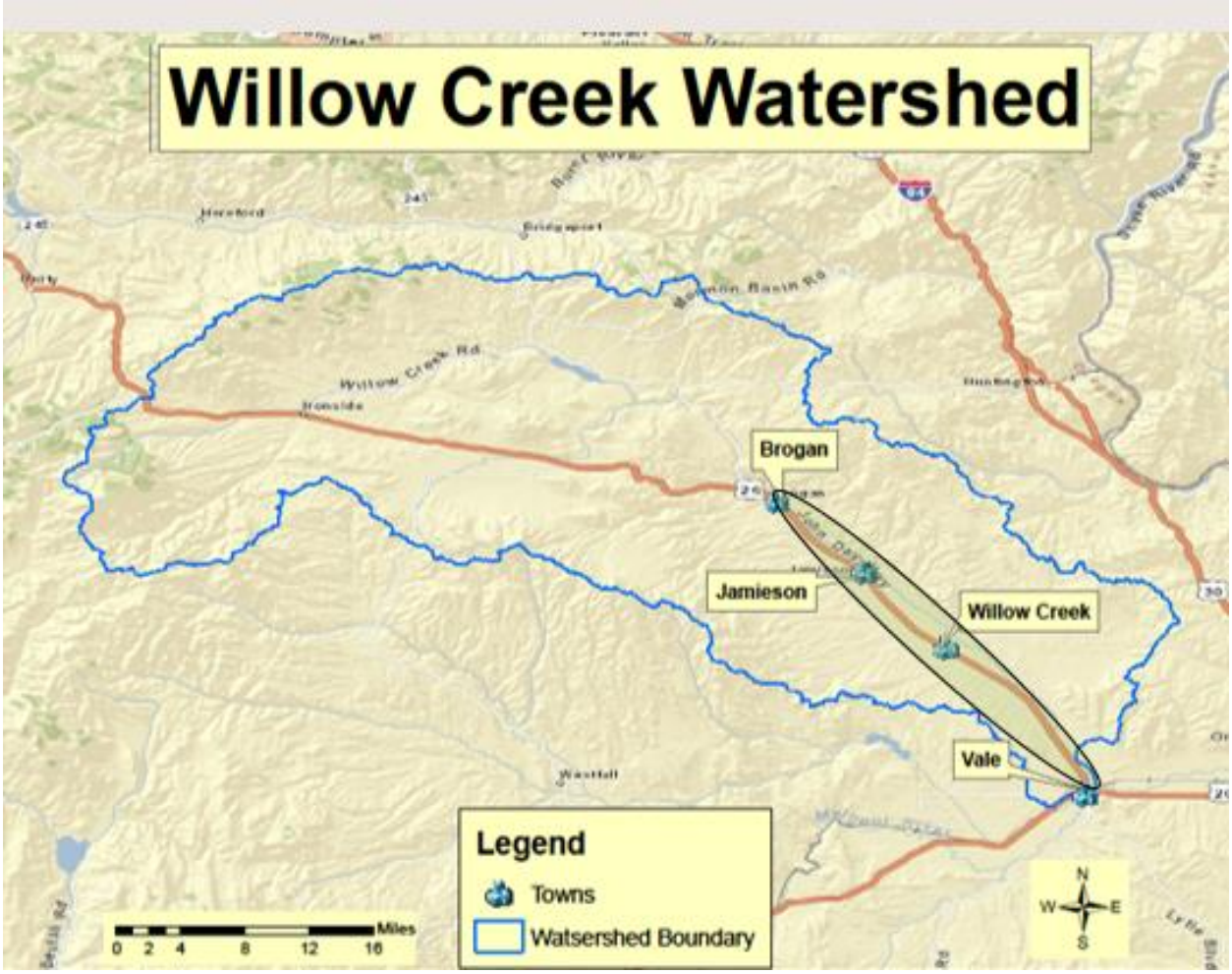
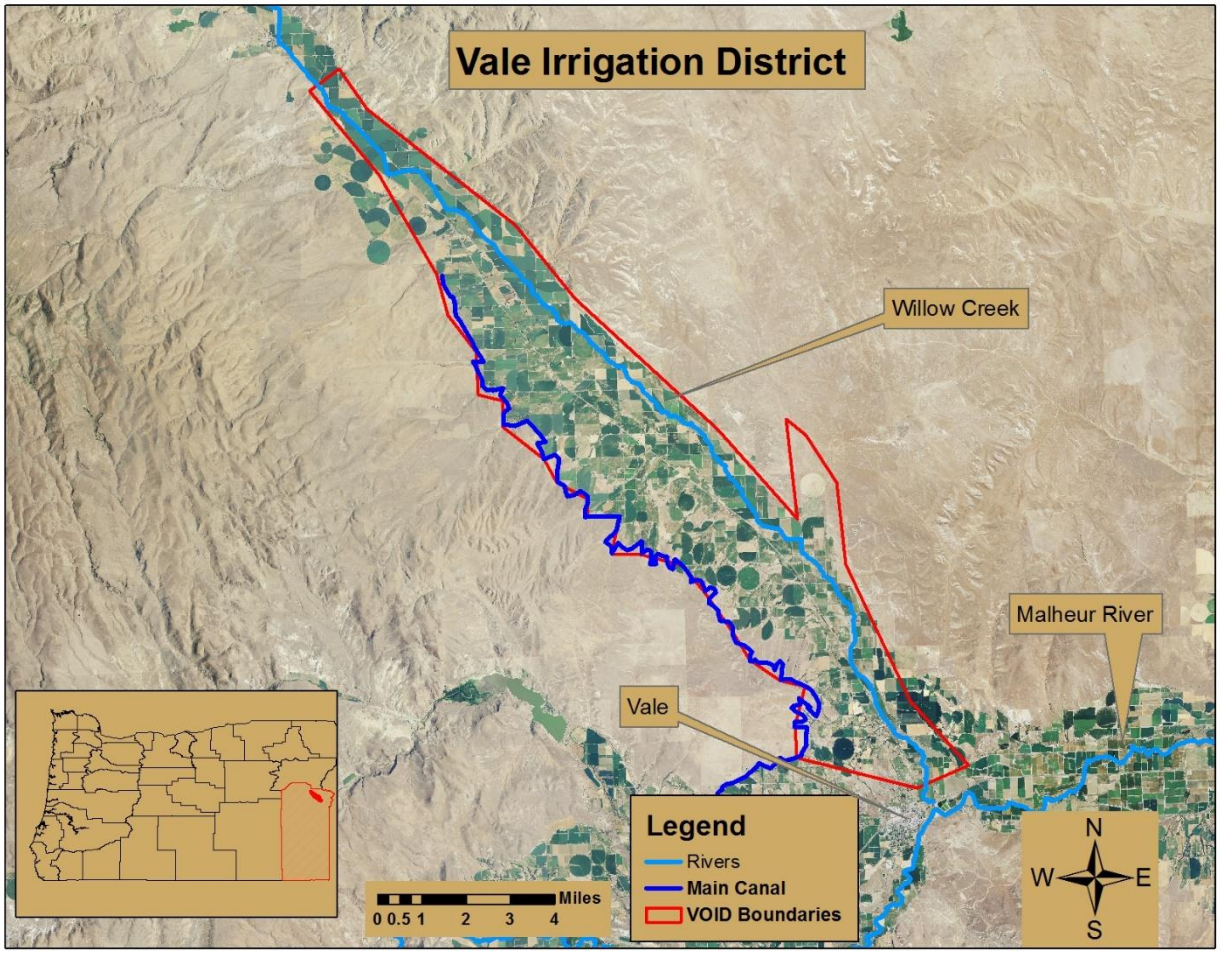
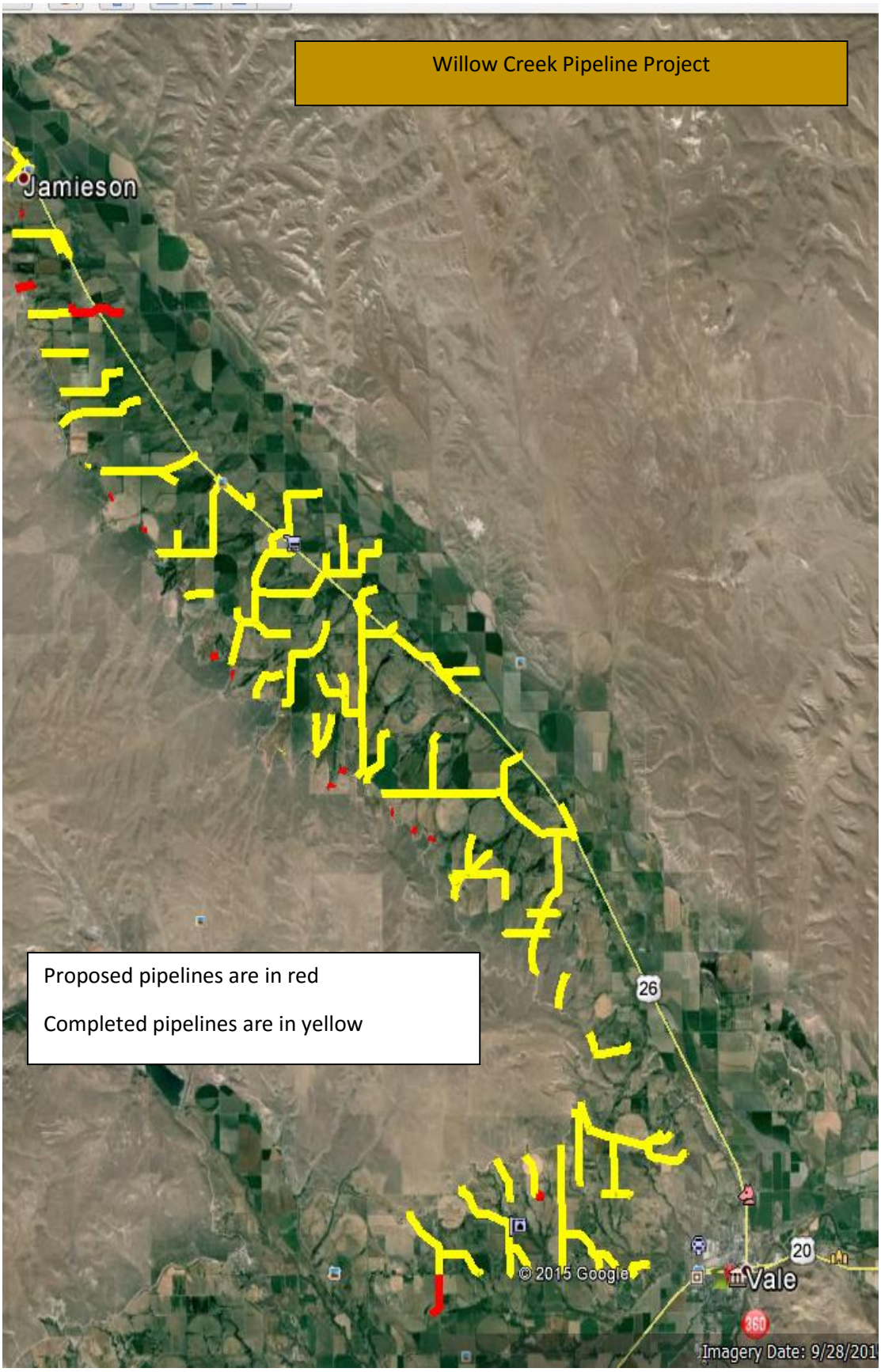
Attachment A:
Maps



Willow Creek watershed location.



Vale Oregon Irrigation District


Willow Creek Pipeline Project
Jamieson
Proposed pipelines are in red
Completed pipelines are in yellow
26
20
Vale
360
© 2015 Google
Imagery Date: 9/28/201

Attachment B:
Budget Details

Pipeline #	Solar Unit to Power Screen	Debris Screen	Headwall	Fittings	Valves	Size (inside diameter in inches)	Pipe Cost per foot	Feet of pipe	Pipe Cost	Total
273	$ 2,000	$ 4,000	$ 5,000	$ 500	$ 6,000	6	$ 1.94	300	$ 582	$ 18,390
274	$ 2,000	$ 4,000	$ 5,000	$ 500	$ 6,000	6	$ 1.94	300	$ 582	$ 18,390
281	$ 2,000	$ 4,000	$ 5,000	$ 500	$ 6,000	6	$ 1.94	300	$ 582	$ 18,390
211				$ 1,000	$ 6,000	8	$ 3.44	6000	$ 20,640	$ 33,651
283	$ 2,000	$ 4,000	$ 5,000	$ 500	$ 6,000	8	$ 3.44	300	$ 1,032	$ 18,843
289	$ 2,000	$ 4,000	$ 5,000	$ 500	$ 6,000	8	$ 3.44	300	$ 1,032	$ 18,843
309	$ 2,000	$ 4,000	$ 5,000	$ 500	$ 6,000	8	$ 3.44	600	$ 2,064	$ 20,175
325	$ 2,000	$ 4,000	$ 5,000	$ 500	$ 6,000	8	$ 3.44	300	$ 1,032	$ 18,843
373				$ 10,000		8	$ 3.44	5000	$ 17,200	$ 32,211
225	$ 2,000	$ 4,000		$ 500	$ 6,000	10	$ 5.41	500	$ 2,705	$ 15,720
271	$ 2,000	$ 4,000	$ 5,000	$ 500	$ 6,000	10	$ 5.41	300	$ 1,623	$ 19,438
332	$ 2,000	$ 4,000	$ 5,000	$ 500	$ 6,000	10	$ 5.41	300	$ 1,623	$ 19,438
307	$ 2,000	$ 4,000	$ 5,000	$ 500	$ 6,000	12	$ 7.81	300	$ 2,343	$ 20,163
372				$ 2,000	$ 6,000	12	$ 7.81	300	$ 2,343	$ 10,663
355	$ 2,000	$ 4,000	$ 5,000	$ 1,000	$ 12,000	15	$ 12.18	300	$ 3,654	$ 27,981
349				$ 4,000	$ 30,000	18	$ 18.39	5000	$ 91,950	$130,986
352	$ 2,000	$ 4,000	$ 5,000	$ 1,000	$ 12,000	18	$ 18.39	1000	$ 18,390	$ 43,426
Totals	**$ 26,000**	**$ 52,000**	**$ 60,000**	**$ 24,500**	**$ 132,000**				**$ 169,377**	**$485,555**

Solar Unit (13 units)	
Solar panels	$ 500
Electrical panel	$ 500
Solar Panel Supports	$ 1,000
Total/unit	**$ 2,000**

Screen (13 units)	$ 4,000

Valves and Fittings (varies for each pipeline)

	Unit Cost	Number	Total
Surge Valves (each)	$ 500	86	$ 43,000
Tee's and Reducers (each)	$ 500	49	$ 24,500
Z-pipe assembly	$ 4,500	20	$ 90,000
		Total	**$ 157,500**

Headwall (12 units)	
Concrete	$ 3,500
Forms	$ 500
Inlet structure	$ 1,000
Total/unit	**$ 5,000**

Attachment C:
Tribal Communication

Subject: RE: WRD application
From: "Quigley Karen M" <karen.m.quigley@state.or.us>
Date: Wed, January 6, 2016 1:18 pm
To: "kprn@eoni.com" <kprn@eoni.com>
Priority: Normal
Options: View Full Header | View Printable Version | Download this as a file | Add to Addressbook | View Message details | View as plain text | Block Sender

Hello Ken,
The Tribes in Oregon who should be notified for this Vale project because of ancestral/traditional ties to the area are the cultural resources directors for the: Burns Paiute -Diane Teeman **dlteeman.burns.paiute@gmail.com**
Confederated Tribes of Warm Springs-Kathleen Sloan **kathleen.sloan@ctwsbnr.org**
And Confederated Tribes of Umatilla-Teara Farrow Ferman **tearafarrowferman@ctuir.org**
Just as an FYI-two out of state Tribes—Nez Perce (ID) and Colville (WA) may have an interest in this area but LCIs deals with the Tribes in OR
Happy New Year.
Karen

Karen Quigley, Executive Director
karen.m.quigley@state.or.us
Legislative Commission on Indian Services

From: kprn@eoni.com
Subject: [Fwd: RE: WRD application]
Date: Fri, January 15, 2016 1:41 pm
To: dlteeman.burns.paiute@gmail.com,kathleen.sloan@ctwsbnr.org,tearafarrowferman@ctuir.org
Cc: void@fmtc.com

Hello,

I am Ken Diebel and I am the coordinator for the Malheur Watershed Council. I am working with the Vale Oregon Irrigation District to apply for Oregon Water Resources funding to pipe irrigation canals in the Willow Creek area outside of Vale Oregon. I have contacted Karen Quigley from the Legislative Commission on Indian Services and she recommended I notify you as you can see from the email below. Please accept this email as the recommended notification.

Some additional information you may find helpful is that the Irrigation District hired a contractor to conduct a cultural resources survey of the entire district, which was completed in 2014 and the resulting data and GIS map submitted to the SHPO. A programmatic agreement with SHPO is pending.

You should also know that we have been working with the Natural Resources Department of the Burns Paiute Tribe in regards to this proposal and Jason Kesling has written a letter of support. Our work will benefit cold water fisheries and the bull trout in particular. Jason's letter is attached.

If have any questions please contact me by replying to this email or calling me at 541 910-4034.

Thank you.

Ken Diebel, Ph.D.
Coordinator, Malheur Watershed Council

Attachment D:

Cultural Resources Statement

VOID entered into a Memorandum of Agreement (MOA) with the Bureau of Reclamation and the Oregon State Historic Preservation Officer (SHPO) under Section 106 of the National Historic Preservation Act in April 2014 for an undertaking involving a prior piping project funded by a previously awarded WaterSMART grant from the Bureau of Reclamation. The stipulations of this agreement required VOID to complete the following items within a set time period:

1) conduct a comprehensive historic resources survey of the irrigation district and prepare a GIS map; 2) nominate a selected lateral segment to the National Register of Historic Places under a Multiple Property Document being prepared by another irrigation district; and 3) prepare and execute a Programmatic Agreement to guide the completion of Section 106 reviews for future undertakings.

A cultural resources survey of the entire district was completed in 2014 and the resulting data and GIS map submitted to the SHPO. The survey identified historic and non-historic features throughout the district. This information still remains under review by the SHPO, in part pending the completion of the National Register Multiple Property Document.

The requisite draft of the National Register Multiple Property Document was completed in January 2015 and submitted to the SHPO. The SHPO provided comments and a revised Multiple Property Document was submitted in June 2015. SHPO's further review of the MPD is pending completion of individual National Register nominations for canal/lateral segments at VOID and COID. Preparation of the individual National Register nominations are in process. Submission to SHPO is expected in March 2016. A draft programmatic agreement is pending.

The District has hired a consultant, Christopher Hetzel, to handle the cultural resources survey.

Attachment E:

Letters of Support

Burns Paiute Tribe
Natural Resources Department
100 Pasigo St
Burns, OR 97720
Phone (541)573-1375
Fax (541)573-7806

23 November 2015

Ken Diebel
Malheur Watershed Council
710 S.W. 5th Ave
Ontario, Oregon 97914

Re: Support for project, "Piping Lateral Irrigation Canals in Willow Creek Watershed"

To whom it may concern;

The Natural Resources Department (Department) supports the proposed grant application within Willow Creek Watershed to pipe 22,000 feet of lateral irrigation canals. For the past 18 years the Department has invested many resources to understand and protect native fisheries within the Malheur River watershed and its tributaries. Both water quantity and quality are limiting factors for salmonids within the Malheur River watershed and stem from existing land use and irrigation practices. Tribal, federal and state agencies have attempted to remedy impaired conditions; however, efforts on public land alone may be too limited in scope to recover native species. As such, irrigators are important partners in restoring ecosystem function particularly in times of drought.

Beulah Reservoir seasonally contains migratory Bull Trout, a federally threatened species that the Tribe has long sought to recover. Bull Trout need cold, clean water in order to survive and a portion of the North Fork Malheur River populations utilize Beulah to grow and mature. However, given the current drought, the needs of native fish such as Bull Trout and those of irrigators can be mutually exclusive and lead to drawdown of the reservoir below suitability for this species. The proposed project is a positive and imperative step towards minimizing that conflict while increasing the likelihood that both needs are met. Piping of irrigation canals has been demonstrated to increase irrigation efficiency and result in higher returns of cooler, cleaner water to stream systems. The proposed project will result in quantifiable benefits to native fish including a decreased demand for water withdrawal from Beulah Reservoir, leading to more water available for native fish; and a decrease return of bacteria, sediment, and phosphorus to the river.

The Burns Paiute Tribe supports this proposal and recommends that funding be allocated. It is very important that projects such as the proposed are implemented for the purpose of restoring the ecological function to the Malheur River and tributaries. We appreciate the opportunity to vocalize our support.

Sincerely,

Jason Kesling, Director
Natural Resources Department, Burns Paiute Tribe
100 Pasigo Street
Burns, OR 97720
541.573.8087
Jason.kesling@burnspaiute-nsn.gov

United States Department of Agriculture

Natural Resources Conservation Service

2925 SW 6th Ave.
Suite 2
Ontario, OR 97914
Voice 541-889-9689

January 15, 2016

Dear Oregon Water Resources Department,

I am writing in support of the grant application submitted by the Malheur Watershed Council to implement irrigation system improvements in the Willow Creek area.

The Malheur Watershed Council is a valued partner with a strong history of quality conservation planning and implementation. Their work specifically in the Willow Creek area has made great impacts to the environment and the economic outlook for the local citizens. NRCS has worked closely with this effort.

This grant application proposes to continue the ongoing efforts to convert to more efficient methods of irrigation. These efforts will give great benefit to the ongoing NRCS conservation efforts and planned implementation in the area. Our current conservation implementation strategies are focused in the Willow Creek and the Vale Bench areas. The goals of this grant application would assist NRCS with accomplishing conservation implementation and the greater work of improving water quality.

Without reservation, I strongly support this grant application.

Lynn Larsen
District Conservationist
USDA-NRCS
2925 SW 6th Ave. Ste 2
Ontario, OR 97914

Oregon
Kate Brown, Governor

Department of Environmental Quality
Eastern Region - Pendleton Office
800 SE Emigrant Ave, Suite 330
Pendleton, OR 97801
Phone: (541) 276-4063
Fax: (541) 278-0168
Relay Service: 711

November 23, 2015

Malheur Watershed Council
710 SW 5th Ave.
Ontario, OR 97914

Re: Letter of Support – Malheur Watershed Council Watershed Development Account Grant Proposal, Willow Creek Lateral Ditch Piping Project

Malheur Watershed Council:

The Department of Environmental Quality (DEQ) would like to express its support for the Oregon Water Resources Department Water Supply Development Account grant application for the Willow Creek lateral ditch piping project submitted by the Malheur Watershed Council for the 2016 funding cycle. The grant proposal describes the Council's plans to continue their very successful work with their partners to pipe irrigation ditches in the Willow Creek Subbasin in Malheur County. The Council has completed many projects that have leveraged grant money with extensive local contributions, allowing for highly efficient project execution. DEQ has supported these efforts which have resulted in the efficient use of water and electricity, reduced pollutant loads to local waterways, and a much more resilient and lower maintenance irrigation system. The continuation of this excellent work will bring the piping project closer to completion.

The Malheur Watershed Council has a proven track record making progress in water quality improvement through the implementation of the Snake River/Hell's Canyon and Malheur River Basin Total Maximum Daily Load (TMDL) requirements. Piping projects such as this reduce nutrient and bacteria loading to streams while reducing demands on stored water in reservoirs. DEQ is confident that this project will further these goals.

If you have any questions or need further assistance from DEQ, please contact me at (541) 278-4616.

Sincerely,

John P. Dadoly
Malheur River Basin Coordinator
Eastern Region

Cc: Tonya Dombrowski, DEQ ER Water Quality Program, Pendleton

Malheur County Soil & Water Conservation District
2925 SW 6th Avenue, Suite #2
Ontario, OR 97914
(541) 889-2588 Ext 114

January 15, 2016

Ken Diebel
Malheur Watershed Council
710 SW 5th Ave
Ontario, OR 97914

To Whom It May Concern:

The Malheur County SWCD is very supportive of the efforts of this application from the Malheur Watershed Council Willow Creek Lateral Ditch Piping Project.

The Malheur Watershed Council will make this a showcase project. The Malheur Watershed Council, NRCS, Vale Oregon Irrigation District, Malheur County SWCD, Bureau of Reclamation, Oregon Watershed Enhancement Board, and landowners have already completed successful projects in the Willow Creek landscape burying many miles of laterals, installing irrigation systems that keep soil in the field and out of ditches, canals, and rivers.

Thank you,

Linda Rowe
District Manager
Malheur County SWCD
2925 SW 6th Ave, Ste 2
Ontario, OR 97914

Oregon
Kate Brown, Governor

Department of Fish and Wildlife
Hines District Office
Malheur Watershed District
237 S. Hines Blvd.
PO Box 8
Hines, Oregon 97738
(541) 573-6582
FAX (541) 573-5306

January 15, 2016

Malheur Watershed Council
710 SW 5th Ave.
Ontario, OR 97914

Re: Letter of support – Malheur Watershed Council Watershed Development Account Grant Proposal, Willow Creek Lateral Ditch Piping Project

The mission of ODFW is to conserve fish and wildlife for current and future generations while providing for utilization by current licensed anglers. This project aligns with the mission of ODFW and has the potential to provide befits to both aquatic organisms and human needs. This is a letter of support for Malheur Watershed Council Watershed Development Account Grant Proposal, Willow Creek Lateral Ditch Piping Project. The project proposes piping 22,000 linear feet of Willow Creek to conserve water and make irrigation more efficient. The conservation of water will have a potential positive effect for bull trout (*Salvelinus confluentus*). The conservation of water will also benefit other native fishes inhabiting the reservoir including bridgelip sucker (*Catostomus columianus*), largescale sucker (*Catostomus macrocheilus*), northern pikeminnow (*Ptychocheilus oregonensis*), redside shiner (*Richardsonius* balteatus) and sculpins (*cottidae spp.*). Game fishes managed by Oregon Department of Fish and Wildlife (ODFW) will also benefit from this project and include stocked rainbow trout (*Oncorhynchus mykiss*), largemouth bass (*Micropterus salmoides*) and white crappie (*Pomoxis annularis*).

ODFW encourage the Malheur Watershed Council, their partners and Oregon Watershed Enhancement Board to consider Oregon Revised Statue 537.470 as a separate, but complimentary piece for this project. The utilization of this statute will provide fisheries managers such as ODFD and the U.S. Bureau of Reclamation the flexibility to use the conserved water in the most beneficial location.

Respectfully,

David T. Banks

Dave Banks
District Fish Biologist
Malheur Watershed District
Hines, OR 97738

Extension Service Malheur County
710 SW 5th Avenue, Ontario, Oregon 97914
Phone: (541) 881-1417 ● Fax: (541) 889-8840 ● http://extension.oregonstate.edu/malheur

January 10, 2016

To whom it may concern,

The purpose of this correspondence is to encourage the support for piping and burial of open irrigation ditches in the Malheur Watershed. The following reasons are paramount in my support for this work:

1. The focus of many of these programs really is watershed quality benefit. However, many of these projects can also have a greater production benefit for their users. With water and soil being available in finite amounts and being asked to feed a rapidly growing population, these water quality projects can also result in greater efficiencies. Pressurizing water delivered to fields enables the adaption of sprinkler and drip technologies. This can completely eliminate the runoff of furrow irrigation. It also enables producers to leave the crop residue on top which reduces both wind and water erosion when adapting reduced tillage cultural operations. High residue farming also helps the soil maintain moisture and nutrients.
2. Pressurized water also reduces the need for electricity to pump water. As we look to the struggle of our utilities trying to meet the needs of industry, one of the best mitigation techniques is to reduce the burden. Buried lines are a great example of using gravity to take pressure off the grid.
3. Weeds are one of the greatest challenges that everybody faces. This goes beyond production agriculture: rangeland managers, homeowners, as well as publicly owned properties. Open ditches have been havens for weeds such as Canada Thistle, Hoary Cress, and Russian Olives. Removing this weed habitat is a massive step towards reducing the habitat for undesirable vegetation.

In closing, I would encourage you to consider this application. Projects like this have great utility is allowing further water quality improvements to take place. They are investments in future investments.

Thank you for your time.

Sincerely,

William H. Buhrig
Extension Crop Agent
william.buhrig@oregonstate.edu

Owyhee Watershed Council
106 Owyhee Street
P.O. Box 275 ◦ Adrian, OR 97901
Telephone: (541) 372-5782 ◦ Fax: (541) 372-5785
Nicole Sullivan-Coordinator
Email: nsullivanowc@qwestoffice.net

January 18, 2016

Malheur Watershed Council
710 SW 5th Ave
Ontario, OR 97914

RE: Piping Willow Creek Project

Dear Ken Diebel,

Owyhee Watershed Council would like to extend support for the proposed project "Piping Willow Creek". Water quality improvement in the Snake River Basin is a major priority for landowners and land managers within the Malheur and Owyhee sub-basins. Irrigation system transformations for irrigation delivery and on-farm distribution are proven best management practices for eliminating the transport of sediment, nutrients, and bacteria into streams and waterways.

Pressurized lateral pipeline systems make on-farm flood to sprinkler conversions economically feasible for landowners. They also reduce energy demand by eliminating the need for large pumping systems to pressurize irrigation water necessary for sprinkler system application. Piping earthen irrigation delivery laterals also conserves irrigation water lost through evaporation, seepage, and overflows. Irrigation water conservation is an important factor in the Malheur drainage, as conserved water can be stored in Beulah Reservoir longer and in turn improve Bull Trout habitat in those upper watershed reaches.

This project compliments many other water quality improvement projects implemented in the Willow Creek Drainage and other areas within the Snake River Basin, and should be a high priority for funding.

Thank you,

Nicole Sullivan
Owyhee Watershed Council Coordinator

Oregon
Kate Brown, Governor

Oregon Watershed Enhancement Board
775 Summer Street NE, Suite 360
Salem, OR 97301-1290
(503) 986-0178
FAX (503) 986-0199
www.oregon.gov/OWEB

January 8, 2016

Jon Unger, Water Resources Grant Administrator
Oregon Water Resources Department
725 Summer Street N.E., Suite A
Salem, Oregon 97301

Dear Mr. Unger:

The Oregon Watershed Enhancement Board invests funding from Oregon's lottery and other sources to support healthy watersheds and native fish and wildlife habitats through grants to locally based organizations such as watershed councils, soil and water conservation districts, land trusts, and others. The Malheur Watershed Council (MWC) has been a recipient of OWEB funds in the past.

The MWC is submitting a proposal entitled, "Willow Creek Lateral Ditch Piping". The application proposes to continue piping irrigation ditches in the Willow Creek sub-basin through a proposal". The MWC has completed over 85 miles of lateral piping, converting 12,000 acres from flood irrigation to sprinklers.

OWEB has awarded the MWC nearly $5 million through our Open Solicitation grant program, including lateral piping projects similar to those which are proposed in this application. The MWC has been successful at leveraging these OWEB funds with other agency and individual contributions.

If you have questions about OWEB's grant programs and investment priorities in the Malheur watershed, please contact me.

Sincerely,

Meta Loftsgaarden
Executive Director

Attachment F:

Project Pictures

Example of pipe, in place and ready to be put in place in a lateral canal.

Pictures of the main canal. The picture to the left is how a dirt canal lateral looked like before installing a pipeline. The picture to the right shows the screen and solar unit that powers it.

Before

After

Dirt Laterals prior to piping.

Canal after pipeline installation.

The Vale Oregon Irrigation District measures water delivered to each field. Piping laterals improves the accuracy of this measurement.

Picture above is Agency Dam that creates Beulah Reservoir, which is a source of water for the VOID and winter home to the federally listed bull trout.

Attachment G:
Water Quality
Information

Total Phosphorus levels rise 3.7 fold from an average of 0.34 mg/L in the applied water to 1.27 mg/L in the tail-water. Picture to the right shows furrow irrigated onions.

Picture below shows irrigation tail water leaving a row crop field.

IMPORTANCE OF PREVENTING IRRIGATION-INDUCED EROSION

"Irrigation-induced erosion is one of the most serious sustainability issues in agriculture, impacting not only the future strategic and commercial viability of irrigation agriculture, but also the survival and comfort of earth's human population. Preventing irrigation-induced erosion to maintain the high crop yield and quality advantages of irrigated agriculture is also a key to the preservation of natural ecosystems." R.E. Sojka and D.L. Bjorneberg, T.S. Strelkoff. 2007. *Irrigation of Agricultural Crops,* 2nd ed., Agronomy Monograph no 30.

Table from DEQ TMDL 2010. The data shows that Willow Creek consistently has the highest levels of bacteria in the Malheur Basin.

Table 7-3. Summary of Malheur River Basin E.coli data 1996-2007.

		Irrigation Season (April 16- October 15)					Non- Irrigation Season (October 16 – April 15)			
Station Name	**River Mile**	**Number of Samples**	**Log Mean**	**Max.**	**% > 406**		**Number of Samples**	**Log Mean**	**Max.**	**% > 406**
Malheur @ Ontario	0	29	**181**	**>2419**	**17%**		24	49	260	0%
Willow Cr. @ mouth	0	30	**469**	**>2419**	**63%**		26	**257**	**2400**	**23%**
Bully Cr. @ Hwy. 20	2	28	**152**	**1733**	**7%**		18	102	**600**	**17%**
Malheur @ Little Valley	50	29	113	**517**	**7%**		22	61	370	0%
Malheur @ Namorf	67	48	29	400	0%		27	2	20	0%
Malheur @ Jones Ranch	83	2	48	64	0%		1	1	1	0%
Malheur @ Warm Spr. Dam	122	25	3	180	0%		25	3	142	0%
Malheur @ Drewsey	140	28	76	**1460**	**11%**		17	29	160	0%
NF Malheur @ Juntura	1	57	**142**	**>2600**	**14%**		36	41	**2600**	**6%**

Notes:

E-coli results reported in organisms/100ml., shaded results exceed E.coli water quality criteria.
Non-detect results reported as 1 org/100 ml in calculations
Results that exceeded the Quantification Limit (QL) reported at the QL in calculations.

Willow Creek Report

Introduction

Concerns about high bacteria and sediment levels in Willow Creek, a tributary to the Malheur River, spurred the implementation of more than 100 restoration projects.To track the results of these improvement projects the Malheur Watershed Council began ambient water quality monitoring in 1997 to develop a baseline for the watershed. The Working Group has continued this monitoring and is proposing to expand to include best management practice effectiveness monitoring. Both the restoration and monitoring occurring in the Willow Creek Watershed have been developed so that the results can be used as model for the rest of Malheur County and other basins in eastern Washington and southern Idaho that are dealing with similar issues.

The objective of our monitoring is to track changes in water quality in the Willow Creek basin since the implementation of the restoration actions. It is essential to continue this ambient monitoring to establish the status and trends of water quality at key sites within the Willow Creek watershed. One is at the mouth of the creek, which allows measurement of water as it leaves the basin. This measurement gives us an integrated view of water quality in the watershed. We also need to monitor the water coming into the intensive agricultural area, which will help determine agriculture's influence on water quality.

Materials and Methods

Ambient Monitoring

There are three ambient sites as follows:

- Brogan Canyon – upstream site, above the intensive agricultural production area.
- 9th Avenue Bridge – approximately midway through the agricultural production.
- The Railroad Crossing near Vale – the mouth of Willow Creek.

These three sites were sampled 12 times per year for 36 samples. These samples were analyzed for:

- *E. coli*,
- Nitrogen,
- Total-phosphorus, and
- Total Suspended Solids.

Data Analysis consisted of simple descriptive statistics, above and below comparisons using paired t tests, Analysis of Variance (ANOVA) techniques, and trend analysis using seasonally adjusted Kendal *tau*

b tests as outlined by Helsel and Hirsch (2002) [1], Zar (1999) [2] and Clauson (2002)[3]. A MANOVA test was run prior to testing individual parameters as suggested by Zar (1999).

Irrigation Return Flow Drain Monitoring

The Working Group's objective in monitoring four key drains is to obtain a better understanding of irrigation return flows' contribution to water quality problems in Willow Creek. These drains, we hypothesized, will be the first areas to show changes from the implementation of the conservation projects. This drain monitoring program started in 2004.

The drains we are monitoring are as follows:

- Kern Creek
- Drain #190 a
- Drain #188 a
- Drain #188 b

We sampled each drain, and samples from above and below, on a monthly basis throughout the year for a total of 144 samples. The lab analyzed these samples for:

- *E. coli*

Caffeine Testing

Clearly not all the bacteria found in Willow Creek derive from domestic livestock. A certain amount can almost certainly be attributed to wildlife and some possibly to human activity other than agriculture. Faulty septic tanks are one possibility.

Some researchers have used ribo-typing of bacteria to trace the origins back to livestock, wildlife, or human waste. These methods are expensive, time consuming, not standardized and results may not be reproducible[4]. Expense alone disqualifies ribo-typing as a method the Willow Creek Group is willing is use. The level of specialized expertise also makes this an unattractive method.

---

[1] Helsel, D.R. and R.M. Hirsch. 2002. Statistical Methods in Water Resources. U.S. GEOLOGICAL SURVEY Publication available at: http://water.usgs.gov/pubs/twri/twri4a3/

[2] Zar, J.H. 1999. Biostatistical Analysis. 4th Edition. Prentice Hall. Upper Saddle River, New Jersey. 664 pgs.

[3] Clausen, J.C. 2002. Natural Resources Conservation Service. National Water Quality Handbook. Analysis of Water Quality Monitoring Data. 204 pgs.

[4] Scott, T.M. ; Rose, J.B.; Jankins, T.M. Farrah, S.R.; Lukasik, J. 2002. Microbial source tracking: Current methodology and future directions. Appl. Eviron. Microbiol. 68:5796-5803.

We used caffeine sampling methods to investigate the potential for septic tank contributions to bacteria levels in Willow Creek. A number of studies have shown caffeine to be a reliable indicator of human influence on bacteria levels in streams (Peeler et al. 2006).[5] Testing for caffeine in water samples is a specialized laboratory technique. The Oregon Department of Agriculture's lab has the capability to run this test, and we used them for this evaluation.

We sampled at the three ambient sites and at the four drain sites twice a year, spring and fall, for a total of 14 samples per year.

Individual Field Return Flow Monitoring

Irrigated Pasture Monitoring

A number of studies have shown that tail-water from irrigated pasture have high levels of *E. coli.* Shock et al. (2003) [6] measured levels as high as 230,000 colonies per 100 mL of sample. Knox et al. (2007)[7] summarized a number of studies conducted in California that found levels ranging as high as 158,000 colonies with an average of 5,000 to 6,000 colonies per 100 mL of sample. Roughly, 94% of the samples violated water quality standards even after flowing through a small wetland. Given these data, our hypothesis is that with the large feedlots being routinely inspected to ensure waste does not enter streams most of the livestock derived bacteria should be originating from flood-irrigated pastures.

Generally, our methods corresponded with Knox et al.'s (2007) methods. We selected three pastures for monitoring. We tested the irrigation water before its application to check for background levels of bacteria.

We sampled each pasture at least once a month during the irrigation season (April – October), above and below. Statistical analysis consisted of paired t-tests.

Furrow Irrigation Monitoring

A second problem the Willow Creek landowners face is irrigation-induced erosion. The most common method of irrigating row crops is furrow irrigation. This method consists of delivering water to a field via a ditch or pipe. Water is then sent by gravity down a furrow, a narrow trench made by a plow. Crops are grown on raised beds between the furrows. Significant amounts of soil are carried off the fields by the irrigation water. When water reaches the end of each furrow it is collected in a receiving ditch. These ditches eventually lead to Willow Creek.

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[5] Peeler, K.A., Opsahl, S.P., and J.P. Chanton. 2006. Tracking anthropogenic inputs using caffeine, indicator bacteria and nutrients in rural freshwater and urban marine systems. Environ. Sci. Technol. 40:7616-7622.

[6] Shock et al. 2003. Reduction of Irrigation-Induced Loss of *E. Coli* From Surface-Irrigated Pastures.

[7] Knox, A.K., K.W. Tate, R. A. Dahlgren, and E.R. Atwill. 2007. Management reduces *E. coli* in irrigated pasture runoff. California Agriculture. 61:159-165.

Sediment is one of the main ways phosphorus enters a stream. Excessive phosphorus and nitrogen cause algae blooms. Fish and other aquatic life have a difficult time surviving under these conditions because the alga removes all the dissolved oxygen in the water. DEQ has identified Willow Creek as failing to meet Oregon's Water Quality Standards for chlorophyll a, which indicates excessive amounts of algae. Additionally, the Snake River-Hells Canyon TMDL requires tributaries like the Malheur River to reduce total-phosphorus loads by 80%.

We tested the irrigation water before its application to check for background levels of nitrogen, total-phosphorus, total suspended solids, and bacteria. We sampled the tail-water as it leaves the property and empties into a return flow ditch. The tail-water samples were sent to the lab and tested for the same parameters listed above. Sampling and lab testing will follow DEQ and BOR procedures.

We will sample each field monthly during the irrigation season (April-October), above and below. Statistical analysis will consist of paired t tests and seasonal analysis of trends.

Results and Discussion

Ambient Monitoring

The MANOVA tests provided strong evidence of significant differences among all the the water quality parameters (all p-values < 0.0001).

The differences between the samples taken at the mouth of Willow Creek and those taken at Brogan Canyon above the irrigated agricultural area were strong for all parameters. The water at the mouth was consistently of poorer quality than at Brogan Canyon. The paired t-Tests confrim this observation ($p < 0.001$ and Table 1).

Trend Analysis

We used a Seasonally Adjusted Kendall Tau trend analysis test on the bacteria levels in the samples taken at the mouth of Willow Creek. We used data taken from the year **2000 to 2013** for a total of 14 water years. The results indicate no statitically significant trend in the data ($p = 0.89$).

Irrigation Return Flow Drain Monitoring

Kern Creek

Kern Creek has become a special emphasis area for the Working Group because of the high percentage of water quality related projects being implmented in this small drainage. For this reason additional sampling was done to develop a baseline data set prior to implementation of the projects.

Samples were taken prior to the water entering the irrigated area and at the mouth of the creek. We only measured the bacteria levels in the additional samples. Paired t-Tests showed significant differences between the two sites (p-value< 0.0001). Samples taken at the mouth contained sigificantly

higher levels of bacteria. (77% of the samples taken at the mouth were greater than the state's criteria, while only 12% of the samples taken above the irrigated area were above the criteria.)

Visual inspection of the raw data (Figure 1) shows a difference in the amount of bacteria detected at the mouth of Kern Creek. In particular, it appears that the maximum levels seem to have declined since 2010. Of course we conducted several statistical tests to verify this insight. There wer no statistical differences among years for means and there was no statically significant trend in the data using the Kendall tau test.

However, we conducted a simple regression test using only the yearly maximums. There was a modestly significant downward trend (Figure 2; $p=0.1035$). One of the pastures located along Kern Creek was partially converted to sprinkler irrigation in 2010, which corresponds to the time we see a change in the data.

This is an important finding. It is the first statitical evidence we have found for changes in in-stream water quality that we can directly relate to our restoration efforts.

Drain Monitoring

We compared bacteria levels in the four main irrigation return flow drains that feed into Willow Creek, Kern Creek, 188A, 188B, and 190A. The ANOVA provides evidence of strong differences among the drains ($p<0.0001$), and season ($p<0.0001$) but no significant differences among years. Tukey's HSD test indicated that drain 188A had the highest levels of bacteria and that there were no significant differences among the other drains. As expected the summer season had the highest levels of bacteria.

Caffeine Sampling

We sampled for caffeine for one season, and found no sigificant levels of caffeine at any of the sampling sites. We decided to discontinue this sampling and concluded that septic tank discharges were not an important factor contributing to the observed bacteria levels in Willow Creek.

Individual Field Return Flow Monitoring

Irrigated Pasture Monitoring

With few exceptions, the levels of bacteria in the irrigation water increased dramatically after it passed throught the pastures, which is what we expected. The paired t-Test results were highly significant ($p < 0.0001$) indicating the water flowing over the pastures was causing a significant increase in bacteria levels. The median level of bacteria in the irrigation water applied to the fields was 320 colonies per 100 mL of sample. The median level in the tail-water was 7,500 colonies, a 23 fold increase.

The pastures were not statistically different at the 0.05 level ($p = 0.067$) among the mean differences between bacteria levels in the applied water and bacteria levels in the tail-water. This is encouraging because we can make the conservative assumption that most fields contribute about the same amount of bacteria.

This result provides evidence that converting irrigated pastures to sprinkler will help reduce bacteria contamination in Willow Creek. The applied irrigation water met water quality criteria but passing it through the pastures increased the bacteria by 23 times.

We estimate, based on the amount of acres converted from flood to sprinkler, that we are preventing about 96 billon colonies of bacteria from entering Willow Creek each year.

This monitoring will be discontinued beccause one pasture has been converted to sprinkler, one no longer is grazed and one is scheduled to be converted to sprinkler soon.

Row Crop Field Monitoring

Paired t-Tests provided statistical evidence that Total Phosphorus levels increased significantly as the irrigation water passed through the fields ($p < 0.0001$), which is not surprising. Total Phosphorus levels rose 3.7 fold from an average of 0.34 mg/L in the applied water to 1.27 mg/L in the tail-water. Neither level meets the TMDL target of 0.07 mg/L, but controling irrigation induced erosion will make significant progress in achieving the goal. Our 2013 results are remarkably similar except that one field is no longer being furrow irrigated. Thus its contribution to sediment is zero.

The fields were not statistically different ($p = 0.55$) between Total Phosphorus levels in the applied water and Total Phosphorus levels in the tail-water. This is encouraging because we can make the conservative assumption that most fields contribute about the same amount of Total Phosphorus. This allows us to make extrapolating estimates of the affect of converting fields to sprinklers.

Calculations show that elimination irrigation return flow prevents 10.36 pounds of Total phosphorus per acre per year from entering Willow Creek. As a result of OWEB, BOR, NRCS, VOID and private landowner investments about 2,000 acres have been converted from flood to sprinkler. Thus, more than **20,000 pounds of Total Phosphorus per year** are no longer entering Willow Creek.

Conclusions

We have just begun to mine the gold field that this data set represents. We can say that:

- irrigated agriculture is having a profound affect on the water quality of Willow Creek
    - there are no apparent trends in the ambient water quality data.
- caffeine analysis provides strong evidence that human actvities other than irrigation are having a minimal affect on water quality
- each drain is unique, but they all signficantly affect Willow Creek's water quality
    - Drain 188A had the highest levels of bacteria among the four tested
- tail-water from irrigated pastures and row crop fields have a significant detrimental affect on water quality. When compared to the applied irrigation water:
    - Bacteria levels increase 23 fold.
        - **We found a decrease in the yearly maximum bacteria counts at the mouth of Kern Creek.This is an important finding. It is the first statitical evidence we**

have found for changes in in-stream water quality that we can directly relate to our restoration efforts.

- Total phosphorus levels increase 3.7 times
- Each field is similar enough that we can extrapolate to determine the effects of conversion from furrow irrigation to sprinkler irrigation
    - We estimate that more than **20,000 pounds of Total Phosphorus per year** are no longer entering Willow Creek as a result of our conservation efforts.
- We are discontinuing our on-farm morintoring because most of the fileds have been converted to sprinklers and are no longer contributing to water quality problems.

Tables and Figures

Table 1. Median values for four water quality parameters, Willow Creek Malheur County, Oregon. Results from the ambient monitoring sites (2008 to 2012)				
	Willow Creek at its mouth below irrigated agriculture		Willow Creek at Brogan Canyon above irrigated agriculture	
	Median	% Samples > state or TMDL criteria	Median	% Samples > state or TMDL criteria
E. coli Colonies/100 mL	270	37%	66	10%
T-Phosphorus mg/L	0.39	100%	0.18	99%
Total Suspended Solids mg/L	64.50	76%	15.00	41 %
NO3/NO2 mg/L	2.40	100%	0.01	14%

Table 1a. Median values for four water quality parameters, Willow Creek Malheur County, Oregon. Results from the ambient monitoring sites 2008 to 2013.

	Willow Creek at its mouth below irrigated agriculture		Willow Creek at Brogan Canyon above irrigated agriculture	
	Median	% Samples > state or TMDL criteria	Median	% Samples > state or TMDL criteria
E. coli Colonies/100 mL	260	32%	63	11%
T-Phosphorus mg/L	0.39	100%	0.18	100%
Total Suspended Solids mg/L	63	75%	12.5	39 %
NO3/NO2 mg/L	2.40	100%	0.01	14%

Attachment H:

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Oregon State University
104 CEOAS Admin Building
Corvallis, Oregon 97331

January 19, 2016

Ken Diebel
Malheur Watershed Council
710 S.W. 5th Ave.
Ontario, Oregon 97914

RE: Support for project, "Piping Willow Creek"

To whom it may concern,

I would like to enthusiastically endorse the Malheur Watershed Council's proposal "Piping Willow Creek," which will greatly improve agricultural resilience to future climate change. For the past five years, the Pacific Northwest Climate Impacts Research Consortium, a collaborative of climate and water experts from the region's leading universities, has conducted research to understand the magnitude and impacts of future climate change in our region.

Our research suggests that watersheds throughout the Pacific Northwest, including the Malheur Watershed and its tributaries, will undergo drastic changes as seasonal temperatures continue to increase. The most recent research indicates that in the next several decades average winter temperatures may likely increase between 5 and 6 degree Fahrenheit and as much as 12 degrees Fahrenheit by the century's end. These changes will result in loss of reliable snowpacks, shift the timing of streamflow earlier in the year, and greatly increase the evaporative demand of cropping systems.

While changes in regional temperature are being determined by human activities on a global scale, we have found that efforts to prepare for and adapt to future conditions on a local scale are not only effective but imperative. In particular, investments to increase irrigation and conveyance efficiency, such as piping lateral canals, can maintain today's volume of agricultural water use even in a future that is more than 10 degrees Fahrenheit warmer. While there are many other benefits of this proposal, we encourage you to consider the dividends that funding this project would have in preparing agricultural systems for the impacts of climate change.

Sincerely,

John Stevenson, *Regional Extension Climate Specialist*
PNW CIRC, Oregon Climate Change Research Institute
jstevenson@coas.oregonstate.edu
541-737-5689