966	58
GsA	GREENSON LOAM, 0-3% SLOPES	3,072	12	0.94	34,651	167
GsB	GREENSON LOAM, 3-6% SLOPES	-	12	0.94	-	0
MlB	MILLVILLE SILT LOAM, 2-4% SLOPES	4,884	12	0.8	46,887	226
NcB	NIBLEY SILTY CLAY LOAM, 3-6% SLOPES	685	12	0.5	4,111	20
PaB	PARLEYS SILT LOAM, 3-6% SLOPES	2,608	12	0.8	25,035	121
RhB	RICKS GRAVELLY LOAM, 3-6% SLOPES	972	12	0.94	10,969	53
RhC	RICKS GRAVELLY LOAM, 6-10% SLOPES	3,028	12	0.94	34,152	165
SwD	STERLING GRAVELLY LOAM, 10-20% SLOPES	265	12	0.94	2,991	14
TmA	TIMPANOGOS SILT LOAM, 0-3% SLOPES	729	12	0.8	7,001	34
TmB	TIMPANOGOS SILT LOAM, 3-6% SLOPES	1,569	12	0.8	15,063	73
TmC	TIMPANOGOS SILT LOAM, 6-10% SLOPES	2,122	12	0.8	20,367	98
Totals for Area of Interest		22,100				1088

Total Length of Project:	22,100 feet
Length of Irrigation Season	210 days
Weighted Seepage Loss along Canal	0.85 ft/day

Seepage losses were calculated to be 1,088 AF or an average of 2.6 cubic feet per second over the irrigation season.

Evaporation losses were calculated using the pan evaporative rates published by Utah State University for the Cache Valley. The evaporative loss during the irrigation season is 50 inches. Using the length and width of the canal water surface and evaporation rate, the loss was calculated. It was determined to be 25 AF. The table of evaporation rates is included in Attachment D.

Evaporation Rate		50
Canal Length FT		22,100
Canal Width FT		12
WS Area FT^2		265,200
Total Loss CF		**1,105,000**
Total Loss AF		**25.37**

Evaporative losses were calculated at 25 AF.

How have average annual canal seepage losses been determined? Have ponding and/or inflow/outflow tests been conducted to determine seepage rates under varying conditions? If so, please provide detailed descriptions of testing methods and all results. If not, please provide an explanation of the method(s) used to calculate seepage losses. All estimates should be supported with multiple sets of data/measurements from representative sections of canals.

Ponding or inflow/outflow tests and evaporation were not able to be performed for the project at this time. Calculations were performed using the methodology described above as published in the ASCE Journals. See Figures for calculations.

» What are the expected post-project seepage/leakage losses and how were these estimates determined (e.g., can data specific to the type of material being used in the project be provided)?

Water losses in the project area will be eliminated by the project. The system will be enclosed in a pipe so no seepage, evaporation or spills will occur in the delivery system. A meter exists at the connection point for the new pipeline and meters will be installed at the turnouts. Meter measurements will be compared monthly by the water master and reported to the irrigation board annually to monitor for any pipeline leaks.

» What are the anticipated annual transit loss reductions in terms of acre-feet per mile for the overall project and for each section of canal included in the project?

Annual transit loss calculations are calculated to be 266 AF per mile for the project. Since there is only one section of the project, the annual transit loss value would be the same across the entire project length.

» How will actual canal loss seepage reductions be verified?

Seepage loss reductions will be verified through a monthly audit of meter readings at the new pipeline connection point and at each turnout location. With the SCADA system that was constructed with the CWRP and new radio read meters that will be installed at each turnout of this project, data will be collected on a monthly basis. This data will then be analyzed and compared monthly to determine if there is any leakage or breaks in the pipeline by the water master. The leakage report will then be reviewed by the irrigation company board at their annual meeting.

» Include a detailed description of the materials being used.

22,090 feet of HDPE pipe of diameters from 8 inches to 32 inches will be used. Ten isolation valves will be installed; five, 1-inch air release valves and five, 2-inch air release valves. There will be 46 turnouts installed ranging from 4 to 12 inches.

At each turnout, gate valves and Octave radio-read ultrasonic meters will be used for operation and measurements. Additional information regarding the project materials is found in Attachment E.

Metered turnout under construction

3. Irrigation Flow Measurement: Irrigation flow measurement improvements can provide water savings when improved measurement accuracy results in reduced spills and over-deliveries to irrigators. Applicants proposing municipal metering projects should address the following:

» How have average annual water savings estimates been determined? Please provide all relevant calculations, assumptions, and supporting data.

Existing turnouts are unmetered. As part of this project we will meter all locations. There will be savings due to metering over usage but we are unable to determine those savings at this time.

» Are flows currently measured at proposed sites and if so what is the accuracy of existing devices? How has the existing measurement accuracy been established?

Flows into the existing canal are measured at the release point into the canal. Flows are not being measured at the turnouts. The water master uses experience to manage the water and its use.

» Provide detailed descriptions of all proposed flow measurement devices, including accuracy and the basis for the accuracy.

Octave Ultra-sonic Flow Meters will be used at all of the turnouts. Their accuracy is 98.5% based upon testing according to AWWA standards. See Attachment E for more information on the flow meters.

» How will actual water savings be verified upon completion of the project?

Meter records will be compared from the inlet and turnouts in a water audit each year. A comparison of the annual water diverted into the canal will be compared annually as well prior to the annual shareholder meeting.

4. SCADA and Automation: SCADA and automation components can provide water savings when irrigation delivery system operational efficiency is improved to reduce spills, over-deliveries, and seepage. Applicants proposing municipal metering projects should address the following:

» How have average annual water savings estimates been determined? Please provide all relevant calculations, assumptions, and supporting data.

Not Applicable

» Have current operational losses been determined? If water savings are based on a reduction of spills, please provide support for the amount of water currently being lost to spills.

Not Applicable

» Will annual farm delivery volumes be reduced by more efficient and timely deliveries? If so, how has this reduction been estimated?

Not Applicable

» Will canal seepage be reduced through improved system management? If so, what is the estimated amount and how was it calculated?

Canal Seepage will be eliminated by piping the canal.

» How will actual water savings be verified upon completion of the project?

Water savings will be verified by comparing system diversion flow measurements taken before the project starts and after the project is operational. We will have two years of data available for comparison before construction of the new pipeline begins.

Subcriterion A.1 (b) - Improved Water Management

Describe the amount of water better managed.

Over 42% of the LNIC water allocation will be better managed after this project is constructed. The need for operational water will be eliminated through the pressurized system. Turnout meters will also allow the water master to monitory distribution to shareholders and allow each user to receive there correct allotment of water and not waste water. Through proper management, water conserved through this project can be used for the used to service new land and generate renewable energy through the Logan Light and Power generation facility.

For projects that improve water management but which may not result in measurable water savings, **state the amount of water expected to be better managed, in acre-feet per year and as a percentage of the average annual water supply.** (The average annual water supply is the amount actually diverted, pumped, or released from storage, on average, each year. This does not refer to the applicant's total water right or potential water supply.) Please use the following formula:

$$\frac{\text{Estimated Amount of Water Better Managed}}{\text{Average Annual Water Supply}}$$

$$\frac{4498 \text{ AF}}{11750 \text{ AF}}$$

$$= \mathbf{42.5\%}$$

This project will better manage all of the water that travels through this section of canal. There are currently no meters in this area. By installing ultra-sonic radio-read meters at each turnout, LNIC can have real time numbers to understand their system, any inefficiencies, and needed improvements. The flow meter at the beginning of the pipe can be read remotely through a SCADA system. The turnout meters will be ready monthly via radio.

Subcriterion No. A.2.—Percentage of Total Supply

Provide the percentage of total water supply conserved:

State the applicant's total average annual water supply in acre-feet. Please use the following formula:

$$\frac{\text{Estimated Amount of Water Conserved}}{\text{Average Annual Water Supply}}$$

$$\frac{1530 \text{ AF}}{11750 \text{ AF}}$$

= 13.0%

Subcriterion No. A.3.—Reasonableness of Costs

Please include information related to the total project cost, annual acre-feet conserved (or better managed), and the expected life of the improvement. Use the following calculation:

$$\frac{\text{Total Project Cost}}{(\text{Acre-Feet Conserved, or Better Managed} \times \text{Improvement Life})}$$

$$\frac{\$2{,}644{,}256}{1530 \text{ AF conserved} \times 100 \text{ Years}}$$

=$17.28/AF

$$\frac{\$2{,}644{,}256}{4498 \text{ AF better managed} \times 100 \text{ Years}}$$

=$5.88/AF

For all projects involving physical improvements, specify the expected life of the improvement in number of years and provide support for the expectation (e.g., manufacturer's guarantee, industry accepted life-expectancy, description of corrosion mitigation for ferrous pipe and fittings, etc.).

» Expected life of the improvement

  100 Years for HDPE pipe.

» Support for the expectation

  The manufacturer of large diameter HDPE piping to be used on this project estimates the service life of the material at 100 years. See Attachment E for industry accepted life-expectancy documentation.

Evaluation Criteria B: Energy-Water Nexus

Subcriterion No. B.1.—Implementing Renewable Energy Projects Related to Water Management and Delivery

Describe the amount of energy capacity. For projects that implement renewable energy systems, state the estimated amount of capacity (in kilowatts) of the system. Please provide sufficient detail supporting the stated estimate, including all calculations in support of the estimate.

The Logan Light and Power Hydroelectric Facility Number 2 will be used to generate power from the water conserved from this project. This facility was re-constructed in 1985 and operates under and existing FERC permit. The facility can handle up to 300 cfs through a 570 foot 72 inch foot diameter penstock fed by 2nd Dam in Logan Canyon through 9,500 feet of 7 foot reinforced concrete pipe. The facility can generate up to 5,700 kW of power. With the water conserved from this project, 314,500 kWh of electricity can be produced.

Irrigation Season Length	210	Days
Power production rate	17	kW/CFS
Water Conserved	1530	AF
CFS Conserved	3.67	CFS
Power Production	62.39	kW
Season Power Production	314,500	kWh
Cost of Power	$72.31	/MWh
Revenue from Power	$22,737.56	
kWh / AF of water	206	kWh

Figure 2: Power Generation at Logan Hydro-Electric Facility

Describe the amount of energy generated. For projects that implement renewable energy systems, state the estimated amount of energy that the system will generate (in kilowatt hours per year). Please provide sufficient detail supporting the stated estimate, including all calculations in support of the estimate.

314,500 kWh of energy can be produced in one year from the water conserved. These amounts were calculated based upon historical usage provided by Logan Light and Power. Additional information may be provided upon request.

Describe any other benefits of the renewable energy project. Please describe and provide sufficient detail on any additional benefits expected to result from the renewable energy project, including:

» Expected environmental benefits of the renewable energy system

Return flows from the hydroelectric generation facility will reenter the Logan River above 1st Dam for users downstream.

» Any expected reduction in the use of energy currently supplied through a Reclamation project

Many pumps along the existing LNC alignment will be taken offline because of system pressurization. There are no apparent connections to Reclamation project producing power.

» Anticipated beneficiaries, other than the applicant, of the renewable energy system

Shareholders who will not need to pump water for their uses will benefit. Logan Light and Power and its users will benefit as power will remain on the grid and will reduce demands.

» Expected water needs of the renewable energy system

The water needs of the renewable energy system are adaptable to the water available. Logan City has an existing right that allows their system to function year round. The conserved water routed through the generators will enhance the power production during the irrigation season.

Subcriterion No. B.2.—Increasing Energy Efficiency in Water Management

Describe any energy efficiencies that are expected to result from implementation of the water conservation or water management project

With 4.2 miles of open canal being piped and pressurized, the existing user pumps along the canal will be eliminated. Several large lateral pumping systems exist along the canal. It is expected that 285,100 kWh of energy will be conserved and over $27,100 saved in pumping costs.

» Please provide sufficient detail supporting the calculation of any energy savings expected to result from water conservation improvements. If quantifiable energy savings are expected to result from water conservation improvements, please provide sufficient details and supporting calculations. If quantifying energy savings, please state the estimated amount in kilowatt hours per year.

By creating a pressurized system, this project will eliminate the need for at least four sizable pump stations that are currently delivering secondary water to residences and agricultural users. The table below shows these pump stations and the large amount of energy and money that is used in their operation. **A direct benefit of this project is the conservation of 125,500 kWh and $12,064.00 annually.**

Average Pumping Cost per kWh		
kWh	kWh	$/kWh
Green Belt Irr.	34,700.00	$ 3,100.00
Kings Row Irr	4,830.00	$ 400.00
North Park Irr	53,400.00	$ 4,700.00
Green Canyon Irr	32,570.00	$ 3,864.00
Totals	**125,500.00**	**$ 12,064.00**

» Please describe the current pumping requirements and the types of pumps (e.g., size) currently being used. How would the proposed project impact the current pumping requirements?

Pumping savings were calculated from the actual power bills and kWh usage for 4 large lateral systems that service agricultural and residential uses along the canal (See Figure 5). The expense and usage for these users were normalized per water share. It was determined that each share required 460 kWh of energy and $43.69 during the irrigation season for pumping and power costs. Based upon developed land area and irrigation practices measured using GIS, 60% of the land was calculated to be pressurized from existing pumps and 40% remained using gravity irrigation.

» Please indicate whether your energy savings estimate originates from the point of diversion, or whether the estimate is based upon an alternate site of origin.

The energy savings estimates originate from turnout points along the canal, not the point of diversion.

» Does the calculation include the energy required to treat the water?

No, the calculations do not include the energy required to treat the water. Water entering the system is treated upstream by an existing bar screen at the point of diversion. A screen cleaner is used to keep the screen clean. Power consumption from the screen cleaner is minimal.

» Will the project result in reduced vehicle miles driven, in turn reducing carbon emissions? Please provide supporting details and calculations.

Piping and metering will improve system operation practices by decreasing the number of trips LNIC personnel must take to drive and inspect the canal. Currently, LNIC staff travels 10 miles per day two times per week.

Traveling only twice a week at 10 miles per round trip would equate to a savings of 1,500 miles per irrigation season. Calculation of CO2 and social cost of the Carbon based on 3% discount rate per ton and cost of gasoline come from information provided by FHWA Benefits Cost Analysis Resource Guide. Calculation and information for the CO2 metric tons saved comes from the "Carbon Foot Print" website located at www.carbonfootprint.com/calculator.aspx

The following are the assumptions made:

» Assume 14 mpg for a 2006 Ford F150 four wheel drive
» Assume fuel cost at $3.39 per gallon
» Assume a Social Cost of Carbon discounted at 3% per ton

Gasoline savings: Savings of $145.00
Pollution savings: Savings of 1.03 metric tons of CO^2 per year, which equates to a Social Cost of Carbon per ton at $22.80 which equals savings of $23.48 per year saved. Discounted by 3% is $22.78.

Describe any renewable energy components that will result in minimal energy savings/production (e.g., installing small-scale solar as part of a SCADA system).
Not applicable

Evaluation Criterion C: Benefits to Endangered Species

The Logan and Northern project area was included in an Environmental Impact Statement prepared for NRCS in August 2011. The EIS listed the following as federally-recognized threatened and endangered species and found no impact to the species.

Maguire's Primrose

(1) What is the relationship of the species to water supply?

Maguire's primrose (Primula maguirei): Threatened. Maguire's primrose lives only in Logan Canyon, Cache County, Utah. This plant lives only on steep cliff faces or rock overhangs. It typically lives on slopes that are north-facing but occasionally is found on south-facing slopes near the canyon bottom (about 5,100 to 6,600 feet in elevation) that are shaded, mossy, and damp.

(2) What is the extent to which the proposed project would reduce the likelihood of listing or would otherwise improve the status of the species?

The project limits do not include any habitat of the Maguire's primrose and would have no effect on the species. However, secondary effects from the project may provide more water to remain in Logan Canyon, contributing to the primrose habitat.

Ute-ladies' Tresses

(1) What is the relationship of the species to water supply?

Ute ladies'-tresses (Sprianthes diluviali): Threatened. This orchid was discovered in Cache County in August 2008 in a grazed wet meadow on the west side of Cache Valley in the Bear River watershed. Prior to this finding, no populations of this species had ever been found or were historically known to be present in Logan Canyon or the Logan River watershed or in any canal sections.

(2) What is the extent to which the proposed project would reduce the likelihood of listing or would otherwise improve the status of the species?

There are no populations or habitats of the Ute-ladies' tresses orchid within the project footprint.

Canada Lynx

(1) What is the relationship of the species to water supply?

Canada lynx (Lynx canadenisis): Threatened. There is potential habitat for this species in the high-elevation coniferous forests in Cache County but they would be outside of the project footprint. According to USFS, Canada lynx might use Logan Canyon as a travel way, but no populations are known to inhabit the project area along the canal.

(2) What is the extent to which the proposed project would reduce the likelihood of listing or would otherwise improve the status of the species?

There are no populations within the project area. The project would not affect lynx travel corridors.

June Sucker

(1) What is the relationship of the species to water supply?

A key part of the June Sucker Recovery Program is located in Logan Utah at the Logan Fisheries Experiment Station. Underground water wells feed the warm water recirculating production facilities for the fish.

(2) What is the extent to which the proposed project would reduce the likelihood of listing or would otherwise improve the status of the species?

By conserving water and not losing it to evaporation through this project, the aquifer that feeds the water for the June Sucker production facilities will be better maintained.

Evaluation Criterion D: Water Marketing

(1) Estimated amount of water to be marketed.

Water marketing is not allowed under Utah State Law. The irrigation company does allow leasing of shares within the existing service area of the company to maintain beneficial use of water and allow irrigators to obtain their full water right.

(2) A detailed description of the mechanism through which water will be marketed (e.g., individual sale, contribution to an existing market, the creation of a new water market, or construction of a recharge facility).
A new market will not be created.

(3) Number of users, types of water use, etc. in the water market
Not applicable.

(4) A description of any legal issues pertaining to water marketing (e.g., restrictions under Reclamation law or contracts, individual project authorities, or State water laws).

Utah law does not currently allow for water banking, but leasing water shares to users to maintain beneficial use is a common practice by irrigation companies in the area. The LNIC has an existing protocol outlined in their bylaws to allow for leasing of water.

(5) Estimated duration of the water market
The internal company leases could be in place into perpetuity.

Evaluation Criterion E: Other Contributions to Water Supply Sustainability

» Describe in detail the adaptation strategy that will be implemented through this WaterSMART Grant project. Identify the specific WaterSMART Basin Study where this adaptation strategy was developed. Describe the water supply or water management issue that this adaptation strategy will address.

Scott Blake and Jonathan Jones at the USBR Provo Office confirmed that they are not aware of a WaterSMART Basin Study that includes the service area.

» Provide a detailed explanation of how the proposed WaterSMART Grant project would help implement the adaptation strategy identified in the Basin Study.

Although this project area is not specifically included in a Reclamation Basin Study, it is included in the Utah State Water Plan "Bear River Basin Planning for the Future". This project will implement many of the water conservation measures outlined in that plan including:

- **Outdoor conservation.** The plan suggests using secondary systems to reduce the demand for more expensive culinary water. The secondary system installed as part of this project will reserve culinary water for indoor uses.
- **Metering.** Accurate measurement of water encourages conservation. This project will include system metering to measure usage.
- **Identify water waste**. The State Water Plan was conducted to identify the water losses and now the measures will be taken to alleviate the losses.

(2) Points may be awarded for projects that will help to expedite future on-farm irrigation improvements, including future on farm improvements that may be eligible for NRCS funding. Please address the following:

» Include a detailed listing of the fields and acreage that may be improved in the future.

No specific fields are identified at this time. However, with pressurized water available, the economic feasibility of installing on farm improvements will be much higher.

» Describe in detail the on-farm improvements that can be made as a result of this project. Include discussion of any planned or ongoing efforts by farmers/ranchers that receive water from the applicant.

This project will allow for the installation of sprinkler systems including hand lines, wheel lines, and pivots with financial assistance from the NRCS AWEP Program. Irrigators are reviewing options for this financial assistance program with NRCS.

» Provide a detailed explanation of how the proposed WaterSMART Grant project would help to expedite such on-farm efficiency improvements.

Providing pressurized water to the irrigators will reduce the cost of installing and operating more efficient irrigation systems. Purchasing pumps and paying for power and maintenance will not be necessary with the pressurized water system. Therefore, the saved money will be able to be applied toward irrigation systems.

» Fully describe the on-farm water conservation or water use efficiency benefits that would result from the enabled on-farm component of this project. Estimate the potential on-farm water savings that could result in acre-feet per year. Include support or backup documentation for any calculations or assumptions.

Many irrigators are flood irrigating. This methodology has an efficiency of 60%. If pressurized irrigation lines are installed, they will improve efficiency up to 85%. This is based upon documented research from NRCS. (See Attachment D)

» Projects that include significant on-farm irrigation improvements should demonstrate the eligibility, commitment, and number or percentage of shareholders who plan to participate in any available NRCS funding programs. Applicants should provide letters of intent from farmers/ranchers in the affected project areas.

No specific on-farm projects are identified at this time.

» There are no specific plans to implement NRCS funding plans established at this time.

(3) **Other benefits** to water supply sustainability.

» Will the project make water available to address a specific concern? For example:

i. Will the project address water supply shortages due to climate variability and/or heightened competition for finite water supplies (e.g., population growth or drought)? Is the river, aquifer or other source of supply over-allocated?

According to the US Census, Cache County has experienced rapid growth over the last 20 years with population increasing by more than 60.5%. This growth, of course, brings increased demands for water for municipal and industrial needs in an already water-short basin. Being the second driest state in the U.S., drought is a continual concern in Utah and population growth has put an additional strain on the water supply. This project will help to accommodate the growth and mitigate the effects of climate change by conserving water, reducing energy demands, and allowing for more efficient irrigation practices.

ii. Will the project market water to other users? If so, what is the significance of this (e.g., does this help stretch water supplies in a water-short basin)?

No, water marketing is not allowed in Utah. However, water conserved will stay in the system for existing users to maintain their full water right in years of drought.

iii. Will the project make additional water available for Indian tribes?

There are no Indian tribal lands located in the project area.

iv. Will the project help to address an issue that could potentially result in an interruption to the water supply if unresolved? (e.g., will the project benefit an endangered species by maintaining an adequate water supply)? Are there endangered species within the basin or other factors that may lead to heightened competition for available water supplies among multiple water uses?

LNIC is very conscientious of possible interruption in water supply and would like to be proactive in reducing this risk. Unfortunately, Cache County water users and the public have seen firsthand the dangers of an open canal breach when in July 2009 a landslide caused a section of the Logan & Northern Canal to break away. Three people were killed by the landslide, nearby property was seriously damaged, and water distribution through the canal stopped. Piping the canal will reduce the potential for another canal breach in the area and reduce the chance for an interruption in water supply.

If more and more water is diverted from Cache County rivers, the federally-recognized endangered species that exist in the area may be negatively affected by a change in the habitat. LNIC is committed to conserving water through this project and previous improvements to prevent additional stress to these sensitive species.

Discuss how our project helps to meet the goals of the June 2013 Climate Action Plan and November 1, 2013 Executive order "Preparing the United States for the Impacts of Climate Change"

This project will help meet the challenge of the Climate Action Plan in at least three specific areas that can be designated as "directly meeting the challenge." They are – Conserving Land and Water Resources, Maintaining Agricultural Sustainability, and Leading in Clean Energy.

Conserving Land and Water Resources

This project enhances and implements a strategy to conserve fresh water resources. By conserving 1,530 acre-feet of water that would otherwise have been lost to seepage, evaporation or spillage. Conserving this water puts less demand on the water system and helps prevent the need to divert more water from rivers and reservoirs. Water storage is necessary to mitigate the volatility of climate change.

Maintaining Agricultural Stability

Agriculture is the primary water use in Cache County. Agriculture is vital to the area's economy and therefore, maintain agricultural stability is an important goal of this project. This project helps to conserve water for agricultural uses and makes the use of that water more efficient through a pressurized system. Individual users will no longer need to pump water onto their land, they will have the pressure available for efficient sprinkler systems, and they will have access to their full water right to ensure that they have enough water to meet the needs of their crops or livestock.

Leading in Clean Energy

By eliminating the many pumps on the current system, this project will conserve 285,100 kWh of power annually. This is an estimated savings of $27,100 annually brought by using a gravity-fed pressurized system rather than an open flow canal and pumping system. The number of vehicle trips taken to drive the open canal and check its operation will be reduced significantly resulting in reduced energy costs and carbon emissions. The water conserved by this project can be used to provide additional power generation at the existing Logan Light & Power facility.

» Will the project generally make more water available in the water basin where the proposed work is located?

Yes. The project will conserve 1,530 acre-feet of water annually.

Does the project promote and encourage collaboration among parties?

Yes. After the 2009 landslide, the Logan & Northern Irrigation Company and the Logan Hyde Park, Smithfield Canal Company formed a partnership to plan and coordinate water delivery. The partnership is formally referred to as the Cache Highline Water Users' Association. Cache County and the Cities of Logan, North Logan, Hyde Park, and Smithfield participate as stakeholders.

i. Is there widespread support for the project?

Yes. The communities of North Logan and Hyde Park are in support of this project. Cache County has identified this project as a priority in its 2013 Water Master Plan and the Water Manager has expressed written support for this project. Logan Light and Power is also in support of this project because of its significant energy savings and additional opportunity to create hydroelectric power. Letters of support for the project can be found in the Letters of Support section of this application.

ii. What is the significance of the collaboration/support?

By having the support of municipalities and other entities, this project can be completed quickly and without major obstructions. Coordination during permitting, design and construction is much easier with significant support from local entities.

iii. Will the project help to prevent a water-related crisis or conflict?

It is the hope of LNIC that by piping and enclosing the canal, a catastrophic failure similar to the breach in July 2009 can be prevented from occurring again.

Also, by increasing irrigation efficiency, it is less likely that agricultural users will experience shortages that could impair their crop outputs.

Conflict often arises as the company tries to meet the needs of all users when river flows drop in the summer and fall. Pressurizing the system will allow for what little water they have available to be distributed more efficiently.

iv. Is there frequently tension or litigation over water in the basin?

Yes. The allocation of water under the Kimball Decree between municipal and agricultural demands is difficult to manage in times of drought. Stretching their water resource is vital to reduce this conflict. Through the decree, the water from the Logan River is proportioned to 16 different entities including 11 irrigation companies, Logan City (who now owns Utah Power and Light Co. rights), five private companies and one individual. As the flow in the Logan River drops, the decree outlines the flow diversions that each entity can take to resolve conflicts during drought years. For example, over the past several years, the flow in the river has dropped to only 120 cfs in the late summer. When this occurs, LNIC is only entitled to 27.6 cfs or less than ¼ of their right. (See Attachment B). Even with the decree in place, there is still a great deal of controversy on applying the decree that comes during times of drought.

Projects like the CWRP have helped to reduce controversy during water shortages from the use of technology and efficient irrigation practices. The Logan and Northern Irrigation Piping and Pressurization Project will continue to do the same.

Is the possibility of future water conservation improvements by other water users enhanced by completion of this project?

By constructing a pressurized irrigation system, this project will enhance the ability for individual users to conserve water on their property through more efficient irrigation practices. The many pumps used to get water onto these properties can be eliminated to allow these users to save energy and money.

Utah State University is a leader in hydraulics and water research. The Utah Water Research Laboratory can store conserved water in their facilities for power generation and research at the Utah Water Research Laboratory.

The Agricultural College at USU will also be able to utilize pressurized irrigation at their research farm facilities located in the service area of the LNIC. Secondary to irrigation benefits, USU's research provides innovative methods of irrigation, crop production and genetic improvements that can help further reduce water consumption and improve production for agricultural purposes. We have included a letter of support for the Project from USU located in the "Letters of Support" section of the application

Will the project increase awareness of water and/or energy conservation and efficiency efforts?

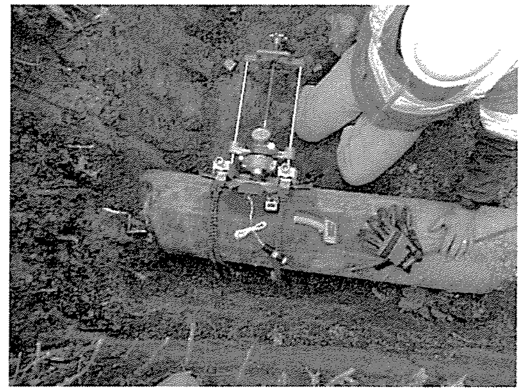
With the option to lease water to the Utah Water Research Laboratory and the Agricultural College, this project opens up research opportunities and increases awareness for those studying water resource issues.

» Will the project serve as an example of water and/or energy conservation and efficiency within a community?

As LNIC has been working closely with various entities on the Cache Water Restoration Project, the company's efforts served as an example to surrounding communities and other local water companies on how they can implement water and energy saving techniques. This project will be a continuation of that effort.

» Will the project increase the capability of future water conservation or energy efficiency efforts for use by others?

By creating a pressurized system, it will be possible for individual users to increase energy efficiency and use less water for irrigation. These users may even implement newer high-efficiency sprinkler technology because they will have the water pressure to make that possible.


Pressure Connection

The communities of North Logan and Hyde Park that provide potable water to residences will be able to conserve that water because it will not need to be used for secondary purposes. This will reduce their energy usage as treatment and pumping costs will also be reduced.

» Does the project integrate water and energy components?

Yes. It saves water from seepage, evaporation and spillage loses on the open canal. By pressurizing the system, the pumps used to get water onto user's property will be eliminated creating significant energy savings.

Evaluation Criterion F: Implementation and Results

Subcriterion No. F.1.—Project Planning

Does the project have a Water Conservation Plan, System Optimization Review (SOR), and/or district or geographic area drought contingency plans in place? Does the project relate/have a nexus to an adaptation strategy developed as part of a WaterSMART Basin Study)? Please self-certify, or provide copies of these plans where appropriate, to verify that such a plan is in place

Provide the following information regarding project planning:

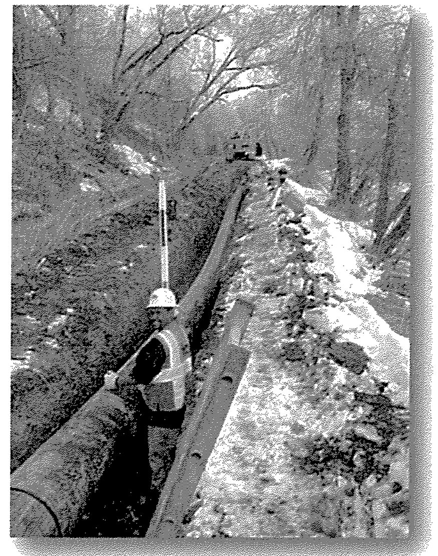
(1) Identify any district-wide, or system-wide, planning that provides support for the proposed project. This could include a Water Conservation Plan, SOR, Basin Study, or other planning efforts done to determine the priority of this project in relation to other potential projects.

This project is in complete alignment with the recommendations of the 2013 Cache County Water Master Plan funded by the WaterSMART: System Optimization Review grant program. The Plan identified the LNIC Piping and Pressurization Project as a step to implement the goal of water conservation to meet future demands. The Executive Summary of the Cache County Water Master Plan can be found in Attachment C. The complete master plan can be found at http://www.cachecounty.org/assets/department/water/water-master-plan/Cache_County_Water_Master_Plan_Report_Aug_2013.pdf

In 2010, LNIC prepared a Water Management and Conservation Plan that identifies goals of water conservation and the success of previous piping projects estimating a 30-40% water savings over the open canals. Portions of this Plan can be viewed in Attachment C.

(2) Identify and describe any engineering or design work performed specifically in support of the proposed project.

Preliminary engineering including pipe size estimates, selecting materials, mapping, costs estimates and project planning have been completed. The prescriptive easements associated with this canal are being prepared and recorded at this time. All final constructed items will be completed within the existing prescriptive easements. Upon entering into a contract with Reclamation, LNIC is prepared to immediately begin the environmental process and final design.



Installation of HDPE in Canal Bank

(3) Describe how the project conforms to and meets the goals of any applicable planning efforts, and identify any aspect of the project that implements a feature of an existing water plan(s).

This project meets the goals of the 2013 Cache County Water Master Plan in that it conserves water to meet current and future municipal growth and improve water efficiencies. The Plan prioritizes projects that implement water conservation.

Subcriterion No. F.2.—Readiness to Proceed

Describe the implementation plan of the proposed project.

LNIC is ready to proceed with this project as soon as the funding is in place. Existing easements are being documented now and planning and preliminary engineering have been completed and final design and the environmental process will be completed shortly after a contract with USBR is in place.

Estimated project schedule that shows the stages and duration of the proposed work, including major tasks, milestones, and dates.

SCHEDULE Year 1 September 2014 –September 2015 ***Milestone/Task***	Sept 2014	Oct 2014	Nov 2014	Dec 2014	Jan 2015	Feb 2015	March 2015	April 2015	May 2015	June 2015	July 2015	Aug 2015	Sept 2015
Sign WaterSMART contracts	■												
Environmental Document		■	■	■	■								
Permitting				■	■								
Engineering Design				■	■	■	■	■	■				
Bid										■			
Award											■		
Materials Procurement												■	
Mobilization												■	■

SCHEDULE Year 2 October 2015 –May 2016 ***Milestone/Task***	Oct 2015	Nov 2015	Dec 2015	Jan2016	Feb 2016	March 2016	April 2016	May 2016	June 2016
Install HDPE Pipe	■	■	■	■	■	■	■	■	
Install meters	■	■	■	■	■	■	■	■	

Please explain any permits that will be required, along with the process for obtaining such permits.

Wetland and other permits will be identified as part of the environmental process and will be obtained during that portion of the project. Construction permits will be obtained from cities where road crossings are located.

Subcriterion No. F.3.—Performance Measures

Provide a brief summary describing the performance measure that will be used to quantify actual benefits upon completion of the project (e.g., water saved, marketed, or better managed, or energy saved). For more information calculating performance measure, see Section VIII.A.1. "FY2013 WaterSMART Water and Energy Efficiency Grants: Performance Measures".

Performance Measure No. A.: Projects with Quantifiable Water Savings

Performance Measure No. A.1.—Canal Lining/Piping

Pre-project methods for quantifying the benefits of canal lining or piping projects:

Ponding or inflow/outflow tests have not been performed. This is due to the shortage of water available during the Water Restoration Project construction preventing the company from delaying service while ponding tests take place. Historical seepage rates have been calculated using the method outlined below:

To determine seepage losses from the canal, a study from the American Society of Civil Engineers (ASCE) Journal of the Irrigation and Drainage Division provided the basis for calculations. The study consisted of 765 seepage measurements canals in 15 western United States over 40 years. Measurements were made from ponding or seepage meters. From the study, seepage losses for various soil types was determined as well as a methodology to determine seepage losses. Following the procedure outlined in the study, the soil type along the project area were determined using the NRCS Web Soil Survey. From the soils survey, the soil types in the canal were determined and the seepage loss rates from the study were applied for each soil type and length of that type along the project reach. The lengths and seepage rates were then multiplied by the water surface width and duration of the irrigation season to calculate the seepage loss. Losses were calculated to be 1088 AF or an average of 2.6 cubic feet per second over the irrigation season. A copy of the calculations is included in the application above.

Evaporation losses were calculated using the pan evaporative rates published by Utah State University for the Cache Valley. The evaporative loss during the irrigation season is 50 inches. Using the length and width of the canal water surface and evaporation rate, the loss was calculated. It was determined to be 25 AF.

Based upon these calculations and knowing that the completed project will be a sealed pipe system with no seepage or evaporation, essentially all water lost will be conserved.

Post-project methods for quantifying the benefits of canal lining or piping projects:

Prior to system startup, the pipeline will be pressure tested to ensure no leakage. Following system startup and during operation, we will collect meter readings from the beginning of the pipe and each turnout on a regular basis. The flow meter at the beginning of the pipe can be read remotely through a SCADA system. The turnout meters will be ready monthly via radio. These flows will be totalized, reviewed and compared for any leakage monthly. If any leaks or loss of water are indicated a crew will be dispatched to determine the location and remedy the problem. The monthly reports will be prepared by the water master and reviewed at the annual meeting each spring by the board of directors.

Evaluation Criterion G: Additional Non-Federal Funding

$$\frac{\text{Non-Federal Funding}}{\text{Total Project Cost}}$$

$$\frac{\$1{,}644{,}256}{\$2{,}644{,}256}$$

= 62.2%

Evaluation Criterion H: Connection to Reclamation Project Activities

(1) How is the proposed project connected to Reclamation project activities?

This project came about as a direct result of the Cache County Water Master Plan funded by Reclamation's WaterSMART: System Optimization Review grant program.

There are two Reclamation projects in the Cache Valley: the Newton Reservoir and Hyrum Reservoir projects. These projects store irrigation water for agricultural and residential irrigation water uses on the southern and western portions of Cache Valley. By improving the water available in the project area, growth in the service area can continue and reduce the already high demand on irrigation water in the areas served by Newton and Hyrum Reservoirs.

(2) Does the applicant receive Reclamation project water?

No. The Logan River is LNIC's main water source.

(3) Is the project on Reclamation project lands or involving Reclamation facilities?

No.

(4) Is the project in the same basin as a Reclamation project or activity?

Yes. This project is located in the Bear River Basin which includes the Newton and Hyrum Reservoirs.

(6) Will the proposed work contribute water to a basin where a Reclamation project is located?

Yes. The water conserved will remain in the Bear River Basin and will reduce the demand to take water from the Hyrum and Newton Reservoirs. This will also help ease future demand as water downstream of this project is combined into the Cutler Reservoir on the Bear River where there is a significant need for water resources in the future. The Cache Valley Water Master Plan identities that within the next 20 years a new storage reservoir will need to be constructed to supply water to Northern Utah. LNIC's project will conserve water to make it available for that future demand.

Environmental

Environmental and Cultural Resources

(1) Will the project impact the surrounding environment (e.g., soil [dust], air, water [quality and quantity], animal habitat)? Please briefly describe all earth-disturbing work and any work that will affect the air, water, or animal habitat in the project area. Please also explain the impacts of such work on the surrounding environment and any steps that could be taken to minimize the impacts.

Impacts will be those associated with installing pipe and placing meters. The proposed project improvements will take place within the existing canal corridor and few construction easements. Best practices to prevent the spread of noxious weeds and dust control will be employed. The surface vegetation will be restored upon completion of the project.

(2) Are you aware of any species listed or proposed to be listed as a Federal threatened or endangered species, or designated critical habitat in the project area? If so, would they be affected by any activities associated with the proposed project?

A complete environmental document will prepared as part of this specific project to understand in depth any impacts to endangered species.

A portion of the Logan and Northern project area was included in an Environmental Impact Statement prepared for NRCS in August 2011. The EIS listed the federally-recognized threatened and endangered species that may exist in the area and found no impact to the species.

3) Are there wetlands or other surface waters inside the project boundaries that potentially fall under CWA jurisdiction as "waters of the United States?" If so, please describe and estimate any impacts the project may have.

There are not any wetlands known to be in the project area, but the project includes a complete wetlands study to determine any impacts.

(4) When was the water delivery system constructed?

The Logan and Northern Canal was construction in 1887.

(5) Will the project result in any modification of or effects to, individual features of an irrigation system (e.g., headgates, canals, or flumes)? If so, state when those features were constructed and describe the nature and timing of any extensive alterations or modifications to those features completed previously.

The project will impact the existing turnout pipes along the canal corridor. It is anticipated that some headgates and turnouts may be removed in order to prevent accidental flooding when the existing channel is converted to storm water conveyance.

(6) Are any buildings, structures, or features in the irrigation district listed or eligible for listing on the National Register of Historic Places? A cultural resources specialist at your local Reclamation office or the State Historic Preservation Office can assist in answering this question.

An assessment will be completed to investigate any historic structures, buildings or features in the project area. With the project being constructed in the existing canal easement, the only historic structures affected will be box culvert crossings and existing irrigation turnouts.

(7) Are there any known archeological sites in the proposed project area?

There are none known or anticipated at this time. The project limit area was disturbed when the canal was originally constructed. This project includes a cultural assessment to investigate if any archeological sites occur.

(8) Will the project have a disproportionately high and adverse effect on low income or minority populations?

No. This project will not have a high or adverse effect on low income and minority populations.

(9) Will the project limit access to and ceremonial use of Indian sacred sites or result in other impacts on tribal lands?

No. There are no known Indian tribal/cultural resources or tribal lands located in the project area. Tribal coordination will take place during the environmental process.

(10) Will the project contribute to the introduction, continued existence, or spread of noxious weeds or non-native invasive species known to occur in the area?

No. Best Management Practices will be employed to prevent the spread of noxious weeds in the area. It is expected that piping the canal will help with the control of noxious weeds and invasive trees.

Required Permits or Approvals

Wetland and other permits will be identified as part of the environmental process and will be obtained during that portion of the project. Storm water and construction permits will be obtained from cities where construction activities will take place.

Letters of Support

COLLEGE of
AGRICULTURE and
APPLIED SCIENCES
UtahStateUniversity

Office of the Dean

January 21, 2014

Zan Murray
J-U-B ENGINEERS, Inc.
1047 South 100 West Suite 180
Logan, UT 84321

Dear Mr. Murray:

The Utah Agricultural Experiment Station at Utah State University is fully supportive of the proposal to extend piped pressurized canal water from its current termination point at about 1500 North to 4400 North in Hyde Park.

We currently draw gravity feed water at two locations on either side of 1900 North in North Logan. We have already been able to remove two pumps, and the proposed extension would allow us to replace the remaining pump. The energy savings for the Greenville Research Farm would amount to hundreds of dollars per year. Further, the additional safety of not having a running open canal and the water savings from both evaporation and seepage would be substantial. Reducing the loss of water during episodes of drought, as we are currently experiencing, would potentially allow the Logan and Northern Canal Company to divert less water while still allowing shareholders to irrigate their total acreage.

The benefits of piped and pressurized water would be substantial for the Utah Agricultural Experiment Station and for other canal shareholders along the proposed pipe. We support this effort.

Sincerely,

Kenneth L. White
Dean, College of Agriculture and Applied Sciences
Director, Utah Agricultural Experiment Station

4900 Old Main Hill Logan, UT 84322-4900 Ph: (435) 797-2201 www.caas.usu.edu

M. LYNN LEMON
COUNTY EXECUTIVE / SURVEYOR

199 NORTH MAIN
LOGAN, UTAH 84321
TEL: 435-755-1850
FAX: 435-755-1981

Cache County
1857

Bureau of Reclamation
Attn: Michelle Maher
Mail Code: 84-27852
P.O. Box 25007
Denver, CO 80225

January 17, 2014

Dear Michelle,

With the assistance of the Bureau of Reclamation, Cache County recently completed a Water Master Plan. The planning document outlines the process that was followed to gather input on projects that would help in meeting the planning goals of the citizens of Cache Valley.

The decision matrix identified the pressurization of secondary water as a viable option for the conservation and optimization of water use. In reviewing the objectives of piping a portion of the Logan and Northern Canal, I see the pressurization option as fulfillment of the selected objective outlined in the Water Master Plan. In addition, it would be a great asset to individuals, the cities, and the county.

Thank you very much for your consideration to fund this request.

Sincerely,

Robert M. Fotheringham
Cache County Water Manager

Official Resolution

OFFICIAL RESOLUTION

RESOLUTION NO. 2014 - ______

Logan & Northern Irrigation Company

WHEREAS, The Logan & Northern Irrigation Company must maintain, provide for, and service the Water System,

WHEREAS, the System is in need of improvements to conserve and better manage water,

WHEREAS, The Company desires to obtain grant funding from the Bureau of Reclamation through the WaterSMART: Water and Energy Efficiency Grant program

NOW THEREFORE, BE IT RESOLVED that the Board of Directors, agrees and authorizes that:

1. **The WaterSMART: Water and Energy Efficiency Grant application prepared has been reviewed by the Board of Directors and supports the contents therein;**
2. **The Logan & Northern Irrigation Company is capable of providing the amount of funding specified in the funding plan; and**
3. **If selected for a WaterSMART: Water and Energy Efficiency Grant, the Company will work with the Bureau of Reclamation to meet established deadlines for entering into a cooperative agreement.**

DATED: 1/9/14

Jon Meikle Pres
Name and Title

Jon Meikle
Authorized Signature

ATTEST:

Lyle D Thornley

Budget

Project Budget

Funding Plan and Letters of Commitment

(1) How you will make your contribution to the cost share requirement, such as monetary and/or in-kind contributions and source funds contributed by the applicant (e.g., reserve account, tax revenue, and/or assessments).

Logan and Northern Irrigation Company has been in contact with the Utah Board of Water Resources and will be seeking a loan from the Board as a match to the Federal funds.

(2) Describe any in-kind costs incurred before the anticipated project start date that you seek to include as project costs. Include:

(a) What project expenses have been incurred?

The cost to prepare the WaterSMART application will be considered in-kind costs.

(b) How they benefitted the project

Preparations for the application included the cost estimate, scheduling, preliminary engineering and finalizing some planning efforts.

(c) The amount of the expense

$10,500

(d) The date of cost incurrence

November 2013 – January 2014

(3) Provide the identity and amount of funding to be provided by funding partners, as well as the required letters of commitment.

LNIC is working with the Utah Board of Water Resources to obtain a loan for $1,633,756 to match the Federal funding.

(4) Describe any funding requested or received from other Federal partners. Note: other sources of Federal funding may not be counted towards your 50 percent cost share unless otherwise allowed by statute.

No other Federal funding has been requested or received.

(5) Describe any pending funding requests that have not yet been approved, and explain how the project will be affected if such funding is denied.

LNIC is requesting funding from the Utah Board of Water Resources. It is unlikely that the funding will be denied as UBWR recognizes the importance of this project and has expressed support for the project.

Funding Sources	**Funding Amount**
Non-Federal Entities	
1. Logan & Northern Irrigation Company in-kind • Preliminary engineering • Grant preparation • Mapping • Planning	$10,500
2. Utah Board of Water Resources Loan	$1,633,756
3.	
Non-Federal Subtotal	$1,644,256
Other Federal Entities	
1.	
2.	
3.	
Other Federal Subtotal	
Requested Reclamation Funding:	$1,000,000
TOTAL PROJECT FUNDING	**$2,644,256**

BUDGET PROPOSAL

The project budget shall include detailed information on the categories listed below and must clearly identify all project costs. Unit costs shall be provided for all budget items including the cost of work to be provided by contractors. Additionally, applicants shall include a narrative description of the items included in the project budget, including the value of in-kind contributions of goods and services provided to complete the project. It is strongly advised that applicants use the budget proposal format shown below on tables 3 and 4 or a similar format that provides this information.

Funding Sources	**Percent of Total Project Cost**	**Total Cost by Source**
Recipient Funding		$1,644,256
Reclamation Funding		$1,000,000
Other Federal Funding		$
TOTALS		$2,644,256

Budget Narrative

Salaries and Wages

No LNIC salaries or wages will be included. All services will be contracted. Any LNIC staff time will be in addition to the cost of the project and will not be counted toward the cost.

Fringe Benefits

No fringe benefits will be required.

Travel

No travel will be required.

Equipment

Equipment will be part of the contracted portion of the project.

Materials and Supplies

Materials and supplies will be part of the contracted portion of the project and will be documented as required.

Contractual

J-U-B ENGINEERS, Inc. has been chosen as the consultant on this project preparing the grant application, cost estimate and preliminary engineering. LNIC selected J-U-B based on their extensive understanding of the LNIC system, relationships with neighboring communities and entities, experience in designing pressurized irrigation systems, and knowledge of Cache County water issues. J-U-B was selected through a competitive proposal process to be the project manager of the Cache Water Restoration Project to repair the canal breach and pipe other sections of canal. J-U-B was also selected through a competitive process to contract with Cache County to prepare the Cache County Water Master Plan in 2013. LNIC considers J-U-B's costs to be fair and reasonable based on their qualifications.

An estimated breakdown of the consultant's project costs is below:

Year 1

Budget Item Description	Computation		Total Cost
	Unit	Quantity	
ENGINEERING			
Funding Applications			$10,510.00
Project Manager	$183.94/HR	16.0 HR	$2,943.00
Project Engineer	$128.08/HR	20.0 HR	$2,562.00
Funding Specialist	$62.56/HR	80.0 HR	$5,005.00
Survey and Easements			$20,094.00
Project Manager	$183.94/HR	4.0 HR	$736.00
Project Engineer	$87.58/HR	8.0 HR	$701.00
Licensed Surveyor	$122.17/HR	24.0 HR	$2,932.00
Survey Crew	$157.25/HR	100.0 HR	$15,725.00
Design Engineering			$171,577.00
Project Manager	$183.94/HR	150.0 HR	$27,591.00
Project Engineer	$130.65/HR	350.0 HR	$45,728.00

Design Engineer	$87.58/HR	400.0 HR	$35,032.00
CAD Technician	$79.60/HR	600.0 HR	$47,760.00
QC/QA	$177.90/HR	60.0 HR	$10,674.00
Clerical	$59.90/HR	80.0 HR	$4,792.00
Administration and Legal			$35,000.00
Legal Counsel	$35,000.00/LS	1 LS	$35,000.00
Easements			$10,000.00
Acquisition	$10,000.00/LS	1 LS	$10,000.00
REPORTING			$7,594.00
Project Manager	$183.94/HR	20.0 HR	$3,679.00
Project Engineer	$133.20/HR	20.0 HR	$2,664.00
Funding Specialist	$62.56/HR	20.0 HR	$1,251.00
OTHER			$ 10,620.00
Legal Counsel	$10,000.00/LS	1	$10,000.00
State BOWR Administration (1.25%)			$620.00
MOBILIZATION			$77,906.00
Materials			
Bond	1.50%		$39,600.00
Labor			
Senior Project Manager	$61.67/HR	100.0 HR	$6,167.00
Truck Driver	$25.50/HR	300.0 HR	$7,650.00
Equipment Operator	$47.30/HR	160.0 HR	$7,569.00
Equipment			
Equipment Delivery Truck	$56.40/HR	300.0 HR	$16,920.00
SWPPP & REVEGITATION			$54,000.00
Materials			
Silt Fence	$2.40/FT	22,000 LF	$52,800.00
Labor			
Senior Project Manager	$61.67/HR	0.0 HR	$0.00
General Labor	$13.34/HR	0.0 HR	$0.00
Other			
Storm Water Permit	$1,200.00/LS	1 LS	$1,200.00

Year 2

Budget Item Description	Computation		Total Cost
	Unit	Quantity	
ENGINEERING			
Construction Observation			$159,691.00
Project Manager	$183.94/HR	110.0 HR	$20,233.00
Project Engineer	$130.65/HR	160.0 HR	$20,904.00
Construction Observer	$87.58/HR	900.0 HR	$78,822.00
Clerical	$59.90/HR	80.0 HR	$4,792.00
CAD Technician	$79.60/HR	200.0 HR	$15,920.00
Licensed Surveyor	$122.17/HR	24.0 HR	$2,932.00
Surveyor	$107.25/HR	150.0 HR	$16,088.00

LNIC will be the construction portion of the project to several prequalified construction companies. The contractual costs shown are estimates for each of the components to furnish and install all equipment. Generally, the low bidder will be selected based on a determination of acceptable qualifications.

In order to determine unit costs for the cost estimate, LNIC relied on contract prices from the 2013 Cache Water Restoration Project which was completed under similar conditions as this upcoming project.

Environmental and Regulatory Compliance Costs

J-U-B ENGINEERS, Inc. will prepare the environmental document and permit submittals.

The following is a breakdown of the costs:

ENVIRONMENTAL AND REGULATORY COMPLIANCE			
Environmental Study			$31,988.00
Project Manager	$183.94/HR	4.0 HR	$736.00
Environmental Scientist	$104.95/HR	140.0 HR	$14,693.00
GIS Specialist	$63.46/HR	140.0 HR	$8,884.00
Project Engineer	$128.08/HR	40.0 HR	$5,123.00
Design Engineer	$87.58/HR	20.0 HR	$1,752.00
Clerical	$40.00/HR	20.0 HR	$800.00

Reporting

Reporting costs are estimated charges from the project engineer. LNIC is not requesting any credit or reimbursement for in-house employee costs for preparing or submitting the necessary reports. Reports will be completed by the project engineer. Time spent reporting will be 30 hours per year; **the cost will total $7,594.00 over the duration of the project.**

Other Expenses

Legal Counsel will be required to review the contracts and give advice on the bid process. The cost will be $35,000 for general counsel. The Utah Board of Water Resources requires a legal opinion that will add an additional $10,000 to the project cost.

Grant Preparation was completed by the project engineer at a cost of $10,500. This included preparing the cost estimate, preliminary engineering, and project planning that will contribute to project readiness.

State Board of Water Resources Administration totaling 1.25% of the project is $620.00.

Easement Acquisition for the project will total $10,000.

COST ESTIMATE

SF-424 Budget Form

Logan Northern Canal Company Preliminary Estimate of Probable Cost Year 1

Budget Item Description	Computation		Total Cost
	Unit	Quantity	
Engineering			
Funding Applications			$10,510.00
Project Manager	$183.94/HR	16.0 HR	$2,943.00
Project Engineer	$128.08/HR	20.0 HR	$2,562.00
Funding Specialist	$62.56/HR	80.0 HR	$5,005.00
Survey and Easements			$20,094.00
Project Manager	$183.94/HR	4.0 HR	$736.00
Project Engineer	$87.58/HR	8.0 HR	$701.00
Licensed Surveyor	$122.17/HR	24.0 HR	$2,932.00
Survey Crew	$157.25/HR	100.0 HR	$15,725.00
Design Engineering			$171,577.00
Project Manager	$183.94/HR	150.0 HR	$27,591.00
Project Engineer	$130.65/HR	350.0 HR	$45,728.00
Design Engineer	$87.58/HR	400.0 HR	$35,032.00
CAD Technician	$79.60/HR	600.0 HR	$47,760.00
QC/QA	$177.90/HR	60.0 HR	$10,674.00
Clerical	$59.90/HR	80.0 HR	$4,792.00
Administration and Legal			$35,000.00
Legal Counsel	$35,000.00/LS	1 LS	$35,000.00
Easements			$10,000.00
Acquisition	$10,000.00/LS	1 LS	$10,000.00
ENVIRONMENTAL AND REGULATORY COMPLIANCE			
Environmental Study			$31,988.00
Project Manager	$183.94/HR	4.0 HR	$736.00
Environmental Scientist	$104.95/HR	140.0 HR	$14,693.00
GIS Specialist	$63.46/HR	140.0 HR	$8,884.00
Project Engineer	$128.08/HR	40.0 HR	$5,123.00
Design Engineer	$87.58/HR	20.0 HR	$1,752.00
Clerical	$40.00/HR	20.0 HR	$800.00
REPORTING			$7,594.00
Project Manager	$183.94/HR	20.0 HR	$3,679.00
Project Engineer	$133.20/HR	20.0 HR	$2,664.00
Funding Specialist	$62.56/HR	20.0 HR	$1,251.00
OTHER			$ 10,620.00
Legal Counsel	$10,000.00/LS	1	$10,000.00
State BOWR Administration (1.25%)			$ 620.00
MOBILIZATION			$ 77,906.00
Materials			
Bond	1.50%		$ 39,600.00
Labor			
Senior Project Manager	$61.67/HR	100.0 HR	$6,167.00
Truck Driver	$25.50/HR	300.0 HR	$7,650.00
Equipment Operator	$47.30/HR	160.0 HR	$7,569.00
Equipment			
Equipment Delivery Truck	$56.40/HR	300.0 HR	$16,920.00
SWPPP & Revegetation			$ 54,000.00
Materials			

Silt Fence	$2.40/FT	22,000 LF	$52,800.00
Labor			
Senior Project Manager	$61.67/HR	0.0 HR	$0.00
General Labor	$13.34/HR	0.0 HR	$0.00
Other			
Storm Water Permit	$1,200.00/LS	1 LS	$1,200.00
Pipe construction			
24" HDPE Pipe DR 21			**$31,710.00**
Materials			
24" HDPE Pipe DR 21	$43.32/FT	720 LF	$31,190.00
# 12 Copper Wire	$0.21/FT	2,000 LF	$420.00
6" Detection Tape	$0.05/FT	2,000 LF	$100.00
26" HDPE Pipe DR 21			**$70,813.00**
Materials			
26" HDPE Pipe DR 21	$50.98/FT	1,382 LF	$70,454.00
# 12 Copper Wire	$0.21/FT	1,382 LF	$290.00
6" Detection Tape	$0.05/FT	1,382 LF	$69.00
28" HDPE Pipe DR 21			**$85,019.00**
Materials			
28" HDPE Pipe DR 21	$59.11/FT	1,432 LF	$84,646.00
# 12 Copper Wire	$0.21/FT	1,432 LF	$301.00
6" Detection Tape	$0.05/FT	1,432 LF	$72.00
30" HDPE Pipe DR 21			**$126,846.00**
Materials			
30" HDPE Pipe DR 21	$67.90/FT	1,861 LF	$126,362.00
# 12 Copper Wire	$0.21/FT	1,861 LF	$391.00
6" Detection Tape	$0.05/FT	1,861 LF	$93.00
32" HDPE Pipe DR 21			**$39,447.00**
Materials			
32" HDPE Pipe DR 21	$77.24/FT	509 LF	$39,315.00
# 12 Copper Wire	$0.21/FT	509 LF	$107.00
6" Detection Tape	$0.05/FT	509 LF	$25.00
34" HDPE Pipe DR 21			**$216,876.00**
Materials			
34" HDPE Pipe DR 21	$87.19/FT	2,480 LF	$216,231.00
# 12 Copper Wire	$0.21/FT	2,480 LF	$521.00
6" Detection Tape	$0.05/FT	2,480 LF	$124.00
Total Project Opinion of Costs			**$ 1,000,000.00**

Logan Northern Canal Company Preliminary Estimate of Probable Cost Year 2

Budget Item Description	Computation		Total Cost
	Unit	Quantity	
ENGINEERING			
Construction Observation			**$159,691.00**
Project Manager	$183.94/HR	110.0 HR	$20,233.00
Project Engineer	$130.65/HR	160.0 HR	$20,904.00
Construction Observer	$87.58/HR	900.0 HR	$78,822.00
Clerical	$59.90/HR	80.0 HR	$4,792.00
CAD Technician	$79.60/HR	200.0 HR	$15,920.00
Licensed Surveyor	$122.17/HR	24.0 HR	$2,932.00
Surveyor	$107.25/HR	150.0 HR	$16,088.00
PIPE CONSTRUCTION			
8" HDPE Pipe DR 21			**$27,703.00**
Materials			
8" HDPE Pipe DR 21	$5.59/FT	1,913 LF	$10,694.00
# 12 Copper Wire	$0.21/FT	1,913 LF	$402.00
6" Detection Tape	$0.05/FT	1,913 LF	$96.00
Labor			
Forman GP6	$43.68/HR	31.9 HR	$1,393.00
Operator GP6	$36.96/HR	31.9 HR	$1,178.00
Operator GP3	$28.56/HR	31.9 HR	$911.00
Pipelayer GP6	$27.72/HR	31.9 HR	$884.00
Laborer GP4	$23.52/HR	31.9 HR	$750.00
Gas Fuser GP8	$26.88/HR	31.9 HR	$857.00
Equipment			
Loader	$78.49/HR	31.9 HR	$2,503.00
Fusion Machine	$389.2/day	4.0/day	$1,551.00
Truck Service	$20.76/HR	31.9 HR	$662.00
Hand Tools	$6.49/HR	31.9 HR	$207.00
Trackhoe	$80.43/HR	31.9 HR	$2,564.00
Trackhoe W/Compactor	$80.43/HR	31.9 HR	$2,564.00
Trench Box	$36.3/day	4.0/day	$145.00
Bedding Box	$13.0/day	4.0/day	$52.00
Trackhoe Mini	$51.89/HR	4.0 HR	$207.00
Generator 50KW	$20.76/HR	4.0 HR	$83.00
10" HDPE Pipe DR 21			**$5,429.00**
Materials			
10" HDPE Pipe DR 21	$8.69/FT	309 LF	$2,685.00
# 12 Copper Wire	$0.21/FT	309 LF	$65.00
6" Detection Tape	$0.05/FT	309 LF	$15.00
Labor			
Forman GP6	$43.68/HR	5.2 HR	$225.00
Operator GP6	$36.96/HR	5.2 HR	$190.00
Operator GP3	$28.56/HR	5.2 HR	$147.00
Pipelayer GP6	$27.72/HR	5.2 HR	$143.00
Laborer GP4	$23.52/HR	5.2 HR	$121.00
Gas Fuser GP8	$26.88/HR	5.2 HR	$138.00
Equipment			
Loader	$78.49/HR	5.2 HR	$404.00
Fusion Machine	$389.2/day	0.6/day	$251.00
Truck Service	$20.76/HR	5.2 HR	$107.00
Hand Tools	$6.49/HR	5.2 HR	$33.00
Trackhoe	$80.43/HR	5.2 HR	$414.00
Trackhoe W/Compactor	$80.43/HR	5.2 HR	$414.00
Trench Box	$36.3/day	0.6/day	$23.00
Bedding Box	$13.0/day	0.6/day	$8.00

Trackhoe Mini	$51.89/HR	0.6 HR	$33.00
Generator 50KW	$20.76/HR	0.6 HR	$13.00
12" HDPE Pipe DR 21			**$36,485.00**
Materials			
12" HDPE Pipe DR 21	$12.22/FT	1,435 LF	$17,536.00
# 12 Copper Wire	$0.21/FT	1,435 LF	$301.00
6" Detection Tape	$0.05/FT	1,435 LF	$72.00
Labor			
Forman GP6	$43.68/HR	35.9 HR	$1,567.00
Operator GP6	$36.96/HR	35.9 HR	$1,326.00
Operator GP3	$28.56/HR	35.9 HR	$1,025.00
Pipelayer GP6	$27.72/HR	35.9 HR	$994.00
Laborer GP4	$23.52/HR	35.9 HR	$844.00
Gas Fuser GP8	$26.88/HR	35.9 HR	$964.00
Equipment			
Loader	$78.49/HR	35.9 HR	$2,816.00
Fusion Machine	$389.2/day	4.5/day	$1,745.00
Truck Service	$20.76/HR	35.9 HR	$745.00
Hand Tools	$6.49/HR	35.9 HR	$233.00
Trackhoe	$80.43/HR	35.9 HR	$2,885.00
Trackhoe W/Compactor	$80.43/HR	35.9 HR	$2,885.00
Trench Box	$36.3/day	4.5/day	$163.00
Bedding Box	$13.0/day	4.5/day	$58.00
Trackhoe Mini	$51.89/HR	4.5 HR	$233.00
Generator 50KW	$20.76/HR	4.5 HR	$93.00
16" HDPE Pipe DR 21			**$71,074.00**
Materials			
16" HDPE Pipe DR 21	$19.25/FT	1,933 LF	$37,210.00
# 12 Copper Wire	$0.21/FT	1,933 LF	$406.00
6" Detection Tape	$0.05/FT	1,933 LF	$97.00
Labor			
Forman GP6	$43.68/HR	64.4 HR	$2,814.00
Operator GP6	$36.96/HR	64.4 HR	$2,381.00
Operator GP3	$28.56/HR	64.4 HR	$1,840.00
Pipelayer GP6	$27.72/HR	64.4 HR	$1,786.00
Laborer GP4	$23.52/HR	64.4 HR	$1,515.00
Gas Fuser GP8	$26.88/HR	64.4 HR	$1,732.00
Equipment			
Loader	$78.49/HR	64.4 HR	$5,057.00
Fusion Machine	$389.2/day	8.1/day	$3,134.00
Truck Service	$20.76/HR	64.4 HR	$1,338.00
Hand Tools	$6.49/HR	64.4 HR	$418.00
Trackhoe	$80.43/HR	64.4 HR	$5,182.00
Trackhoe W/Compactor	$80.43/HR	64.4 HR	$5,182.00
Trench Box	$36.3/day	8.1/day	$293.00
Bedding Box	$13.0/day	8.1/day	$104.00
Trackhoe Mini	$51.89/HR	8.1 HR	$418.00
Generator 50KW	$20.76/HR	8.1 HR	$167.00
18" HDPE Pipe DR 21			**$68,727.00**
Materials			
18" HDPE Pipe DR 21	$24.36/FT	1,641 LF	$39,975.00
# 12 Copper Wire	$0.21/FT	1,641 LF	$345.00
6" Detection Tape	$0.05/FT	1,641 LF	$82.00
Labor			
Forman GP6	$43.68/HR	54.7 HR	$2,389.00
Operator GP6	$36.96/HR	54.7 HR	$2,022.00
Operator GP3	$28.56/HR	54.7 HR	$1,562.00

Pipelayer GP6	$27.72/HR	54.7 HR	$1,516.00
Laborer GP4	$23.52/HR	54.7 HR	$1,287.00
Gas Fuser GP8	$26.88/HR	54.7 HR	$1,470.00
Equipment			
Loader	$78.49/HR	54.7 HR	$4,293.00
Fusion Machine	$389.2/day	6.8/day	$2,661.00
Truck Service	$20.76/HR	54.7 HR	$1,136.00
Hand Tools	$6.49/HR	54.7 HR	$355.00
Trackhoe	$80.43/HR	54.7 HR	$4,400.00
Trackhoe W/Compactor	$80.43/HR	54.7 HR	$4,400.00
Trench Box	$36.3/day	6.8/day	$248.00
Bedding Box	$13.0/day	6.8/day	$89.00
Trackhoe Mini	$51.89/HR	6.8 HR	$355.00
Generator 50KW	$20.76/HR	6.8 HR	$142.00
20" HDPE Pipe DR 21			**$138,914.00**
Materials			
20" HDPE Pipe DR 21	$30.07/FT	2,919 LF	$87,774.00
# 12 Copper Wire	$0.21/FT	2,919 LF	$613.00
6" Detection Tape	$0.05/FT	2,919 LF	$146.00
Labor			
Forman GP6	$43.68/HR	97.3 HR	$4,250.00
Operator GP6	$36.96/HR	97.3 HR	$3,596.00
Operator GP3	$28.56/HR	97.3 HR	$2,779.00
Pipelayer GP6	$27.72/HR	97.3 HR	$2,697.00
Laborer GP4	$23.52/HR	97.3 HR	$2,288.00
Gas Fuser GP8	$26.88/HR	97.3 HR	$2,615.00
Equipment			
Loader	$78.49/HR	97.3 HR	$7,637.00
Fusion Machine	$389.2/day	12.2/day	$4,733.00
Truck Service	$20.76/HR	97.3 HR	$2,020.00
Hand Tools	$6.49/HR	97.3 HR	$631.00
Trackhoe	$80.43/HR	97.3 HR	$7,826.00
Trackhoe W/Compactor	$80.43/HR	97.3 HR	$7,826.00
Trench Box	$36.3/day	12.2/day	$442.00
Bedding Box	$13.0/day	12.2/day	$158.00
Trackhoe Mini	$51.89/HR	12.2 HR	$631.00
Generator 50KW	$20.76/HR	12.2 HR	$252.00
22" HDPE Pipe DR 21			**$88,882.00**
Materials			
22" HDPE Pipe DR 21	$36.41/FT	1,549 LF	$56,399.00
# 12 Copper Wire	$0.21/FT	1,549 LF	$325.00
6" Detection Tape	$0.05/FT	1,549 LF	$77.00
Labor			
Forman GP6	$43.68/HR	62.0 HR	$2,706.00
Operator GP6	$36.96/HR	62.0 HR	$2,290.00
Operator GP3	$28.56/HR	62.0 HR	$1,770.00
Pipelayer GP6	$27.72/HR	62.0 HR	$1,718.00
Laborer GP4	$23.52/HR	62.0 HR	$1,457.00
Gas Fuser GP8	$26.88/HR	62.0 HR	$1,665.00
Equipment			
Loader	$78.49/HR	62.0 HR	$4,863.00
Fusion Machine	$389.2/day	7.7/day	$3,014.00
Truck Service	$20.76/HR	62.0 HR	$1,286.00
Hand Tools	$6.49/HR	62.0 HR	$402.00
Trackhoe	$80.43/HR	62.0 HR	$4,983.00
Trackhoe W/Compactor	$80.43/HR	62.0 HR	$4,983.00
Trench Box	$36.3/day	7.7/day	$281.00

Bedding Box	$13.0/day	7.7/day	$100.00
Trackhoe Mini	$51.89/HR	7.7 HR	$402.00
Generator 50KW	$20.76/HR	7.7 HR	$161.00
24" HDPE Pipe DR 21			**$144,258.00**
Materials			
24" HDPE Pipe DR 21	$43.32/FT	2,017 LF	$87,377.00
# 12 Copper Wire	$0.21/FT	737 LF	$155.00
6" Detection Tape	$0.05/FT	737 LF	$37.00
Labor			
Forman GP6	$43.68/HR	109.5 HR	$4,782.00
Operator GP6	$36.96/HR	109.5 HR	$4,046.00
Operator GP3	$28.56/HR	109.5 HR	$3,127.00
Pipelayer GP6	$27.72/HR	109.5 HR	$3,035.00
Laborer GP4	$23.52/HR	109.5 HR	$2,575.00
Gas Fuser GP8	$26.88/HR	109.5 HR	$2,943.00
Equipment			
Loader	$78.49/HR	109.5 HR	$8,593.00
Fusion Machine	$389.2/day	13.7/day	$5,326.00
Truck Service	$20.76/HR	109.5 HR	$2,273.00
Hand Tools	$6.49/HR	109.5 HR	$711.00
Trackhoe	$80.43/HR	109.5 HR	$8,805.00
Trackhoe W/Compactor	$80.43/HR	109.5 HR	$8,805.00
Trench Box	$36.3/day	13.7/day	$497.00
Bedding Box	$13.0/day	13.7/day	$177.00
Trackhoe Mini	$51.89/HR	13.7 HR	$710.00
Generator 50KW	$20.76/HR	13.7 HR	$284.00
26" HDPE Pipe DR 21			**$28,625.00**
Materials			
26" HDPE Pipe DR 21	$50.98/FT	0 LF	$0.00
# 12 Copper Wire	$0.21/FT	0 LF	$0.00
6" Detection Tape	$0.05/FT	0 LF	$0.00
Labor			
Forman GP6	$43.68/HR	55.3 HR	$2,415.00
Operator GP6	$36.96/HR	55.3 HR	$2,043.00
Operator GP3	$28.56/HR	55.3 HR	$1,579.00
Pipelayer GP6	$27.72/HR	55.3 HR	$1,532.00
Laborer GP4	$23.52/HR	55.3 HR	$1,300.00
Gas Fuser GP8	$26.88/HR	55.3 HR	$1,486.00
Equipment			
Loader	$78.49/HR	55.3 HR	$4,339.00
Fusion Machine	$389.2/day	6.9/day	$2,689.00
Truck Service	$20.76/HR	55.3 HR	$1,148.00
Hand Tools	$6.49/HR	55.3 HR	$359.00
Trackhoe	$80.43/HR	55.3 HR	$4,446.00
Trackhoe W/Compactor	$80.43/HR	55.3 HR	$4,446.00
Trench Box	$36.3/day	6.9/day	$251.00
Bedding Box	$13.0/day	6.9/day	$90.00
Trackhoe Mini	$51.89/HR	6.9 HR	$359.00
Generator 50KW	$20.76/HR	6.9 HR	$143.00
28" HDPE Pipe DR 21			**$29,661.00**
Materials			
28" HDPE Pipe DR 21	$59.11/FT	0 LF	$0.00
# 12 Copper Wire	$0.21/FT	0 LF	$0.00
6" Detection Tape	$0.05/FT	0 LF	$0.00
Labor			
Forman GP6	$43.68/HR	57.3 HR	$2,502.00
Operator GP6	$36.96/HR	57.3 HR	$2,117.00

Operator GP3	$28.56/HR	57.3 HR	$1,636.00
Pipelayer GP6	$27.72/HR	57.3 HR	$1,588.00
Laborer GP4	$23.52/HR	57.3 HR	$1,347.00
Gas Fuser GP8	$26.88/HR	57.3 HR	$1,540.00
Equipment			
Loader	$78.49/HR	57.3 HR	$4,496.00
Fusion Machine	$389.2/day	7.2/day	$2,786.00
Truck Service	$20.76/HR	57.3 HR	$1,189.00
Hand Tools	$6.49/HR	57.3 HR	$372.00
Trackhoe	$80.43/HR	57.3 HR	$4,607.00
Trackhoe W/Compactor	$80.43/HR	57.3 HR	$4,607.00
Trench Box	$36.3/day	7.2/day	$260.00
Bedding Box	$13.0/day	7.2/day	$93.00
Trackhoe Mini	$51.89/HR	7.2 HR	$372.00
Generator 50KW	$20.76/HR	7.2 HR	$149.00
30" HDPE Pipe DR 21			**$48,181.00**
Materials			
30" HDPE Pipe DR 21	$67.90/FT	0 LF	$0.00
# 12 Copper Wire	$0.21/FT	0 LF	$0.00
6" Detection Tape	$0.05/FT	0 LF	$0.00
Labor			
Forman GP6	$43.68/HR	93.1 HR	$4,064.00
Operator GP6	$36.96/HR	93.1 HR	$3,439.00
Operator GP3	$28.56/HR	93.1 HR	$2,658.00
Pipelayer GP6	$27.72/HR	93.1 HR	$2,579.00
Laborer GP4	$23.52/HR	93.1 HR	$2,189.00
Gas Fuser GP8	$26.88/HR	93.1 HR	$2,501.00
Equipment			
Loader	$78.49/HR	93.1 HR	$7,303.00
Fusion Machine	$389.2/day	11.6/day	$4,526.00
Truck Service	$20.76/HR	93.1 HR	$1,932.00
Hand Tools	$6.49/HR	93.1 HR	$604.00
Trackhoe	$80.43/HR	93.1 HR	$7,484.00
Trackhoe W/Compactor	$80.43/HR	93.1 HR	$7,484.00
Trench Box	$36.3/day	11.6/day	$422.00
Bedding Box	$13.0/day	11.6/day	$151.00
Trackhoe Mini	$51.89/HR	11.6 HR	$604.00
Generator 50KW	$20.76/HR	11.6 HR	$241.00
32" HDPE Pipe DR 21			**$13,179.00**
Materials			
32" HDPE Pipe DR 21	$77.24/FT	0 LF	$0.00
# 12 Copper Wire	$0.21/FT	0 LF	$0.00
6" Detection Tape	$0.05/FT	0 LF	$0.00
Labor			
Forman GP6	$43.68/HR	25.5 HR	$1,112.00
Operator GP6	$36.96/HR	25.5 HR	$941.00
Operator GP3	$28.56/HR	25.5 HR	$727.00
Pipelayer GP6	$27.72/HR	25.5 HR	$705.00
Laborer GP4	$23.52/HR	25.5 HR	$599.00
Gas Fuser GP8	$26.88/HR	25.5 HR	$684.00
Equipment			
Loader	$78.49/HR	25.5 HR	$1,998.00
Fusion Machine	$389.2/day	3.2/day	$1,238.00
Truck Service	$20.76/HR	25.5 HR	$528.00
Hand Tools	$6.49/HR	25.5 HR	$165.00
Trackhoe	$80.43/HR	25.5 HR	$2,047.00
Trackhoe W/Compactor	$80.43/HR	25.5 HR	$2,047.00

Trench Box	$36.3/day	3.2/day	$116.00
Bedding Box	$13.0/day	3.2/day	$41.00
Trackhoe Mini	$51.89/HR	3.2 HR	$165.00
Generator 50KW	$20.76/HR	3.2 HR	$66.00
34" HDPE Pipe DR 21			**$64,206.00**
Materials			
34" HDPE Pipe DR 21	$87.19/FT	0 LF	$0.00
# 12 Copper Wire	$0.21/FT	0 LF	$0.00
6" Detection Tape	$0.05/FT	0 LF	$0.00
Labor			
Forman GP6	$43.68/HR	124.0 HR	$5,416.00
Operator GP6	$36.96/HR	124.0 HR	$4,583.00
Operator GP3	$28.56/HR	124.0 HR	$3,541.00
Pipelayer GP6	$27.72/HR	124.0 HR	$3,437.00
Laborer GP4	$23.52/HR	124.0 HR	$2,916.00
Gas Fuser GP8	$26.88/HR	124.0 HR	$3,333.00
Equipment			
Loader	$78.49/HR	124.0 HR	$9,733.00
Fusion Machine	$389.2/day	15.5/day	$6,032.00
Truck Service	$20.76/HR	124.0 HR	$2,574.00
Hand Tools	$6.49/HR	124.0 HR	$805.00
Trackhoe	$80.43/HR	124.0 HR	$9,973.00
Trackhoe W/Compactor	$80.43/HR	124.0 HR	$9,973.00
Trench Box	$36.3/day	15.5/day	$563.00
Bedding Box	$13.0/day	15.5/day	$201.00
Trackhoe Mini	$51.89/HR	15.5 HR	$804.00
Generator 50KW	$20.76/HR	15.5 HR	$322.00
PRESSURIZED TURN OUTS CONSTRUCTION			
4 inch	**31**		**$ 343,046.00**
Materials			
4" Gate Valve	$460.00/EA	2 EA	$920.00
4" Flow Meter	$1,600.00/EA	1 EA	$1,600.00
Valve Box	$100.00/EA	2 EA	$200.00
Irrigation Box	$502.00/EA	1 EA	$502.00
4" Fusion Sadle	$500.00/EA	1 EA	$500.00
4" 90 Bend	$40.00/EA	2 EA	$80.00
Labor			
Cement GP3	$30.24/HR	12.0 HR	$363.00
Forman GP6	$43.68/HR	12.0 HR	$524.00
Operator GP6	$36.96/HR	12.0 HR	$444.00
Operator GP3	$28.56/HR	12.0 HR	$343.00
Pipelayer GP6	$27.72/HR	12.0 HR	$333.00
Laborer GP4	$23.52/HR	12.0 HR	$282.00
Gas Fuser GP8	$26.88/HR	12.0 HR	$323.00
Forman GP7	$47.05/HR	12.0 HR	$565.00
Equipment			
Truck-Bobtail Dump	$25.94/HR	12.0 HR	$311.00
Air Compressor	$22.24/HR	12.0 HR	$267.00
Generator 30KW	$19.77/HR	12.0 HR	$237.00
Trackhoe	$80.43/HR	12.0 HR	$965.00
Trackhoe W/Compactor	$80.43/HR	12.0 HR	$965.00
Loader	$78.49/HR	12.0 HR	$942.00
Truck Service	$20.76/HR	12.0 HR	$249.00
Hand Tools	$6.49/HR	12.0 HR	$78.00
Trench Box	$36.3/day	1.5/day	$54.00
Bedding Box	$13.0/day	1.5/day	$19.00
6 inch	**7**		**$ 103,124.00**

Materials			
6" Gate Valve	$525.00/EA	2 EA	$1,050.00
6" Flow Meter	$2,610.00/EA	1 EA	$2,610.00
Valve Box	$100.00/EA	2 EA	$200.00
Irrigation Box	$502.00/EA	1 EA	$502.00
6" Fusion Sadle	$534.00/EA	1 EA	$534.00
6" 90 Bend	$75.00/EA	2 EA	$150.00
Labor			
Cement GP3	$30.24/HR	16.0 HR	$484.00
Forman GP6	$43.68/HR	16.0 HR	$699.00
Operator GP6	$36.96/HR	16.0 HR	$591.00
Operator GP3	$28.56/HR	16.0 HR	$457.00
Pipelayer GP6	$27.72/HR	16.0 HR	$444.00
Laborer GP4	$23.52/HR	16.0 HR	$376.00
Gas Fuser GP8	$26.88/HR	16.0 HR	$430.00
Forman GP7	$47.05/HR	16.0 HR	$753.00
Equipment			
Truck-Bobtail Dump	$25.94/HR	16.0 HR	$415.00
Air Compressor	$22.24/HR	16.0 HR	$356.00
Generator 30KW	$19.77/HR	16.0 HR	$316.00
Trackhoe	$80.43/HR	16.0 HR	$1,287.00
Trackhoe W/Compactor	$80.43/HR	16.0 HR	$1,287.00
Loader	$78.49/HR	16.0 HR	$1,256.00
Truck Service	$20.76/HR	16.0 HR	$332.00
Hand Tools	$6.49/HR	16.0 HR	$104.00
Trench Box	$36.3/day	2.0/day	$73.00
Bedding Box	$13.0/day	2.0/day	$26.00
8 inch	**6**		**$ 94,428.00**
Materials			
8" Gate Valve	$650.00/EA	2 EA	$1,300.00
8" Flow Meter	$3,200.00/EA	1 EA	$3,200.00
Valve Box	$100.00/EA	2 EA	$200.00
Irrigation Box	$502.00/EA	1 EA	$502.00
8" Fusion Sadle	$650.00/EA	1 EA	$650.00
8" 90 Bend	$100.00/EA	2 EA	$200.00
Labor			
Cement GP3	$30.24/HR	16.0 HR	$484.00
Forman GP6	$43.68/HR	16.0 HR	$699.00
Operator GP6	$36.96/HR	16.0 HR	$591.00
Operator GP3	$28.56/HR	16.0 HR	$457.00
Pipelayer GP6	$27.72/HR	16.0 HR	$444.00
Laborer GP4	$23.52/HR	16.0 HR	$376.00
Gas Fuser GP8	$26.88/HR	16.0 HR	$430.00
Forman GP7	$47.05/HR	16.0 HR	$753.00
Equipment			
Truck-Bobtail Dump	$25.94/HR	16.0 HR	$415.00
Air Compressor	$22.24/HR	16.0 HR	$356.00
Generator 30KW	$19.77/HR	16.0 HR	$316.00
Trackhoe	$80.43/HR	16.0 HR	$1,287.00
Trackhoe W/Compactor	$80.43/HR	16.0 HR	$1,287.00
Loader	$78.49/HR	16.0 HR	$1,256.00
Truck Service	$20.76/HR	16.0 HR	$332.00
Hand Tools	$6.49/HR	16.0 HR	$104.00
Trench Box	$36.3/day	2.0/day	$73.00
Bedding Box	$13.0/day	2.0/day	$26.00
10 inch	**1**		**$ 17,088.00**
Materials			

10" Gate Valve	$750.00/EA	2 EA	$1,500.00
10" Flow Meter	$4,000.00/EA	1 EA	$4,000.00
Valve Box	$100.00/EA	2 EA	$200.00
Irrigation Box	$502.00/EA	1 EA	$502.00
10" Fusion Sadle	$800.00/EA	1 EA	$800.00
8" 90 Bend	$200.00/EA	2 EA	$400.00
Labor			
Cement GP3	$30.24/HR	16.0 HR	$484.00
Forman GP6	$43.68/HR	16.0 HR	$699.00
Operator GP6	$36.96/HR	16.0 HR	$591.00
Operator GP3	$28.56/HR	16.0 HR	$457.00
Pipelayer GP6	$27.72/HR	16.0 HR	$444.00
Laborer GP4	$23.52/HR	16.0 HR	$376.00
Gas Fuser GP8	$26.88/HR	16.0 HR	$430.00
Forman GP7	$47.05/HR	16.0 HR	$753.00
Equipment			
Truck-Bobtail Dump	$25.94/HR	16.0 HR	$415.00
Air Compressor	$22.24/HR	16.0 HR	$356.00
Generator 30KW	$19.77/HR	16.0 HR	$316.00
Trackhoe	$80.43/HR	16.0 HR	$1,287.00
Trackhoe W/Compactor	$80.43/HR	16.0 HR	$1,287.00
Loader	$78.49/HR	16.0 HR	$1,256.00
Truck Service	$20.76/HR	16.0 HR	$332.00
Hand Tools	$6.49/HR	16.0 HR	$104.00
Trench Box	$36.3/day	2.0/day	$73.00
Bedding Box	$13.0/day	2.0/day	$26.00
12 inch	**1**		**$ 18,388.00**
Materials			
12" Gate Valve	$950.00/EA	2 EA	$1,900.00
12" Flow Meter	$4,500.00/EA	1 EA	$4,500.00
Valve Box	$100.00/EA	2 EA	$200.00
Irrigation Box	$502.00/EA	1 EA	$502.00
12" Fusion Sadle	$1,000.00/EA	1 EA	$1,000.00
8" 90 Bend	$300.00/EA	2 EA	$600.00
Labor			
Cement GP3	$30.24/HR	16.0 HR	$484.00
Forman GP6	$43.68/HR	16.0 HR	$699.00
Operator GP6	$36.96/HR	16.0 HR	$591.00
Operator GP3	$28.56/HR	16.0 HR	$457.00
Pipelayer GP6	$27.72/HR	16.0 HR	$444.00
Laborer GP4	$23.52/HR	16.0 HR	$376.00
Gas Fuser GP8	$26.88/HR	16.0 HR	$430.00
Forman GP7	$47.05/HR	16.0 HR	$753.00
Equipment			
Truck-Bobtail Dump	$25.94/HR	16.0 HR	$415.00
Air Compressor	$22.24/HR	16.0 HR	$356.00
Generator 30KW	$19.77/HR	16.0 HR	$316.00
Trackhoe	$80.43/HR	16.0 HR	$1,287.00
Trackhoe W/Compactor	$80.43/HR	16.0 HR	$1,287.00
Loader	$78.49/HR	16.0 HR	$1,256.00
Truck Service	$20.76/HR	16.0 HR	$332.00
Hand Tools	$6.49/HR	16.0 HR	$104.00
Trench Box	$36.3/day	2.0/day	$73.00
Bedding Box	$13.0/day	2.0/day	$26.00
AIR AND PRESSURE CONTROLS			
2 inch combination air valve	**5**		**$ 36,015.00**
Materials			

2" Combo Air/Vac Assembly	$1,200.00/EA	1 EA	$1,200.00
30" Std. Ring and Cover	$250.00/EA	1 EA	$250.00
30" RCP Class 3	$40.00/FT	4 LF	$160.00
Irrigation Box	$502.00/EA	1 EA	$502.00
2" Fusion Sadle	$250.00/EA	1 EA	$250.00
Labor			
Cement GP3	$30.24/HR	8.0 HR	$242.00
Forman GP6	$43.68/HR	8.0 HR	$349.00
Operator GP6	$36.96/HR	8.0 HR	$296.00
Operator GP3	$28.56/HR	8.0 HR	$228.00
Pipelayer GP6	$27.72/HR	8.0 HR	$222.00
Laborer GP4	$23.52/HR	8.0 HR	$188.00
Gas Fuser GP8	$26.88/HR	8.0 HR	$215.00
Forman GP7	$47.05/HR	8.0 HR	$376.00
Equipment			
Truck-Bobtail Dump	$25.94/HR	8.0 HR	$208.00
Air Compressor	$22.24/HR	8.0 HR	$178.00
Generator 30KW	$19.77/HR	8.0 HR	$158.00
Trackhoe	$80.43/HR	8.0 HR	$643.00
Trackhoe W/Compactor	$80.43/HR	8.0 HR	$643.00
Loader	$78.49/HR	8.0 HR	$628.00
Truck Service	$20.76/HR	8.0 HR	$166.00
Hand Tools	$6.49/HR	8.0 HR	$52.00
Trench Box	$36.3/day	1.0/day	$36.00
Bedding Box	$13.0/day	1.0/day	$13.00
1 inch combination air valve	5		**$ 34,015.00**
Materials			
1" Combo Air/Vac Assembly	$850.00/EA	1 EA	$850.00
30" Std. Ring and Cover	$250.00/EA	1 EA	$250.00
30" RCP Class 3	$40.00/FT	4 LF	$160.00
Irrigation Box	$502.00/EA	1 EA	$502.00
1" Fusion Sadle	$200.00/EA	1 EA	$200.00
Labor			
Cement GP3	$30.24/HR	8.0 HR	$242.00
Forman GP6	$43.68/HR	8.0 HR	$349.00
Operator GP6	$36.96/HR	8.0 HR	$296.00
Operator GP3	$28.56/HR	8.0 HR	$228.00
Pipelayer GP6	$27.72/HR	8.0 HR	$222.00
Laborer GP4	$23.52/HR	8.0 HR	$188.00
Gas Fuser GP8	$26.88/HR	8.0 HR	$215.00
Forman GP7	$47.05/HR	8.0 HR	$376.00
Equipment			
Truck-Bobtail Dump	$25.94/HR	8.0 HR	$208.00
Air Compressor	$22.24/HR	8.0 HR	$178.00
Generator 30KW	$19.77/HR	8.0 HR	$158.00
Trackhoe	$80.43/HR	8.0 HR	$643.00
Trackhoe W/Compactor	$80.43/HR	8.0 HR	$643.00
Loader	$78.49/HR	8.0 HR	$628.00
Truck Service	$20.76/HR	8.0 HR	$166.00
Hand Tools	$6.49/HR	8.0 HR	$52.00
Trench Box	$36.3/day	1.0/day	$36.00
Bedding Box	$13.0/day	1.0/day	$13.00
6 inch Pressure Release Valve			**$ 9,287.00**
Materials			
6" Pressure Relief Valve	$3,000.00/EA	1 EA	$3,000.00
30" Std. Ring and Cover	$250.00/EA	1 EA	$250.00
30" RCP Class 3	$40.00/FT	4 LF	$160.00

Irrigation Box	$502.00/EA	1 EA	$502.00
6" Fusion Sadle	$534.00/EA	1 EA	$534.00
Labor			
Cement GP3	$30.24/HR	8.0 HR	$242.00
Forman GP6	$43.68/HR	8.0 HR	$349.00
Operator GP6	$36.96/HR	8.0 HR	$296.00
Operator GP3	$28.56/HR	8.0 HR	$228.00
Pipelayer GP6	$27.72/HR	8.0 HR	$222.00
Laborer GP4	$23.52/HR	8.0 HR	$188.00
Gas Fuser GP8	$26.88/HR	8.0 HR	$215.00
Forman GP7	$47.05/HR	8.0 HR	$376.00
Equipment			
Truck-Bobtail Dump	$25.94/HR	8.0 HR	$208.00
Air Compressor	$22.24/HR	8.0 HR	$178.00
Generator 30KW	$19.77/HR	8.0 HR	$158.00
Trackhoe	$80.43/HR	8.0 HR	$643.00
Trackhoe W/Compactor	$80.43/HR	8.0 HR	$643.00
Loader	$78.49/HR	8.0 HR	$628.00
Truck Service	$20.76/HR	8.0 HR	$166.00
Hand Tools	$6.49/HR	8.0 HR	$52.00
Trench Box	$36.3/day	1.0/day	$36.00
Bedding Box	$13.0/day	1.0/day	$13.00
ROAD CROSSING			
1900 North			**$ 4,904.00**
Materials			
8" Road Base	$6.00/Ton	3.8 Ton	$23.00
Road Base 1"	$12.00/Ton	30.0 Ton	$360.00
Asphalt	$3.00/SF	210 SF	$629.00
Labor			
Forman GP5	43.7 HR	8.0 HR	$349.00
Operator GP6	37.0 HR	8.0 HR	$296.00
Operator GP3	28.6 HR	8.0 HR	$228.00
Laborer GP3	23.5 HR	8.0 HR	$188.00
Equipment			
Trackhoe	$80.43/HR	8.0 HR	$643.00
Roller-Walk Behind	$12.35/HR	8.0 HR	$99.00
Truck Service	$20.76/HR	8.0 HR	$166.00
Truck-Water	$35.83/HR	8.0 HR	$287.00
Roller	$37.06/HR	8.0 HR	$296.00
Grader	$88.95/HR	8.0 HR	$712.00
Loader	$78.49/HR	8.0 HR	$628.00
2100 North With Sidwalk, Curb and Gutter			**$ 9,436.00**
Materials			
8" Road Base	$6.00/Ton	6.0 Ton	$36.00
Road Base 1"	$12.00/Ton	46.0 Ton	$552.00
Asphalt	$3.00/SF	330 SF	$990.00
Ready- Mix 6 Bag	$45.00/CY	3.0 CY	$135.00
Labor			
Forman GP5	43.7 HR	12.0 HR	$524.00
Operator GP6	37.0 HR	12.0 HR	$444.00
Operator GP3	28.6 HR	12.0 HR	$343.00
Laborer GP3	23.5 HR	12.0 HR	$282.00
Forman GP7	47.1 HR	12.0 HR	$565.00
Laborer GP4	23.5 HR	12.0 HR	$282.00
Cement GP3	30.2 HR	12.0 HR	$363.00
Equipment			
Trackhoe	$80.43/HR	12.0 HR	$965.00

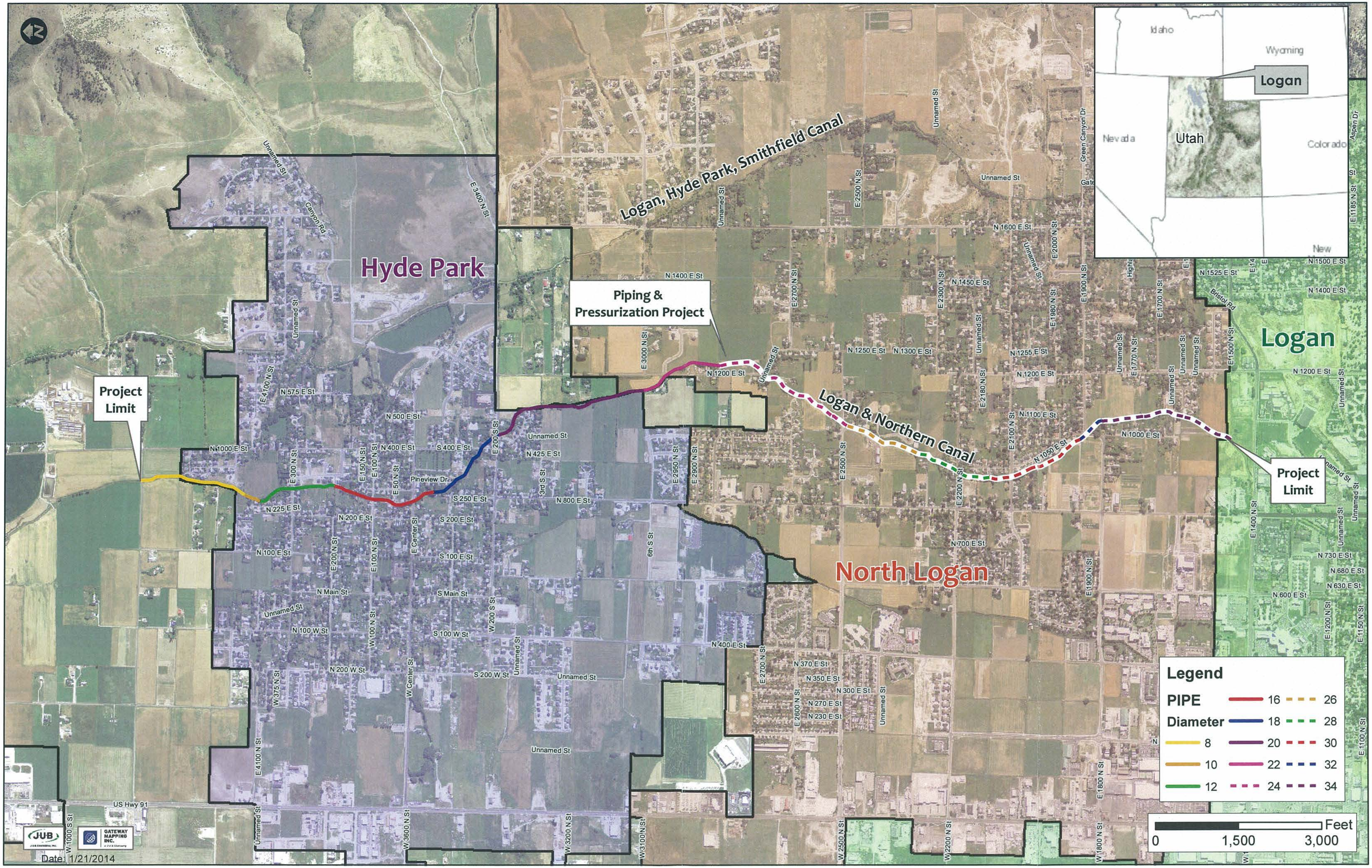
Roller-Walk Behind	$12.35/HR	12.0 HR	$148.00
Truck Service	$20.76/HR	12.0 HR	$249.00
Truck-Water	$35.83/HR	12.0 HR	$430.00
Roller	$37.06/HR	12.0 HR	$445.00
Grader	$88.95/HR	12.0 HR	$1,067.00
Loader	$78.49/HR	12.0 HR	$942.00
Hand Tools	$6.49/HR	12.0 HR	$78.00
Truck Form	$49.66/HR	12.0 HR	$596.00
2200 North With Sidwalk, Curb and Gutter			**$ 5,856.00**
Materials			
8" Road Base	$6.00/Ton	2.2 Ton	$13.00
Road Base 1"	$12.00/Ton	16.5 Ton	$198.00
Asphalt	$3.00/SF	121 SF	$363.00
Ready- Mix 6 Bag	$45.00/CY	3.0 CY	$135.00
Labor			
Forman GP5	43.7 HR	8.0 HR	$349.00
Operator GP6	37.0 HR	8.0 HR	$296.00
Operator GP3	28.6 HR	8.0 HR	$228.00
Laborer GP3	23.5 HR	8.0 HR	$188.00
Forman GP7	47.1 HR	8.0 HR	$376.00
Laborer GP4	23.5 HR	8.0 HR	$188.00
Cement GP3	30.2 HR	8.0 HR	$242.00
Equipment			
Trackhoe	$80.43/HR	8.0 HR	$643.00
Roller-Walk Behind	$12.35/HR	8.0 HR	$99.00
Truck Service	$20.76/HR	8.0 HR	$166.00
Truck-Water	$35.83/HR	8.0 HR	$287.00
Roller	$37.06/HR	8.0 HR	$296.00
Grader	$88.95/HR	8.0 HR	$712.00
Loader	$78.49/HR	8.0 HR	$628.00
Hand Tools	$6.49/HR	8.0 HR	$52.00
Truck Form	$49.66/HR	8.0 HR	$397.00
2500 North With Sidwalk, Curb and Gutter			**$ 9,111.00**
Materials			
8" Road Base	$6.00/Ton	4.8 Ton	$29.00
Road Base 1"	$12.00/Ton	34.5 Ton	$414.00
Asphalt	$3.00/SF	270 SF	$810.00
Ready- Mix 6 Bag	$45.00/CY	3.0 CY	$135.00
Labor			
Forman GP5	43.7 HR	12.0 HR	$524.00
Operator GP6	37.0 HR	12.0 HR	$444.00
Operator GP3	28.6 HR	12.0 HR	$343.00
Laborer GP3	23.5 HR	12.0 HR	$282.00
Forman GP7	47.1 HR	12.0 HR	$565.00
Laborer GP4	23.5 HR	12.0 HR	$282.00
Cement GP3	30.2 HR	12.0 HR	$363.00
Equipment			
Trackhoe	$80.43/HR	12.0 HR	$965.00
Roller-Walk Behind	$12.35/HR	12.0 HR	$148.00
Truck Service	$20.76/HR	12.0 HR	$249.00
Truck-Water	$35.83/HR	12.0 HR	$430.00
Roller	$37.06/HR	12.0 HR	$445.00
Grader	$88.95/HR	12.0 HR	$1,067.00
Loader	$78.49/HR	12.0 HR	$942.00
Hand Tools	$6.49/HR	12.0 HR	$78.00
Truck Form	$49.66/HR	12.0 HR	$596.00
1200 East 2750 North			**$ 4,517.00**

Materials			
8" Road Base	$6.00/Ton	2.4 Ton	$14.00
Road Base 1"	$12.00/Ton	17.2 Ton	$206.00
Asphalt	$3.00/SF	135 SF	$405.00
Labor			
Forman GP5	43.7 HR	8.0 HR	$349.00
Operator GP6	37.0 HR	8.0 HR	$296.00
Operator GP3	28.6 HR	8.0 HR	$228.00
Laborer GP3	23.5 HR	8.0 HR	$188.00
Equipment			
Trackhoe	$80.43/HR	8.0 HR	$643.00
Roller-Walk Behind	$12.35/HR	8.0 HR	$99.00
Truck Service	$20.76/HR	8.0 HR	$166.00
Truck-Water	$35.83/HR	8.0 HR	$287.00
Roller	$37.06/HR	8.0 HR	$296.00
Grader	$88.95/HR	8.0 HR	$712.00
Loader	$78.49/HR	8.0 HR	$628.00
1200 East			**$ 4,744.00**
Materials			
8" Road Base	$6.00/Ton	3.2 Ton	$19.00
Road Base 1"	$12.00/Ton	22.9 Ton	$275.00
Asphalt	$3.00/SF	186 SF	$558.00
Labor			
Forman GP5	43.7 HR	8.0 HR	$349.00
Operator GP6	37.0 HR	8.0 HR	$296.00
Operator GP3	28.6 HR	8.0 HR	$228.00
Laborer GP3	23.5 HR	8.0 HR	$188.00
Equipment			
Trackhoe	$80.43/HR	8.0 HR	$643.00
Roller-Walk Behind	$12.35/HR	8.0 HR	$99.00
Truck Service	$20.76/HR	8.0 HR	$166.00
Truck-Water	$35.83/HR	8.0 HR	$287.00
Roller	$37.06/HR	8.0 HR	$296.00
Grader	$88.95/HR	8.0 HR	$712.00
Loader	$78.49/HR	8.0 HR	$628.00
200 South			**$ 4,484.00**
Materials			
8" Road Base	$6.00/Ton	2.2 Ton	$13.00
Road Base 1"	$12.00/Ton	15.0 Ton	$180.00
Asphalt	$3.00/SF	133 SF	$399.00
Labor			
Forman GP5	43.7 HR	8.0 HR	$349.00
Operator GP6	37.0 HR	8.0 HR	$296.00
Operator GP3	28.6 HR	8.0 HR	$228.00
Laborer GP3	23.5 HR	8.0 HR	$188.00
Equipment			
Trackhoe	$80.43/HR	8.0 HR	$643.00
Roller-Walk Behind	$12.35/HR	8.0 HR	$99.00
Truck Service	$20.76/HR	8.0 HR	$166.00
Truck-Water	$35.83/HR	8.0 HR	$287.00
Roller	$37.06/HR	8.0 HR	$296.00
Grader	$88.95/HR	8.0 HR	$712.00
Loader	$78.49/HR	8.0 HR	$628.00
400 East			**$ 4,399.00**
Materials			
8" Road Base	$6.00/Ton	2.0 Ton	$12.00
Road Base 1"	$12.00/Ton	12.5 Ton	$150.00

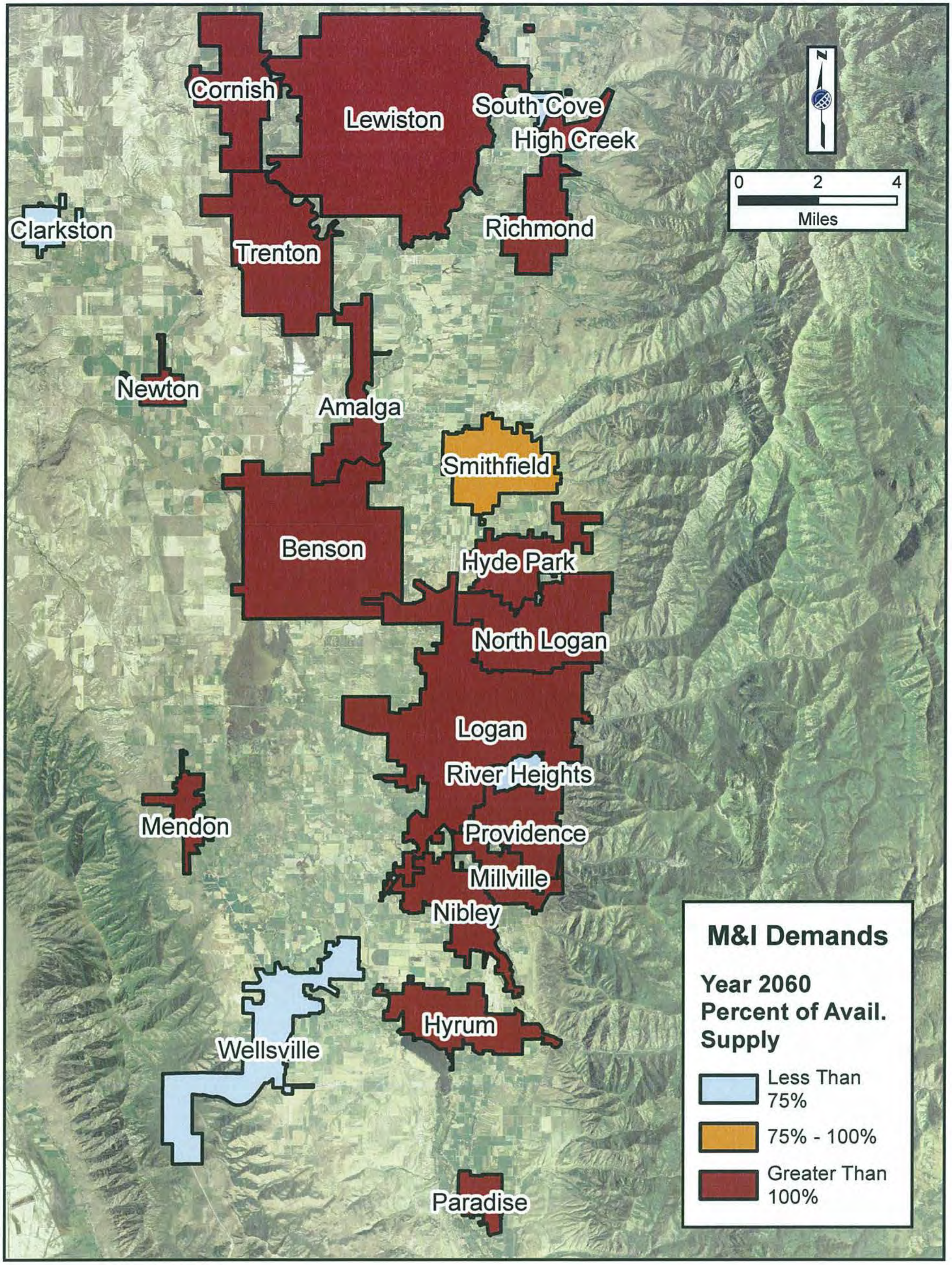
Asphalt	$3.00/SF	115 SF	$345.00
Labor			
Forman GP5	43.7 HR	8.0 HR	$349.00
Operator GP6	37.0 HR	8.0 HR	$296.00
Operator GP3	28.6 HR	8.0 HR	$228.00
Laborer GP3	23.5 HR	8.0 HR	$188.00
Equipment			
Trackhoe	$80.43/HR	8.0 HR	$643.00
Roller-Walk Behind	$12.35/HR	8.0 HR	$99.00
Truck Service	$20.76/HR	8.0 HR	$166.00
Truck-Water	$35.83/HR	8.0 HR	$287.00
Roller	$37.06/HR	8.0 HR	$296.00
Grader	$88.95/HR	8.0 HR	$712.00
Loader	$78.49/HR	8.0 HR	$628.00
Center			**$ 4,281.00**
Materials			
8" Road Base	$6.00/Ton	1.5 Ton	$9.00
Road Base 1"	$12.00/Ton	8.9 Ton	$107.00
Asphalt	$3.00/SF	91 SF	$273.00
Labor			
Forman GP5	43.7 HR	8.0 HR	$349.00
Operator GP6	37.0 HR	8.0 HR	$296.00
Operator GP3	28.6 HR	8.0 HR	$228.00
Laborer GP3	23.5 HR	8.0 HR	$188.00
Equipment			
Trackhoe	$80.43/HR	8.0 HR	$643.00
Roller-Walk Behind	$12.35/HR	8.0 HR	$99.00
Truck Service	$20.76/HR	8.0 HR	$166.00
Truck-Water	$35.83/HR	8.0 HR	$287.00
Roller	$37.06/HR	8.0 HR	$296.00
Grader	$88.95/HR	8.0 HR	$712.00
Loader	$78.49/HR	8.0 HR	$628.00
300 North			**$ 4,353.00**
Materials			
8" Road Base	$6.00/Ton	1.7 Ton	$10.00
Road Base 1"	$12.00/Ton	10.1 Ton	$121.00
Asphalt	$3.00/SF	110 SF	$330.00
Labor			
Forman GP5	43.7 HR	8.0 HR	$349.00
Operator GP6	37.0 HR	8.0 HR	$296.00
Operator GP3	28.6 HR	8.0 HR	$228.00
Laborer GP3	23.5 HR	8.0 HR	$188.00
Equipment			
Trackhoe	$80.43/HR	8.0 HR	$643.00
Roller-Walk Behind	$12.35/HR	8.0 HR	$99.00
Truck Service	$20.76/HR	8.0 HR	$166.00
Truck-Water	$35.83/HR	8.0 HR	$287.00
Roller	$37.06/HR	8.0 HR	$296.00
Grader	$88.95/HR	8.0 HR	$712.00
Loader	$78.49/HR	8.0 HR	$628.00
4400 North			**$ 4,230.00**
Materials			
8" Road Base	$6.00/Ton	1.3 Ton	$8.00
Road Base 1"	$12.00/Ton	7.0 Ton	$84.00
Asphalt	$3.00/SF	82 SF	$246.00
Labor			
Forman GP5	43.7 HR	8.0 HR	$349.00

Operator GP6	37.0 HR	8.0 HR	$296.00
Operator GP3	28.6 HR	8.0 HR	$228.00
Laborer GP3	23.5 HR	8.0 HR	$188.00
Equipment			
Trackhoe	$80.43/HR	8.0 HR	$643.00
Roller-Walk Behind	$12.35/HR	8.0 HR	$99.00
Truck Service	$20.76/HR	8.0 HR	$166.00
Truck-Water	$35.83/HR	8.0 HR	$287.00
Roller	$37.06/HR	8.0 HR	$296.00
Grader	$88.95/HR	8.0 HR	$712.00
Loader	$78.49/HR	8.0 HR	$628.00
Total Project Opinion of Costs			**$ 1,644,256.00**

Attachment A



Hyde Park
North Logan
Logan
Logan, Hyde Park, Smithfield Canal
Logan & Northern Canal
Piping & Pressurization Project
Project Limit
Project Limit
Idaho
Wyoming
Nevada
Utah
Colorado
Logan
Legend
PIPE Diameter
8
10
12
16
18
20
22
24
26
28
30
32
34
Feet
0
1,500
3,000
Date: 1/21/2014


Cornish
Lewiston
South Cove
High Creek
Clarkston
Richmond
Trenton
Newton
Amalga
Smithfield
Benson
Hyde Park
North Logan
Logan
River Heights
Mendon
Providence
Millville
Nibley
Hyrum
Wellsville
Paradise
0 2 4
Miles
M&I Demands
Year 2060
Percent of Avail.
Supply
Less Than 75%
75% - 100%
Greater Than 100%

Attachment B

utah.gov Online Services Agency List Business Search

Utah Division of Water Rights

Select Related Information

```
   (WARNING: Water Rights makes NO claims as to the accuracy of this data.) RUN DATE: 01/21/2014    Page 1
CHANGE: a36298          WATER RIGHT: 25-3056  CERT. NO.:          COUNTY TAX ID#:     AMENDATORY? No
BASE WATER RIGHTS: 25-3056
                   25-6110
                   25-6111
                   25-6112
                   25-6113
RIGHT EVIDENCED BY: 25-3056, 6110, 6111, 6112, 6113
CHANGES: Point of Diversion [X], Place of Use [X], Nature of Use [ ], Reservoir Storage [ ].
*------------------------------------------------------------------------------------------------------------*

NAME: Logan and Northern Irrigation Company
ADDR: C/O Lyle Thornley
      3700 South 450 West
      Nibley, UT 84321
                    REMARKS:
*------------------------------------------------------------------------------------------------------------*
FILED:      03/01/2010|PRIORITY:  03/01/2010|ADV BEGAN: 03/18/2010|ADV ENDED: 03/25/2010|NEWSPAPER:  The Herald Journal
ProtestEnd:04/14/2010|PROTESTED: [Hear Hel]|HEARNG HLD:05/04/2010|SE ACTION: [Approved]|ActionDate:08/17/2011|PROOF DUE:  08/31/2016
EXTENSION:           |ELEC/PROOF:[        ]|ELEC/PROOF:          |CERT/WUC:             |LAP, ETC:            |LAPS LETTER:
RUSH LETTR:          |RENOVATE:            |RECON REQ:           |TYPE: [               ]
Status: Approved
*****************************************************************  ****************************************************************
***********************H E R E T O F O R E***********************  ***********************H E R E A F T E R***********************
*****************************************************************  ****************************************************************

|FLOW:   133.2 cfs                                                 ||FLOW:   133.2 cfs                                                |
|------------------------------------------------------------------||-----------------------------------------------------------------|
|SOURCE: Logan River                                               ||SOURCE: Logan River                                              |
|------------------------------------------------------------------||-----------------------------------------------------------------|
|COUNTY: Cache                                                     ||COUNTY: Cache      COM DESC: Logan Canyon, Summit Creek          |
|------------------------------------------------------------------||-----------------------------------------------------------------|
|                                                                  ||     Due to a landslide in the Logan Island                      |
|                                                                  ||     area that damaged their canal beyond                        |
|                                                                  ||     repair, the Canal Company plans to                          |
|                                                                  ||     divert water under their right from Logan                   |
|                                                                  ||     River through the Logan Hyde Park &                         |
|                                                                  ||     Smithfield Canal.                                           |
|------------------------------------------------------------------||-----------------------------------------------------------------|

|POINT(S) OF DIVERSION ------> MAP VIEWER***GOOGLE VIEW           ||SAME AS HERETOFORE, AND IN ADDITION TO: (Click link for WRPLAT) |
|------------------------------------------------------------------||-----------------------------------------------------------------|
|Point Surface:                                                    ||Point Surface:                                                   |
|(1)  N 1080 ft E  765 ft from W4 cor, Sec 36, T 12N, R  1E, SLBM  ||(1)  S  280 ft W  715 ft from NE cor, Sec 31, T 12N, R  2E, SLBM|
| Dvrting Wks:                                                     || Dvrting Wks: Logan Hyde Park & Smithfield Canal                 |
| Source:                                                          || Source:      Logan River                                       |
|                                                                  ||                                                                 |
|                                                                  ||Stream Alt?: No                                                  |
|------------------------------------------------------------------||-----------------------------------------------------------------|
|Point Rediversion:                                                ||Point Rediversion:                                               |
|                                                                  ||(1)  S 2640 ft E 1200 ft from NW cor, Sec 27, T 13N, R  1E, SLBM|
|                                                                  || Dvrting Wks: Smithfield Irrigation Company                      |
|                                                                  || Source:      Summit Creek                                       |
|------------------------------------------------------------------||-----------------------------------------------------------------|
|Point Return:                                                     ||Point Return:                                                    |
|                                                                  ||(1)  S 1322 ft E  417 ft from NW cor, Sec 26, T 13N, R  1E, SLBM|
|                                                                  ||    COMMENT:                                                     |
|------------------------------------------------------------------||-----------------------------------------------------------------|

|PLACE OF USE ------>                                              ||SAME AS HERETOFORE, AND IN ADDITION TO:                          |
|------------------------------------------------------------------||-----------------------------------------------------------------|
|                               --NW¼--  --NE¼--  --SW¼--  --SE¼-- ||                                 --NW¼--  --NE¼--  --SW¼--  --SE¼-- |
|                              |N N S S||N N S S||N N S S||N N S S|||                                |N N S S||N N S S||N N S S||N N S S||
|                              |W E W E||W E W E||W E W E||W E W E|||                                |W E W E||W E W E||W E W E||W E W E||
|Sec 02 T 12N R  1E SLBM        *X: :X: ** : : : **X:X:X: ** : : : *||Sec 01 T 12N R  1E SLBM       *X:X:X:X** : : : **X:X:X:X** : :X: *|
|Sec 03 T 12N R  1E SLBM        *X:X:X:X**X:X:X:X** : : : **X:X:X:X*||Sec 02 T 12N R  1E SLBM       *X:X:X:X**X:X:X:X**X:X:X:X**X:X:X:X*|
|Sec 04 T 12N R  1E SLBM        * :X: :X**X:X:X:X** :X: : **X:X: : *||Sec 03 T 12N R  1E SLBM       *X:X:X:X**X:X:X:X**X:X: : **X:X: :X*|
|Sec 10 T 12N R  1E SLBM        * : : : ** :X: :X** : : : ** :X: : *||Sec 04 T 12N R  1E SLBM       *X:X:X:X**X:X:X:X**X:X:X:X**X:X: : *|
|Sec 11 T 12N R  1E SLBM        *X: :X:X** : : : **X:X:X:X** : : : *||Sec 05 T 12N R  1E SLBM       *X:X:X:X**X:X:X:X**X:X:X:X**X:X:X:X*|
|Sec 14 T 12N R  1E SLBM        *X:X:X:X** : :X: **X:X:X:X** : : : *||Sec 10 T 12N R  1E SLBM       * : : : ** :X: :X** : : : ** :X: :X*|
|Sec 15 T 12N R  1E SLBM        * : : : ** :X: :X** : : : **X:X:X:X*||Sec 11 T 12N R  1E SLBM       *X:X:X:X**X:X:X:X**X:X:X:X**X:X:X:X*|
|Sec 22 T 12N R  1E SLBM        * : : : **X:X:X:X** : : :X**X:X:X:X*||Sec 12 T 12N R  1E SLBM       *X:X:X:X**X:X:X:X**X:X:X:X**X:X:X:X*|
|Sec 23 T 12N R  1E SLBM        *X: :X:X** : : : **X:X:X:X** : : : *||Sec 13 T 12N R  1E SLBM       *X:X:X:X**X:X:X:X**X:X:X:X**X:X:X:X*|
|Sec 26 T 12N R  1E SLBM        *X:X: : ** : : : ** : : : ** : : : *||Sec 14 T 12N R  1E SLBM       *X:X:X:X**X:X:X:X**X:X:X:X**X:X:X:X*|
|Sec 27 T 12N R  1E SLBM        * :X: :X**X:X:X:X** :X: :X**X:X:X:X*||Sec 15 T 12N R  1E SLBM       * : : : ** :X: :X** : : : ** :X:X:X*|
|Sec 34 T 12N R  1E SLBM        * :X:X:X**X:X:X:X**X:X:X: **X:X:X: *||Sec 22 T 12N R  1E SLBM       * : : : **X:X:X:X** : : : **X:X:X:X*|
|Sec 35 T 12N R  1E SLBM        * :X:X:X**X:X:X: ** : : : ** : : : *||Sec 23 T 12N R  1E SLBM       *X:X:X:X**X:X:X:X**X:X:X:X**X: :X:X*|
|Sec 03 T 13N R  1E SLBM        * : : : ** : : : **X:X:X:X**X:X:X:X*||Sec 24 T 12N R  1E SLBM       *X:X:X:X**X:X:X: **X:X:X:X**X: :X: *|
|Sec 04 T 13N R  1E SLBM        * : : : ** : : :X** : : : ** :X: : *||Sec 25 T 12N R  1E SLBM       *X:X:X:X** : : : **X:X:X:X** : : : *|
|Sec 08 T 13N R  1E SLBM        * : : : ** : : : ** :X:X:X** : : : *||Sec 26 T 12N R  1E SLBM       *X:X:X:X**X:X:X:X**X:X:X:X**X:X:X:X*|
|Sec 09 T 13N R  1E SLBM        * : :X:X** : : :X**X:X:X:X**X:X:X:X*||Sec 27 T 12N R  1E SLBM       * :X: :X**X:X:X:X** :X: :X**X:X:X:X*|
|Sec 10 T 13N R  1E SLBM        *X:X:X:X**X:X:X:X**X:X:X:X**X:X:X:X*||Sec 34 T 12N R  1E SLBM       * :X: :X**X:X:X:X** :X: : **X:X: : *|
|Sec 15 T 13N R  1E SLBM        *X:X:X:X**X: : : **X: :X: ** : : : *||Sec 35 T 12N R  1E SLBM       *X:X:X:X**X:X:X:X** : : : ** : : : *|
|Sec 16 T 13N R  1E SLBM        *X:X:X:X**X:X:X:X**X:X:X:X**X:X:X:X*||Sec 36 T 12N R  1E SLBM       *X:X:X:X**X:X:X:X** : : : ** : : : *|
|Sec 17 T 13N R  1E SLBM        *X:X:X:X**X:X:X: ** : : : ** : : : *||Sec 06 T 12N R  2E SLBM       * : : : ** : : : ** : :X:X** : : : *|
```

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|Sec 20 T 13N R  1E SLBM     * : : :X**X:X:X:X**X:X: : **X:X:X:X*||Sec 07 T 12N R  2E SLBM     *X:X:X:X** : : : **X:X:X: ** : : : *|
|Sec 21 T 13N R  1E SLBM     *X:X:X:X**X:X:X:X**X:X:X:X**X:X:X:X*||Sec 18 T 12N R  2E SLBM     *X: :X: ** : : : ** : : : ** : : : *|
|Sec 27 T 13N R  1E SLBM     *X: :X: ** : : : ** : : :X** : :X: *||Sec 02 T 13N R  1E SLBM     * : : : ** : : : **X:X:X:X** : : : *|
|Sec 28 T 13N R  1E SLBM     * :X: : **X:X: :X** : : : ** :X: : *||Sec 03 T 13N R  1E SLBM     * : :X:X** : :X:X**X:X:X:X**X:X:X:X*|
|Sec 33 T 13N R  1E SLBM     * : : : ** :X: :X** : : : **X:X: :X*||Sec 04 T 13N R  1E SLBM     * : : : ** : : :X** : : : ** :X: : *|
|Sec 34 T 13N R  1E SLBM     *X:X:X:X**X: :X:X**X:X:X:X**X:X:X:X*||Sec 08 T 13N R  1E SLBM     * : : : ** : : : ** :X:X:X** : : : *|
|Sec 35 T 13N R  1E SLBM     * : : : ** : : : ** : :X: ** : : : *||Sec 09 T 13N R  1E SLBM     * : :X:X** : : :X**X:X:X:X**X:X:X:X*|
|                                                                ||Sec 10 T 13N R  1E SLBM     *X:X:X:X**X:X:X:X**X:X:X:X**X:X:X:X*|
|                                                                ||Sec 11 T 13N R  1E SLBM     *X:X:X: ** : : : **X: : : ** : : : *|
|                                                                ||Sec 15 T 13N R  1E SLBM     *X:X:X:X**X:X:X: **X:X:X:X**X: :X:X*|
|                                                                ||Sec 16 T 13N R  1E SLBM     *X:X:X:X**X:X:X:X**X:X:X:X**X:X:X:X*|
|                                                                ||Sec 17 T 13N R  1E SLBM     * : : : **X:X: : ** : : : ** : : : *|
|                                                                ||Sec 20 T 13N R  1E SLBM     * : : : **X: :X:X**X:X: : **X:X:X:X*|
|                                                                ||Sec 21 T 13N R  1E SLBM     *X:X:X:X**X:X:X:X**X:X:X:X**X:X:X:X*|
|                                                                ||Sec 22 T 13N R  1E SLBM     *X:X:X:X**X:X:X:X**X:X:X:X**X:X:X:X*|
|                                                                ||Sec 23 T 13N R  1E SLBM     * : :X:X** : :X:X**X:X:X:X**X:X:X: *|
|                                                                ||Sec 25 T 13N R  1E SLBM     * : : : ** : : : **X: :X: ** : : : *|
|                                                                ||Sec 26 T 13N R  1E SLBM     *X:X:X:X**X: :X:X**X:X:X:X**X:X:X:X*|
|                                                                ||Sec 27 T 13N R  1E SLBM     *X:X:X:X**X:X:X:X**X:X:X:X**X:X:X:X*|
|                                                                ||Sec 28 T 13N R  1E SLBM     *X:X:X:X**X:X:X:X**X:X:X:X**X:X:X:X*|
|                                                                ||Sec 29 T 13N R  1E SLBM     * :X: :X**X:X:X:X** :X: :X**X:X:X:X*|
|                                                                ||Sec 32 T 13N R  1E SLBM     *X:X:X:X**X:X:X:X**X:X:X:X**X:X:X:X*|
|                                                                ||Sec 33 T 13N R  1E SLBM     *X:X:X:X**X:X:X:X**X:X:X:X**X:X:X:X*|
|                                                                ||Sec 34 T 13N R  1E SLBM     *X:X:X:X**X:X:X:X**X:X:X:X**X:X:X:X*|
|                                                                ||Sec 35 T 13N R  1E SLBM     *X:X:X:X**X:X:X:X**X:X:X:X**X:X:X:X*|
|                                                                ||Sec 36 T 13N R  1E SLBM     *X: :X:X** : : : **X:X:X:X** : : : *|
 ________________________________________________________________  _______________________________________________________________
 ________________________________________________________________  _______________________________________________________________
|NATURE OF USE ------>                                            ||SAME AS HERETOFORE                                             |
|-----------------------------------------------------------------||---------------------------------------------------------------|
|IRR  = values are in acres.                                      ||                                                               |
|STK  = values are in ELUs meaning Cattle or Equivalent.          ||                                                               |
|DOM  = values are in EDUs meaning Equivalent Domestic Units      ||                                                               |
|       (or Families).                                            ||                                                               |
|-----------------------------------------------------------------||---------------------------------------------------------------|
|SUPPLEMENTAL to Other Water Rights: Yes                          ||SUPPLEMENTAL to Other Water Rights: No                         |
|-----------------------------------------------------------------||---------------------------------------------------------------|
|-----------------------------------------------------------------||---------------------------------------------------------------|
|IRR:   7427.4000 acres.                      USED 04/01 - 10/31  ||                                                               |
 ________________________________________________________________  _______________________________________________________________
*---------------------------------------------------------------------------------------------------------------------------------*
*---------------------------------------------------------------------------------------------------------------------------------*
PROTESTANTS************************************************************************************************************************
*---------------------------------------------------------------------------------------------------------------------------------*

NAME: Logan City Power and Light                                   NAME: Ray Pehrson
ADDR: c/o Jeff White                                               ADDR: 1215 Canyon Road
      950 West 600 North                                                 Logan, UT  84321-4326
      Logan, UT  84321
-----------------------------------------------------------------------------------------------------------------------------------
NAME: Utah State University                                        NAME:  Smithfield Irrigation Company
ADDR: c/o Mac McKee, Water Research Lab                            ADDR: c/o Jeffry R. Gittins
      8200 Old Mail Hill                                                 215 South State Street, Ste. 600
      Logan, UT  84322-8200                                              Salt Lake City, UT  84111
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***********************************************************************************************************************************
******************************************************E N D   O F   D A T A********************************************************
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Schedule "A"

Appropriators	120	130	140	150	160	170	180	190	200	210	220	230	240	250	260	263
Logan, Hyde Park & Smithfield	21.6	23.4	25.2	27.0	28.8	30.6	32.4	34.2	36.0	37.8	39.6	40.2	42.4	44.6	46.8	47.4
Thos. Smart																
Logan & Northern Irr., Co.,	27.6	29.9	32.2	34.5	36.8	39.1	41.4	43.7	46.0	48.3	50.6	52.9	55.2	57.5	59.8	60.5
Providence-Logan Irr., Co.,	3.9	4.2	4.6	4.9	5.2	5.5	5.9	6.2	6.5	6.8	7.2	7.5	7.8	8.1	8.5	8.6
Providence Pioneer Irr., Co.,	1.6	1.7	1.8	2.0	2.1	2.2	2.4	2.5	2.6	2.8	2.9	3.0	3.2	3.3	3.4	3.5
Hyde Park Irr. Co. Logan Northfield Irr., Co.,	16.5	17.9	19.3	20.7	22.1	23.4	24.8	26.2	27.6	29.0	30.3	31.7	33.1	34.5	35.9	36.2
Logan Northwest Field Irr. Co., Benson Irr. Co.,	20.1	21.8	23.5	25.2	26.8	28.5	30.2	31.9	33.5	35.2	36.9	38.6	40.3	41.9	43.6	44.1
Logan Hollow	0.7	0.7	0.8	0.8	0.9	1.0	1.0	1.1	1.1	1.2	1.3	1.3	1.4	1.4	1.5	1.5
Logan Island Irr., Co.,	2.4 3.6	2.6 4.0	2.8 4.3	3.0 4.6	3.2 4.9	3.4 5.2	3.6 5.5	3.8 5.8	4.0 6.1	4.2 6.4	4.4 6.7	4.6 7.0	4.8 7.3	5.0 7.6	5.2 7.9	5.2 8.1
Seventh Ward Irr., Co.,	0.7	0.8	0.8	0.9	0.9	1.0	1.0	1.1	1.2	1.2	1.3	1.3	1.4	1.4	1.5	1.5
Thatcher Irr., Co.,	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.5
Logan City.	4.6	5.0	5.4	5.7	6.1	6.5	6.9	7.3	7.7	8.0	8.4	10.0	10.0	10.0	10.0	10.0
Logan Stone & Monument Co.,	3.7	4.0	4.3	4.6	4.9	5.2	5.5	5.8	6.1	6.4	6.7	7.0	7.3	7.6	8.0	8.0
Thatcher Milling & Elevator Co.,	36.5	39.5	42.5	45.5	48.7	51.7	54.7	57.7	60.8	63.9	66.9	69.9	72.9	76.0	79.0	80.0
Central Milling & Elevator Co.,	11.9	13.0	13.9	14.8	15.9	16.8	17.8	18.8	19.8	20.7	21.8	22.6	22.6	22.6	22.6	22.6
Thatcher M. & E. Co.	20.9	22.7	24.4	26.2	27.9	29.6	31.4	33.2	34.8	36.6	38.3	39.9	33.9	39.9	39.9	39.9
Anderson & Sons Co.,	7.7	8.3	9.0	9.6	10.2	10.9	11.5	12.2	12.8	13.4	14.1	14.7	15.4	16.0	16.6	16.8
Utah Power & Light Co., [Card Right]	9.4	10.2	11.0	11.8	12.6	13.3	14.1	15.0	15.7	16.5	17.2	18.0	18.9	19.6	20.4	20.7
Utah Power & Light Co.,	93.8	101.6	109.4	117.2	125.6	132.9	140.7	148.5	156.3	164.1	171.9	179.8	187.6	195.4	200.	200.

Appropriators	264	265	266	267	270	280	290	300	310	320	330	340	350	360	370	380	390	400
Logan, Hyde Park & Smithfield	47.4	47.4	47.4	47.4	48.3	51.2	54.0	60.0	65.9	72.2	76.0	79.7	83.5	87.3	91.1	95.1	99.1	103.2
Thos. Smart	1.0	2.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Logan & Northern Irr., Co.,	60.5	60.5	60.5	60.5	61.2	63.5	65.8	68.1	70.4	72.3	76.0	79.7	83.5	87.3	91.1	95.1	99.1	103.2
Providence-Logan Irr., Co.,	8.6	8.6	8.6	8.6	8.7	9.0	9.3	9.6	10.0	10.3	10.8	11.4	11.9	12.4	13.0	13.5	14.1	14.7
Providence Pioneer Irr., Co.,	3.5	3.5	3.5	3.5	3.5	3.6	3.8	3.9	4.0	4.2	4.4	4.6	4.8	5.0	5.3	5.5	5.7	6.0
Hyde Park Irr. Co. Logan Northfield Irr., Co.,	36.2	36.2	36.2	36.2	36.5	37.2	37.9	38.5	39.2	39.9	40.6	41.3	42.0	43.7	43.7	44.1	44.7	45.4
Logan Northwest Field Irr. Co., Benson Irr. Co.,	44.1	44.1	44.1	44.1	44.6	46.3	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0
Logan Hollow	1.5	1.5	1.5	1.5	1.5	1.6	1.6	1.7	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.5
Logan Island Irr., Co.,	5.2 8.1	5.2 8.1	5.2 8.1	5.2 8.1	5.3 8.1	5.5 8.4	5.7 8.7	5.9 9.0	6.1 9.3	6.3 9.7	6.6 10.2	6.9 10.7	7.2 11.2	7.6 11.7	7.9 12.2	8.2 12.2	8.6 12.2	9.0 12.2
Seventh Ward Irr., Co.,	1.5	1.5	1.5	1.5	1.5	1.6	1.7	1.7	1.7	1.9	1.9	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Thatcher Irr., Co.,	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.8	0.8
Logan City.	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Logan Stone & Monument Co.,	8.0	8.0	8.0	8.0	8.1	8.5	8.7	9.1	9.4	9.7	10.2	10.7	11.2	11.7	12.2	12.2	12.2	12.2
Thatcher Milling & Elevator Co.,	80.0	80.0	80.0	80.0	80.8	83.9	87.0	87.0	87.0	87.0	87.0	87.0	87.0	87.0	87.0	87.0	87.0	87.0
Central Milling & Elevator Co.,	22.6	22.6	22.6	22.6	22.6	22.6	22.6	22.6	22.6	22.6	22.6	22.6	22.6	22.6	22.6	22.6	22.6	22.6
Thatcher M. & E. Co.	39.9	39.9	39.9	39.9	39.9	39.9	39.9	39.9	39.8	39.8	39.8	39.8	39.8	39.8	39.8	39.8	39.8	39.8
Anderson & Sons Co.,	16.8	16.8	16.8	16.8	17.0	17.7	18.3	18.3	18.3	18.3	18.3	18.3	18.3	18.3	18.3	18.3	18.3	18.3
Utah Power & Light Co., [Card Right]	20.7	20.7	20.7	20.7	20.9	21.8	22.6	22.6	22.6	22.6	22.6	22.6	22.6	22.6	22.6	22.6	22.6	22.6
Utah Power & Light Co.,	200.	200.	200.	200.	200.	200.	200.	200.	200.	200.	200.	200.	200.	200.	200.	200.	200.	200.

Attachment C

Cache County's population is growing and consequently increasing stress on its most valuable resource, water. The County population has grown nearly 30 percent since 2000, and is projected to double by approximately 2050, placing progressively more stress on water resources. Any plan to address this reality should have the following purposes:

1. **Evaluate existing water resources and demands;**
2. **Determine future water demands;**
3. **Educate and build consensus;**
4. **Create a plan for the future; and**
5. **Establish a plan and system to manage water resources in the County.**

The recommendations in this master plan are founded on extensive analysis and evaluation of technical data and feedback from county, municipal, irrigation and environment stakeholders. This collaborative process informed the creation of an objective criterion which was used to assess and evaluate dozens of options and resulted in the proposed solutions.

Problem Statement

Cache County will not be able to protect and use its water resources efficiently without a water master plan and management system that empowers it to maximize the benefit of its existing resources and secure the Bear River water allocation.

Opportunity

Create a plan and management system that protects and conserves Cache County's long-term agricultural, environmental, and municipal water interests with an emphasis on securing its allocation entitlements pursuant to the Bear River Water Development Act.

Recommendations

Recommended Projects and Studies

Dozens of projects were evaluated using the objective criteria. The following projects are recommended based on how well they meet the objectives.

- Implement a water conservation program to conserve 25% by year 2025
- Evaluate environmental water demands and prioritize critical areas
- Bank water rights made available through agricultural to municipal conversion or through Bear River development

- Develop Bear River water through:
  1. Aquifer Storage and Recovery to develop 5,000 to 20,000 acre feet
  2. Above ground storage reservoirs to develop up to 60,000 acre feet
- Start a canal rehabilitation program
- Construct secondary water systems

These projects:

- Develop the Bear River water allocation
- Preserve agriculture
- Extend supply for future municipal growth
- Improve understanding of environmental water needs
- Improve water efficiencies

Management System

Create a Water Conservancy District

A water conservancy district is the most viable management system to realize the stated goals and objectives, and implement the recommended projects. It also incorporates the key purposes of the water master plan. More specifically, a conservancy district:

- Protects the Bear River water allocation through planning and development
- Provides a stronger voice for Cache County on water legislation issues
- Promotes water conservation
- Provides representation for both irrigators and drinking water users
- Functions as a water bank
- Facilitates cooperation between communities and irrigation companies to complete regional projects
- Provides a funding source to plan for and help complete needed regional water projects
- Allows individual communities and irrigation companies to manage their own water systems
- Provides a local governing water board that is 100% focused on water issues.

More details of how the analysis was completed and how the recommendations were determined are given in the master plan report.

C. Current Water Use and Determination of Future Requirements - Water Management Issues and Goals.

This section includes the historical patterns of water delivery and use by the water utility. Future water needs and infrastructure requirements based on growth projections should be identified. Comparison of current water supplies and future projections will reveal if and when additional supplies will be needed. List past water conservation measures as well as opportunities for improving the efficiency of water use. Indicate any opportunities to coordinate with other companies to develop and implement management conservation measures. List short and long term goals for efficient water use. Identify potential use of any water gained from reductions in use due to the implementation of the water conservation plan. The current and possible future water rates should be discussed in detail.

We expect significant future growth in the east bench areas above our canal and our sister canal, the Logan Hyde Park Smithfield Canal (LHPS Canal) as uphill water delivery techniques improve. Our water conservation measures over the past 30 years have been previously noted as w have only a small quantity of water use in open ditches. We have recorded evidence of 30% to 40% water savings because water use is now mostly in buried pipelines. Our eventual plan to merge and rebuild with our sister canal (LHPS) will give us a canal system that will be lined for a major portion of its running distance that will be a very significant tool in the conservation of water.

D. Identification of Alternatives to Meet Future Water Needs

Strategies to meet future demands beyond the limits of existing supplies or infrastructure should be identified. These strategies should include conservation alternatives as well as traditional water development plans. Economics and environmental impacts of the alternatives, including infrastructure requirements, should be determined and evaluated.

When the merge finalizes into our new entity, the Cache Highline Water Association, we will have an efficient water delivery system with metering stations to monitor and control water use throughout the canal system. We will benefit from many economies of scale through this merger. There will be several positive environmental impacts, including having a canal system that no longer would require the constant weekly use of chemicals such as magnacide, a chemical that has been used heavily over the years to kill and control massive moss problems in the old canal.

Attachment D

UTAH

MONTHLY AVERAGE PAN EVAPORATION (INCHES)

	PERIOD OF RECORD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
ARCHES NATL PARK HQ	1980-2005	0.00	0.00	0.00	7.44	9.81	12.33	12.94	11.15	8.16	4.73	0.00	0.00	66.56
BEAR RIVER BAY	1969-1996	0.00	0.00	0.00	6.27	10.17	12.59	13.86	12.29	7.83	4.89	0.00	0.00	67.90
BEAR RIVER REFUGE	1948-1984	0.00	0.00	0.00	4.80	7.21	8.66	10.46	9.30	6.13	3.27	1.27	0.00	51.10
BRYCE CANYON NAT'L PRK	1971-1978	0.00	0.00	0.00	0.00	6.86	7.86	8.07	7.21	5.30	0.00	0.00	0.00	35.30
FARMINGTON USU FLD STN	1948-2005	0.00	0.00	0.00	0.00	7.33	6.35	9.25	8.62	4.63	2.97	0.00	0.00	39.15
FERRON	1948-2005	0.00	0.00	0.00	5.20	5.66	8.06	6.58	6.39	5.49	3.53	0.00	0.00	40.91
FISH SPRINGS REFUGE	1960-2005	0.00	0.00	0.00	7.02	10.70	12.90	15.92	13.58	9.92	5.84	0.00	0.00	75.88
FLAMING GORGE	1957-2005	0.00	0.00	0.00	0.00	6.23	8.74	9.71	8.62	5.76	3.94	0.00	0.00	43.00
FORT DUCHESNE	1894-2005	0.00	0.00	0.00	5.16	7.41	8.61	9.06	7.98	5.57	3.25	0.00	0.00	47.04
GREEN RIVER AVIATION	1893-2005	0.00	0.00	0.00	6.07	8.07	9.29	9.49	7.97	5.74	3.52	1.60	0.00	51.75
GUNNISON	1956-1990	0.00	0.00	0.00	5.10	7.23	8.70	9.65	8.26	6.03	3.81	0.00	0.00	48.78
HITE	1949-1962	0.00	0.00	0.00	7.84	11.74	14.14	14.01	12.44	8.34	4.86	1.94	0.00	75.31
LOGAN USU EXP STN	1950-1978	0.00	0.00	0.00	4.01	5.98	7.05	8.37	7.50	5.02	2.92	0.00	0.00	40.85
LOGAN 5 SW EXP FARM	1969-2005	0.00	0.00	3.30	4.57	6.57	8.48	10.05	8.93	5.88	3.51	0.00	0.00	51.29
MANILA	1952-2005	0.00	0.00	0.00	0.00	7.31	8.66	9.83	8.37	6.50	4.63	0.00	0.00	45.30
MEXICAN HAT	1948-2005	0.00	0.00	6.31	8.45	11.99	14.42	14.87	12.48	9.37	5.52	2.25	0.00	85.66
MILFORD	1906-2005	0.00	0.00	0.00	7.47	10.22	13.54	15.47	13.24	9.88	6.16	2.32	0.00	78.30
MOAB	1889-2005	0.00	0.00	4.19	7.29	10.41	12.03	12.72	10.75	7.66	4.25	2.26	0.00	71.56
MORGAN	1948-2005	0.00	0.00	0.00	4.94	6.96	7.30	9.07	8.01	6.15	3.74	0.00	0.00	46.17
PIUTE DAM	1948-1971	0.00	0.00	0.00	0.00	7.91	9.98	10.13	8.40	6.98	4.60	0.00	0.00	48.00
PROVO AIRPORT	1948-1953	0.00	0.00	2.91	6.03	6.83	8.62	8.88	8.36	6.09	3.41	0.00	0.00	51.13
PROVO BYU	1980-2005	0.00	0.00	2.59	4.71	6.81	8.77	9.85	8.70	5.59	2.92	0.00	0.00	49.94
PROVO RADIO KAYK	1952-1977	0.00	0.00	0.00	4.38	5.94	7.53	8.32	7.58	5.40	3.21	1.53	0.00	43.89
ST GEORGE	1862-2005	0.00	0.00	4.57	7.36	10.08	12.22	13.17	11.55	8.22	4.83	2.68	0.00	74.68
SALTAIR SALT PLANT	1956-1991	0.00	0.00	3.66	6.20	9.19	11.88	14.40	12.67	8.58	4.86	2.32	0.00	73.76
SCOFIELD DAM	1948-1991	0.00	0.00	0.00	0.00	5.52	7.84	8.29	6.94	5.13	3.90	0.00	0.00	37.62
SEVIER DRY LAKE	1987-1993	0.00	0.00	2.93	6.33	13.52	16.06	18.32	0.00	0.00	0.00	0.00	0.00	57.16
STRAWBERRY RESERVOIR EA	1956-1977	0.00	0.00	0.00	0.00	5.82	7.28	7.87	7.31	5.08	3.02	0.00	0.00	36.38
UTAH LAKE LEHI	1928-2003	0.00	0.00	2.77	5.19	7.11	8.80	9.61	8.58	6.10	3.81	1.42	0.00	53.39
VERNAL ARPT	1928-2005	0.00	0.00	0.00	5.07	6.41	7.48	6.64	6.34	4.89	2.92	0.00	0.00	39.75
WANSHIP DAM	1955-2005	0.00	0.00	0.00	0.00	6.09	6.79	7.41	6.59	4.79	3.19	0.00	0.00	34.86

11960 MARCH 1976 IR1

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Estimating Seepage Losses from Canal Systems

By Robert V. Worstell[1]

Introduction

Seepage and operational losses from distribution systems are continuing problems for designers and managers of irrigation districts and for water users. The designer must provide sufficient capacity in the canals to allow for these losses, and the managers must divert extra water into parts of the system to assure ample flow to the lower reaches of all laterals. The water users must provide for ample storage to offset seepage losses. The managers also have to deal with more complex legal and technical problems that arise if seepage losses cause high water tables in fields adjacent to the canal.

As demands increase on all the water supplies of the West, regional and state resource management agencies are looking critically at the large volumes of water diverted by agriculture, especially when these volumes are much larger than the amounts used in evapotranspiration. These agencies need guidelines for more accurately determining reasonable water diversions to irrigated agriculture. Some information is available. Hart (6) estimated seepage losses from canals in several of the soils found in southern Idaho (Table 1), but such information for other areas is not available in the literature. This paper presents a simplified method that engineers and resource planners can use to estimate seepage losses from new or existing canal systems.

Methods of Seepage Measurement

Four principal methods have been used to estimate or measure seepage and operational losses from distribution systems. Normally, estimates are made with an "inflow-outflow" approach by using the records of diversion and delivery for the district. This approach gives an estimate of the total seasonal operational losses, which include canal seepage, canal spill, generous deliveries, and gains

Note.—Discussion open until August 1, 1976. To extend the closing date one month, a written request must be filed with the Editor of Technical Publications, ASCE. This paper is part of the copyrighted Journal of the Irrigation and Drainage Division, Proceedings of the American Society of Civil Engineers, Vol. 102, No. IR1, March 1976. Manuscript was submitted for review for possible publication on May 7, 1975.

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or losses from inaccurate measurements. Inflow-outflow estimates usually express the loss as a percentage of the total flow into the entire system or large parts

TABLE 1.—Loss Rates from Canals in Southern Idaho* (6)

Type of soil (1)	Loss rate, in feet per day (meters per day) (2)
Medium clay loam	0.5-1.5 (0.15-0.46)
Impervious clay	0.5 (0.15)
Medium soils	1.0 (0.3)
Somewhat pervious soils	1.5-2.0 (0.46-0.61)
Gravel (depending on porosity)	2.5-5.0 (0.76-1.52)

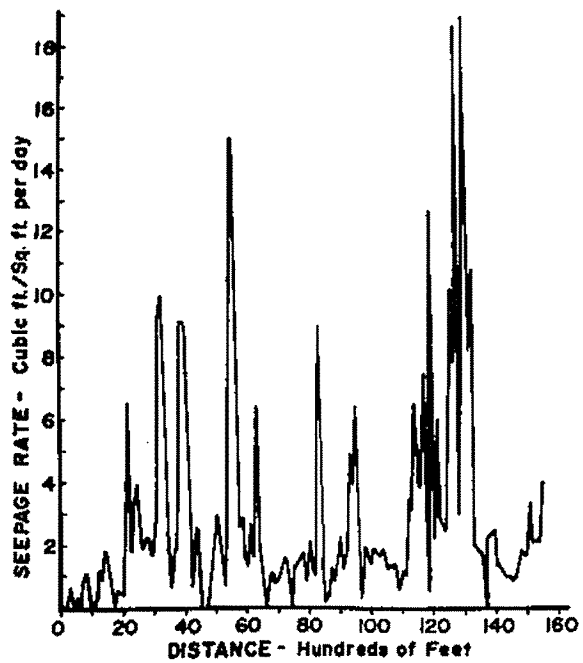

FIG. 1.—Variations of Seepage Rates Measured at 100-ft (30-m) Intervals along Center Line of Canal in Sandy Loam Soil near Rupert, Idaho, July 1970 [Average Rate = 2.58 ft/day (0.79 m/day)]

of it. Expressed in this manner, it is difficult to relate the loss in one system to those in other systems. Published losses based on a percentage of total flow seldom include data on the size of canals, soil types, or length of irrigation

season. With demands on water supplies increasing, it is important that losses of various districts be compared and the magnitude of each aspect of operational losses in parts of the systems be identified to aid in deciding priorities for making improvements.

The second method is a refinement of the first in that it is based on actual inflow-outflow measurements made over 1 hr or 2 hr on specified reaches of a canal or lateral. This method eliminates some of the undefined variables of the first method, but the inaccuracy of water measurement techniques continues to be a major problem, especially on the older irrigation systems. As a result, the losses obtained by this method are often based on total flow measurements by current metering natural streams and canal sections, and the deliveries are measured by current metering or by flow over weirs or structures with questionable accuracies. A small change in the canal water level during measurement of discharges can cause errors large enough to mask part or all of the losses. This is particularly true if the losses are less than 10% of the total flow in the canal. However, this type of measurement has merit on canals with high losses and where long reaches are being tested so that the seepage loss is a significant percentage of the total flow.

A third method of seepage measurement is to pond water in the canal to the approximate operating depth and then record or periodically measure the drop in the water surface with time. This is the most accurate method, but large canals must be taken out of operation for about 2 weeks to make the measurements. Measurements must be made on main canals either before or after the irrigation season, and the seepage rate then probably differs from the seasonal average. Inasmuch as reservoirs and lakes usually have much lower seepage losses than canals, the canal seepage rate measured by ponding may be less than it would be when influenced by canal currents near the bottom. If the ponded section is long, the average seepage rate measured by ponding will not identify any localized high loss zones within the ponded section.

A fourth method of measuring canal seepage losses consists of making spot measurements with a small meter that measures seepage through a small area. There are several variations in seepage meter design. Two models have been described by Robinson and Rohwer (11). Because seepage rates vary widely from point to point, many measurements must be made throughout the length of a canal to achieve an acceptable average value. Brockway and Worstell (3) presented a method to statistically estimate the number of seepage meter measurements required in a given reach of canal to approach the true value. The seepage meter can be used in many operating canals, which extends the time during which the seepage losses can be measured. This method also will identify localized high-loss reaches. However, it cannot be used in canals with rocky or rubbly perimeters, nor in canals with flow velocities higher than about 2 ft (0.6 m)/sec.

Several variables affect the seepage according to location along the canal and the time of day or the time of the year that the measurement is made (3,11,20,22). Some of these are: (1) Water temperature changes; (2) siltation conditions; (3) bank storage changes; (4) soil chemicals; (5) water velocity; (6) microbiological activity; (7) irrigation of adjacent fields; and (8) water table fluctuations. For example, Robinson and Rohwer (11) found that seepage from experimental seepage rings fluctuated daily as much as 40% in sandy soils.

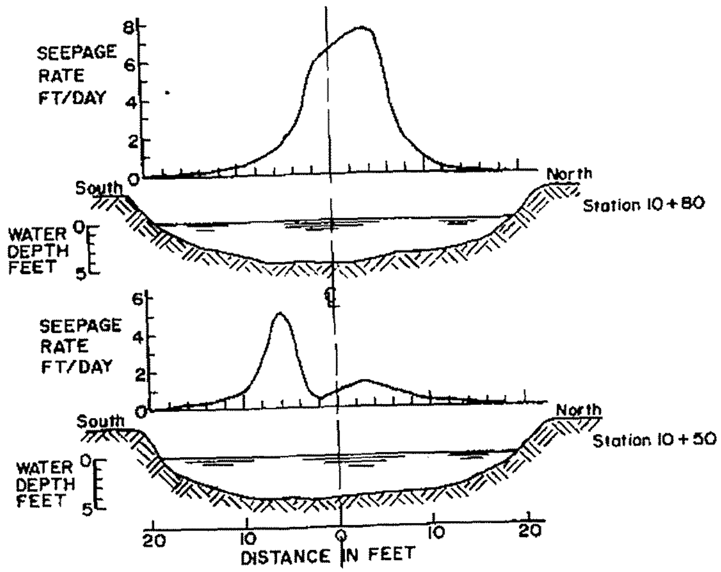

FIG. 2.—Variations in Seepage Rates Found Across Width of Large Canal

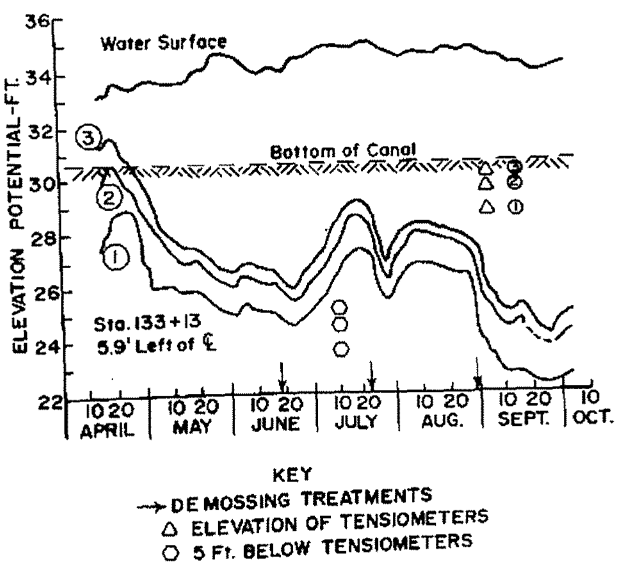

FIG. 3.—Changes in Hydraulic Potentials Found with Tensiometers Installed under Canal in Silt Loam Soil

Most of this was attributed to rather small water temperature changes that affected the gas pressures in the soil which, in turn, affected the soil hydraulic conductivity.

Fig. 1 shows the variations in seepage rates measured in July 1970 with a seepage meter at 100-ft (30-m) intervals along the center line of a canal in a sandy loam soil near Rupert, Idaho. Fig. 2 is an example of the variations in seepage rates that were measured across a large canal. Fig. 3 shows the seasonal variations in hydraulic head that were measured immediately beneath an operating canal during an irrigation season in southern Idaho. Water in the canal was about 5 ft (1.5 m) deep and measurements were made a few inches below the bottom of the canal. At a depth of 3 in. (76 mm) below the bottom, soil moisture tensions gradually increased to a maximum of about 5 ft (1.5 m) of tension at the end of the season. This indicated that seepage from this canal in a Portneuf silt loam soil decreased throughout most of the season, because a thin sealing layer formed at the soil-water interface. The fluctuations in hydraulic head may have been caused by xylene treatments to remove moss from the canal. This treatment could have reduced the effectiveness of the bottom seal.

Since many variables affect seepage rates, it is unusual to measure a consistent seepage value for a given reach of a canal. The objective of this study was to determine an approximate range of seepage losses as related to soil texture and canal size.

Procedure

A literature survey yielded 765 seepage measurements made by ponding, or by seepage meter, where seepage was recorded in (or could be converted to) cubic feet per square foot per day, or feet per day as a "unit seepage rate" (1,2,4,5,8,9,10,12,13,14,15,16,17,18,19,20,21). These data were from tests in 15 states in the western United States over more than 40 yr, with much of the work done of the last 20 yr. Some recent unpublished data from Idaho and Washington also were included. Minimal soil texture and profile information was reported in 85% of the seepage measurements. Data on lined canals were included when tests had been made to determine the effectiveness and durability of different types of linings. When the same reach of a lined canal was retested for several years, the seepage rate measured after 3 yr–4 yr of service was considered to be the representative rate for that lining. This was done to allow for the initial rapid aging or deterioration that often occurred in the first 2 yr–3 yr.

The tabulated information included the following data, if available: (1) Location of test by state, district, canal, and location along the canal; (2) year test was made; (3) length of reach tested; (4) width and depth of canal; (5) topsoil texture; (6) subsurface soil and other subsurface conditions; (7) unit seepage rate; (8) type of lining, if any; and (9) type of test (ponding, seepage meter).

The soils were grouped into four broad textural classifications based on the limited topsoil descriptions given. These classifications were: clayey soils, silty soils, loamy soils, and sandy soils. When the soil texture was not reported, that test was placed in an "unspecified" category. A test by the seepage meter technique was tabulated when there were at least several individual locations

TABLE 2.—Seepage Rates of General Soil Groups

General soil group (1)	Ponding Tests: Number of tests (2)	Ponding Tests: Average rate, in feet per day (meters per day) (3)	Seepage Meter Tests: Number of tests (4)	Seepage Meter Tests: Average rate, in feet per day (meters per day) (5)
Clayey	20	0.23 (0.07)	3	0.65 (0.20)
Silty	120	0.80 (0.24)	16	0.55 (0.17)
Loamy	196	0.94 (0.29)	11	0.85 (0.26)
Sandy	77	1.56 (0.48)	28	1.91 (0.58)
Unspecified	55	1.01 (0.31)	30	1.13 (0.35)

TABLE 3.—Seepage from Lined Canals (Ponded Seepage)

Lining type (1)	Number of tests (2)	Average seepage rate, in feet per day (meters per day) (3)	Range, in feet per day (meters per day) (4)
Concrete	11	0.24 (0.07)	0.03–0.96 (0.009–0.29)
Compacted earth	45	0.17 (0.05)	0.01–0.95 (0.003–0.29)
Asphalt membrane	32	0.46 (0.14)	0.01–3.0 (0.003–0.92)
Soil cement	5	0.08 (0.02)	0.03–0.20 (0.009–0.06)
Chemical sealant	12	1.79 (0.55)	0.32–8.3 (0.1–2.53)
Sediment seal	10	0.78 (0.24)	0.39–1.3 (0.12–0.4)
Unlined—all soil types	468	0.99 (0.30)	0.01–17.6 (0.003–5.37)

tested within a reach of canal. There were only 20 ponding tests and three seepage meter tests of canals in clayey soils, probably because little loss was expected in such soils. Some of the data were reported in more than one publication; a special effort was made to avoid duplication. Sorting routines available on the Mark IV file Management System Program were applied to the data and standard statistical techniques were used for the analysis.

Results

Table 2 shows the average seepage rates for broad soil groups in unlined canals. Many more tests were made by ponding than by seepage meter. Table

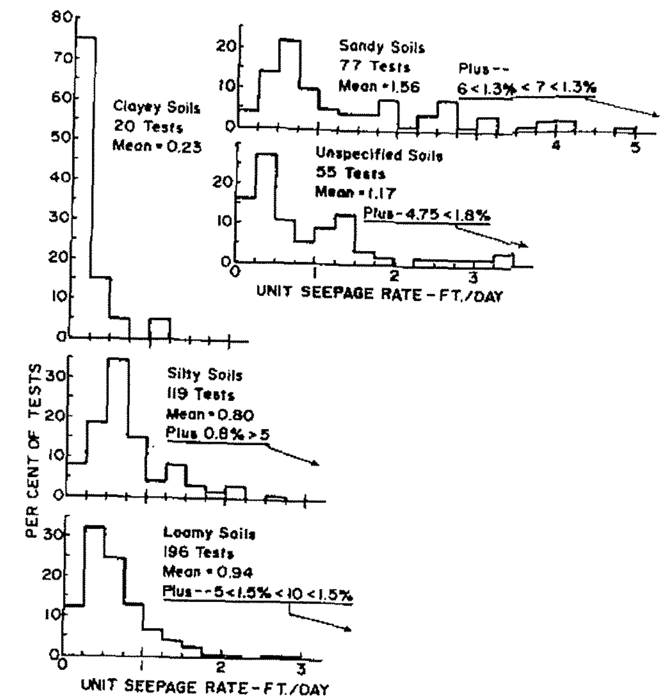

FIG. 4.—Histograms of Ponded Seepage Tests

3 summarizes the ponded seepage rates measured in lined and unlined canals. The histograms of Fig. 4 show that the ponded seepage rates for each soil group are skewed to the left. Moreover, even these values may be greater than the true average for all canals in the western United States because seepage measurements tend to be made on canals where high loss rates are suspected. The average unit seepage rate was found to be unrelated to pond (or canal) dimensions.

Analysis of Results

Measurements with seepage meters compare favorably with measurements made by ponding (Table 2). Where many seepage meter tests are made along a reach of canal, their average value tend to be quite close to the value obtained by ponding (3).

The tests summarized in Table 3 indicate that most of the lined canals tested lost water at rates between about 0.1 ft/day and 1.0 ft/day (0.03 m/day and 0.3 m/day) after they have weathered and aged for a few years. The chemical sealant linings deteriorated more rapidly to even higher rates. However, average rates for the first four linings listed in Table 3 are one-fourth of the average rates of all the unlined canals. These data indicate that linings for seepage control would be most effective when installed in the high loss reaches of a canal, such as from station 2,000 ft-6,500 ft (610 m to 1,980 m), and from station 11,000 ft-13,500 ft (3,350 m-4,120 m) in the canal represented by Fig. 1.

Fig. 4 shows that seepage measurements do not follow a statistical "normal" distribution. In most ponding tests, seepage rates were in the lower ranges of less than 1 ft/day (0.3 m/day). Of the clayey soils tested, 90% seeped at rates below 0.5 ft/day (0.15 m/day); 76% of the silty soils, 82% of the loamy soils, 50% of the sands, and 59% of the unspecified soils seeped at rates of less than 1.0 ft/day (0.3 m/day). A few high values, especially in the loamy soils, caused the averages to be near 1.0 ft/day (0.3 m/day).

A seepage rate of 1.0 ft/day (0.3 m/day) corresponds to the basic irrigation intake rate of 0.5 in./hr (13 mm/hr) which is in the intake range for fine sandy loam soils in good condition or sandy soils that are puddled or crusted.

Col. 4 of Table 3 shows that the measured unit seepage rates for the unlined canals (all soil types) are highly variable. This is influenced by the natural variability of seepage previously mentioned, as well as the inadequately described soil textures and soil profiles. This natural variability indicates that, where high losses are suspected, seepage tests should be made on each specific reach of canal involved rather than using average rates. The values given in Cols. 3 and 5 of Tables 2 and 3 also indicate that average seepage rates range from 0.1 ft-1.9 ft (0.03 m-0.57 m) per day for any soil texture, lining type, and measurement method. The average unit seepage rates tend to be greater as soil texture grades from fine to coarse. Average rates for the western United States are similar to those cited by Hart (6) for southern Idaho as given in Table 1.

Because average seepage loss rates fall within a limited range, the average seepage losses from a canal system can be estimated reasonably accurately. To estimate the seepage loss from a system, the planner or resource manager will need a soils map, a map of the canal system, and a table of the approximate widths and lengths of the system's canals and laterals. For a given reach, the predominant soil texture can be determined and the associated average seepage rate determined from Col. 3 of Table 2. By using a set of curves as shown in Fig. 5, the flow loss in cubic feet per second per mile can be determined for different canal and lateral widths.

Better estimates of canal seepage rates provide input for economic analysis in evaluating the merits of canal lining. The following example is used to illustrate such an evaluation. A canal near Rupert, Idaho has the following characteristics: (1) Length, 2.94 miles (4.73 km); (2) water surface width, 14.0 ft (4.3 m); (3) slope, 0.00015 ft/ft; (4) seepage rate (sandy soil), 1.5 ft/day (0.48 m/day)

(from Table 1); (5) design delivery, 30 cfs (0.85 m^3/s); and (6) flow lost to seepage, 4.38 cfs (0.124 m^3/s) approx 14.5% of design delivery.

The seepage loss would be reduced to about 0.56 cfs (0.016 m^3/s) or less if a lining were installed. This would be less than 2% of the design delivery rate and provide 3.8 cfs (0.11 m^3/s) of water for other applications during the 6-month irrigation season.

Lauritzen (7) cited costs of canal linings in the early 1960's as ranging between \$0.85 and \$3.02/sq yd (\$1.02 and \$3.65/m^2). (For this comparison, the effects of inflation and the offsetting effects of improved materials and installation

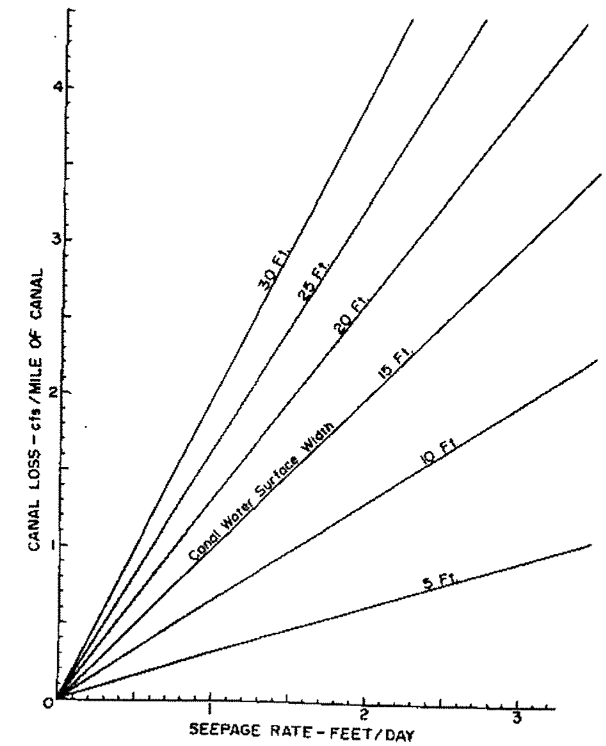

FIG. 5.—Chart to Aid in Estimating Flow Loss (Seepage Rate and Canal Dimensions Known)

equipment and techniques are not being considered.) One of the lower cost linings was heavy compacted earth at \$1.00/sq yd (\$1.20/m^2), and one of the more expensive linings was 3-in. (76-mm) thick unreinforced concrete at \$3.00 sq yd (3.6/m^2). The cost of completely lining this canal using these figures would be \$55,000 and \$67,000 for earth and concrete linings, respectively. The cross section of the concrete-lined canal would be 18 sq ft (1.67 m^2), as compared to 28 sq ft (2.6 m^2) for the earth-lined canal, so that the concrete lining only costs 22% more than the earth lining. Which of the two linings one should select would also depend on other considerations, such as the availability of a satisfactory soil for an earth lining and possible damage to the concrete lining from frost heaving or soil settlement.

The main reason for concern about seepage losses from this particular canal is the problem of delivering an adequate supply of water to the lower end of the canal during periods of high demand. If the water saved by the lining could not be used on other land in the district, it would be an expensive answer to this immediate, but only intermittent, problem. If the water could be sold locally or transferred elsewhere (with the costs amortized over 20 yr at 5%), the lining could be paid for simply by the water saved and sold at $192-$234/yr/cu ft/sec, depending on the type of lining installed. This is about 69-84% of the cost of irrigation water in the older districts of southern Idaho. Part of the area would also benefit from the lower water table that would result from the canal lining, and some of the lining cost might be assessed against this area. This example analysis indicates that lining this lateral would be profitable if the water saved could be sold elsewhere.

Conclusions

A review and summary of 765 seepage tests made in the western United States show that average unit seepage loss rates in cubic feet per square foot per day (or feet per day) range from 0.1 ft/day-2 ft/day (0.03 m/day 0.6 m/day). Seepage losses tend to increase as topsoil texture grades from clay toward sand, but losses vary widely within any one soil texture.

This information can help irrigation system planners and water resource managers make better estimates of the seepage losses from a canal system. Planning personnel can also use this approach in assessing the potential value of canal lining as compared to other improved water management practices.

Acknowledgments

The counseling of C. E. Brockway, of the University of Idaho, Water Resources Research Institute, Kimberly, Idaho, the programming assistance of B. J. Pratt, of USDA-ARS-WR, Snake River Conservation Research Center, Kimberly, Idaho, are greatfully acknowledged. Access to the records of the many seepage tests made by the Bureau of Reclamation on the Columbia Basin Project in Washington from 1962 to 1968 was helpful and is greatly appreciated. This paper is a contribution from the Western Region, Agricultural Research Service, U.S. Department of Agriculture, with the University of Idaho College of Agriculture Research and Extension Center, Kimberly, cooperating.

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11960 ESTIMATING SEEPAGE LOSSES FROM CANAL SYSTEMS

KEY WORDS: **Canals; Irrigation; Seepage; Seepage losses; Water loss;** Water resources; Water supply

ABSTRACT: Canal seepage rates for broad soil textural groups were evaluated by analyzing results of 765 tests made in the western United States. Seepage rates varied widely within each broad texture class, but the average rates for all the classes ranged from 0.2 ft to 2.0 ft (0.06 m/day to 0.6 m/day). Seepage rates were less than 1.0 ft (0.3 m) per day in most tests. Average rates were similar, whether measured by ponding or by seepage meter. No significant linear regression was found between canal dimensions and seepage rates within any one soil texture group. Average seepage rates for lined canals ranged from 0.1 ft to 1.0 ft (0.03 m to 0.3 m) per day. Irrigation system designers and resource planners will find these average rates helpful in estimating seepage losses for existing or planned systems. Average rates also will be helpful in evaluating alternative improvements in water management, such as canal-lining programs, modernizing measurement and delivery methods, and installing computer-controlled automatic regulation of diversions and deliveries.

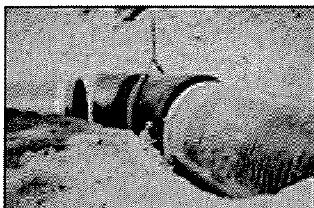
REFERENCE: Worstell, Robert V., "Estimating Seepage Losses from Canal Systems," *Journal of the Irrigation and Drainage Division,* ASCE, Vol. 102, No. IR1, **Proc. Paper 11960**, March, 1976, pp. 137-147

Attachment E

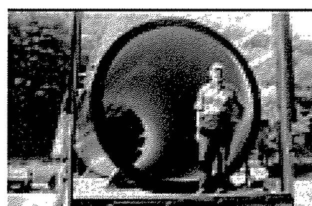
Large Diameter HDPE Piping Systems Offer:

- Corrosion Resistance
- Light Weight
- Multiple Jointing Options
- Hydraulic Efficiency
- 100-Year Plus Service Life
- Impact Resistance
- 100% Leak-Free Restrained Joints
- Flexibility of Design
- Environmental Protection
- Chemical Resistance
- Cost Effectiveness
- Abrasion Resistance
- High strength
- Long-term durability

Irrigation and Hydroelectric Penstocks



Pressurized Municipal & Industrial Applictions



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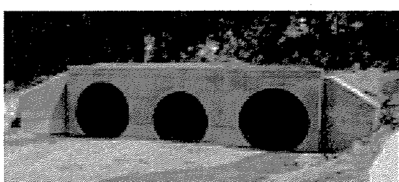
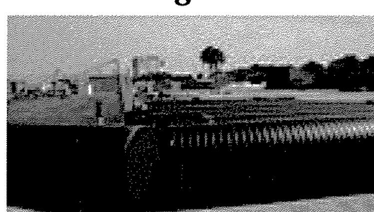
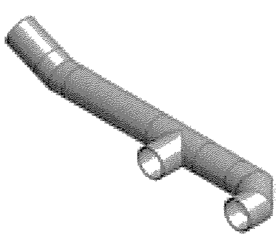
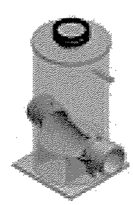
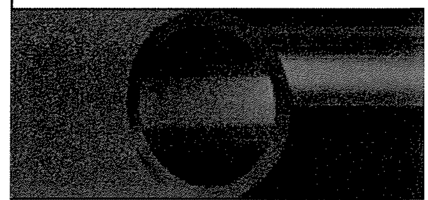




Design Assistance





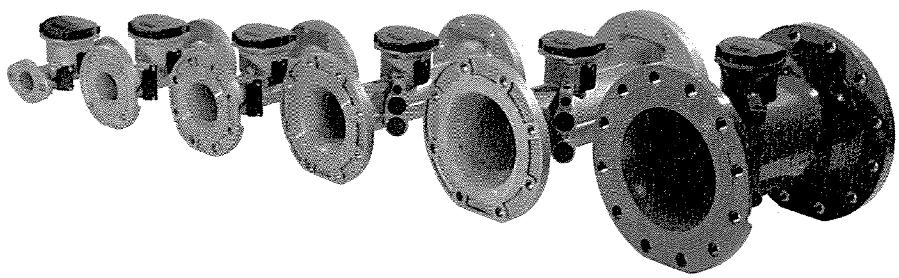


HDPE Pipe

1-800-345-ISCO

www.isco-pipe.com

MASTER METER



NSF FM APPROVED SS 316

Octave brings the latest in ultrasonic metering technology to Commercial/Industrial (C&I) water meters and puts precise measurement where the real flows exist. An excellent alternative to mechanical compound, single-jet, floating ball, fire-service type and turbine meters, Octave excels at maintaining sustained accuracy for the life of the meter while providing smart AMR capabilities.

Technical Specifications:

Working Pressure - 175 PSI

Liquid Temperature - 32° - 122 °F

Metrological Characteristics - Meets AWWA Standard C-750-10, ISO 4064 rev. 2005

Configuration - Compact-Display built into unit

Power Source - 2 x D Size Lithium Thionyl Chloride batteries - 10 year warranted life time

Environmental Protection - NEMA 6P+ (IP68+), Ambient operation temp. -13 °F / +131 °F for the display

Display Units - Multi line 9 digit LC (Programmable USG, Cu Ft, M³, Acre Feet for volume with GPM or metric flow rate choices)

Output - Programmable single/dual open collector pulse output, encoder OR externally powered loop 4-20 mA

Features & Benefits:

- Flow sensitivity starting as low as 1/16 GPM
- Grade 316 Stainless Steel or Epoxy Coated Ductile Iron body design provides full compliance with ANSI/NSF 372 (AB1953 or NSF61G)
- No moving parts. Minimal flow intrusion. Enduring accuracy.
- No required strainer
- Double beam ultrasonic measurement sensors for high accuracy and reliable operation
- FM Approved*
- Industry standard communication protocol for integration with most third-party AMR/AMI systems
- Active leak, theft, backflow, meter damage/tamper, rate of flow, and battery life indication
- Detailed LCD display features immediate reporting and visual indicators for 8 critical conditions
- Ruggedized NEMA 6P/IP-68+ construction; fully submersible design
- Designed to meet standards for both North American and International C&I water meters
- Optional flow measurements; Forward Only, Net Volume or Alternating Display (Forward and Reverse Consumption displayed separately)

MASTER METER

Performance Data

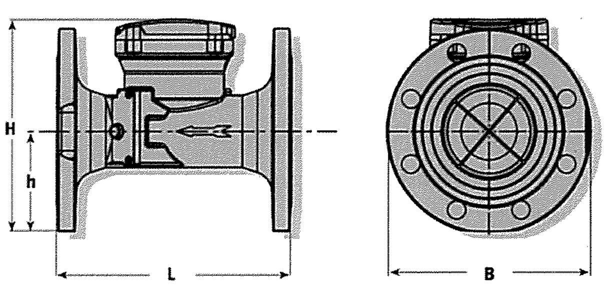
Octave Nominal Size inch (mm)	† Typical Starting Flow GPM (Lt/s)	Extended Low Flow 95% - 105% Accuracy GPM (Lt/s)	Normal Flow Range 98.5% - 101.5% Accuracy GPM (Lt/s)	‡ Continuous Safe Max Flow GPM (Lt/s)	Linearity Range +/- 0.5% Maximum Deviation GPM (Lt/s)
2" (50mm)	1/16 (.004)	1/4 (.016)	1/2 - 250 (.032 - 15.77)	250 (15.77)	4 - 200 (.25 - 12.62)
3" (80 mm)	1/16 (.004)	1/2 (.032)	1 - 500 (.06 - 31.54)	500 (31.54)	5 - 350 (.32 - 22.08)
4" (100 mm)	1/16 (.004)	3/4 (.047)	1-1/2 - 1,000 (.09 - 63.09)	1000 (63.09)	15 - 700 (.94 - 44.16)
6" (150 mm)	3/4 (.047)	2 (.13)	3 - 1,600 (.19 - 100.94)	1,600 (100.94)	20 - 1,150 (1.26 - 72.55)
8" (200 mm)	3/4 (.047)	4 (.25)	5 - 2,800 (.32 - 176.65)	2,800 (176.65)	50 - 2,000 (3.15 - 126.18)
10" (250 mm)	2.5 (.16)	8 (.50)	14 - 5,500 (.88 - 346.99)	5,500 (346.99)	400 - 4,000 (25.24 - 252.36)
12" (300 mm)	2.5 (.16)	8 (.50)	14 - 5,500 (.88 - 346.99)	5,500 (346.99)	400 - 4,000 (25.24 - 252.36)

† Starting flows vary per meter but can go as low as the above listed flow rates.

‡ Continuous Safe Max Flow ranges listed for the Octave are for accurate flow measurement only and do not limit the Octave from meeting the Short-term Deluge Flow for fire services.

Dimensions

Model	Octave							
Nominal Size	2" SS (50 mm)	2" DI (50 mm)	3" (80 mm)	4" (100 mm)	6" (150 mm)	8" (200 mm)	10" (250 mm)	12" (300 mm)
L - Length	10" (250 mm)	17" (432 mm)	12" (305 mm)	14" (356 mm)	18" (457 mm)	20" (508 mm)	18" (457 mm)	20" (508 mm)
B - Width	5 3/4" (146 mm)	5 3/4" (146 mm)	7 1/2" (190 mm)	9" (229 mm)	11" (280 mm)	13 1/2" (343 mm)	16" (406 mm)	19 1/4" (489 mm)
H - Height	6 3/4" (172 mm)	6 3/4" (172 mm)	8 1/2" (216 mm)	9 7/8" (250 mm)	10 7/8" (276 mm)	12 7/8" (327 mm)	15" (383 mm)	18" (456 mm)
h - Height	2 1/8" (54 mm)	2 1/8" (54 mm)	3 1/2" (90 mm)	4 1/2" (115 mm)	5 1/8" (130 mm)	6 3/8" (162 mm)	8" (203 mm)	9 5/8" (245 mm)
Weight - Ductile Iron	N/A	24 lbs. (11 kg)	36 lbs. (16 kg)	48.5 lbs. (22 kg)	76 lbs. (34 kg)	108 lbs. (49 kg)	150 lbs. (68 kg)	210 lbs. (96 kg)
Weight - Stainless Steel	15 lbs (7 kg)	N/A	28 lbs (13 kg)	40 lbs. (18 kg)	62 lbs. (28 kg)	88 lbs. (40 kg)	N/A	N/A



MASTER® METER

Master Meter, Inc.

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Fax: 817.842.8100

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*FM Approval currently pending on 10" and 12" Octave meters.

NOTE — For Performance charts please see **Engineering Document - Octave | Version 8.13**