



Oregon Water Resources Department
 725 Summer Street NE, Suite A
 Salem Oregon 97301-1271
 (503) 986-0900
 www.wrd.state.or.us

Application for a Permit to Store Water in a Reservoir

(Standard Review)

Standard Review Process (ORS 537): You must use this form for any reservoir storing more than 9.2 acre-feet and with a dam more than 10 feet high.

Use a separate form for each reservoir. However, to obtain authorization for multiple reservoirs, multiple forms may be combined into one application if filed at the same time.

Please type or print in dark ink. If your application is found to be incomplete or inaccurate, we will return it to you. A summary of review criteria and procedures that are generally applicable to these applications is available at www.wrd.state.or.us/OWRD/PUBS/forms.shtml

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1. APPLICANT INFORMATION

JUN 28 2017

Applicant: Terry Long
First Last

Mailing Address: 704 SW Palatine RD PO Box 145
SALEM, OR

Portland Mitchell Oregon 97219 97750
City State Zip

Phone: 541-462-3222
Home Work Other

Fax: _____ E-Mail Address*: canyonranching@yahoo.com

* By providing an e-mail address, consent is given to receive all correspondence from the department electronically. (paper copies of the final order documents will also be mailed.)

I(We) make application for a permit to construct a reservoir and store the following described waters of the State of Oregon. The name of the reservoir is Long Reservoir.

2. SOURCE OF WATER for the proposed use: Bear Creek,
 a tributary of Bridge Creek

Is the proposed use an enlargement of an existing dam/reservoir? Yes No

If the reservoir is not in channel of a stream, state how it is to be filled:

Diversion from Bear Creek under transfer T-8691 will supply water to the reservoir up to 24 acre-feet per year.

For Department Use		
App. No. <u>R-88422</u>	Permit No. _____	Date _____



CASCADE
GEOENGINEERING

21145 Scottsdale DR, Bend, Oregon 97701
360-907-4162 newtonjim@hotmail.com

June 13, 2017

Keith Mills, Dam Safety Engineer
Oregon Water Resources Department
725 Summer ST NE, Suite A
Salem, OR 97301

RE: APPLICATION FOR A PERMIT TO STORE WATER IN A RESERVOIR (STANDARD REVIEW); LONG RESERVOIR; CANYON RANCHING, MITCHELL, OREGON

Dear Keith:

Cascade Geoengineering, LLC (CGE) has prepared the enclosed Oregon Water Resources Department application for a permit to store water in a reservoir, standard review (Application), to increase storage in the existing Long Reservoir located in Wheeler County, Oregon. With the increase in storage request in this new Application, the existing reservoir intends to be authorized to operate at an increased depth and volume of water that exceeds the original storage permit R-13455 reservoir dam storage height of 10 feet (R-13455 was authorized under the alternate review permit application process).

Considering the requirements of the enclosed Application, a Dam Breach Evaluation was prepared in the enclosed Memorandum by Newton Consultants, Inc. dated March 2016. If during processing of the Application questions arise that pertain to the existing Long Reservoir, or the Dam Breach Evaluation, please feel free to contact CGE at your convenience to address your needs.

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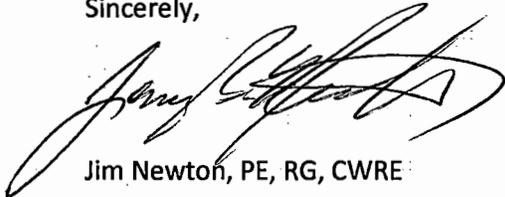
SALEM, OR

R-88422

CLOSURE

If you have questions regarding this letter or the enclosed Application, please feel free to contact me at your convenience. I can be reached by email at newtonjim@hotmail.com, or by telephone at 360-9047-4162.

Sincerely,



Jim Newton, PE, RG, CWRE
Principal – Engineer-Geologist
Cascade Geoengineering, LLC

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3. DAM HEIGHT AND COMPOSITION

The maximum height of the structure will be approx. 22 feet above streambed or ground surface at the centerline of the crest of the dam.

Attach preliminary plans, specifications and supporting information for the dam and impoundment area including dam height, width, crest width and surface area.

Note: If your dam height is greater than or equal to 10.0' above land surface AND your reservoir will store equal to or greater than 9.2 acre-feet, engineered plans and specifications must be approved prior to storage of water.

The dam will be (check one): Earthfill Concrete Flash board Other

If "other" give description:

4. PRIMARY OUTLET WORKS

Describe the location and the dimensions of the outlet conduit through the dam:

On the NW portion of the dam, one 10" diameter smooth polyethylene pipe runs through the embankment for 94 feet and extends beyond the embankment on each side. On the upstream side of the dam, a manual valve controls the discharge from the inlet at the bottom of the reservoir. A second, vertical overflow pipe bypasses the valve on the 10" outlet pipe and releases water wehn the level reaches the inlet of the vertical overflow pipe.

NOTE: Most dams across a natural stream channel will need an outlet conduit having a minimum diameter of 8 inches or greater.

5. EMERGENCY SPILLWAY

Describe the location and the dimensions of the spillway channel:

The spillway is located on the NE portion of the dam and runs along the side of a nearby native hill. See attachment for dimensions.

6. THE USE(s) of the impounded water will be:

Fish Life, Fire Protection, Wildlife, and Recreation.

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7. THE AMOUNT OF WATER to be stored is: 120 acre-feet acre-feet.

The area submerged by the reservoir, when filled, will be 11.7 acres.

8. PROJECT SCHEDULE: (List Month and Year)

Proposed date construction work will begin: estimated June 2017

Proposed date construction work will be completed: October 2018

Proposed date water use will be completed: October 2022

Is this project fully or partially funded by the American Recovery and Reinvestment Act? (Federal stimulus dollars)

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9. PROPERTY OWNERSHIP

Do you own all the land where you propose to divert, transport, and use water?

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Yes (Please check appropriate box below then skip to section 10)

SALEM, OR

There are no encumbrances.

This land is encumbered by easements, rights of way, roads or other encumbrances (please provide a copy of the recorded deed(s))

No (Please check the appropriate box below)

I have a recorded easement or written authorization permitting access.

I do not currently have written authorization or an easement permitting access.

Written authorization or an easement is not necessary, because the only affected lands I do not own are state-owned submersible lands, and this application is for irrigation and/or domestic use only (ORS 274.040).

You must provide the legal description of: (1) the property from which the water is to be diverted, (2) any property crossed by the proposed ditch, canal or other work, and (3) any property on which the water is to be used as depicted on the map.

List the names and mailing addresses of all affected landowners: N/A

11. WITHIN A DISTRICT

Check here if the point of diversion or place of use are located within or served by an irrigation or other water district.

Irrigation District Name	N/A	Address	
City		State	Zip

R-00422

11. MAP REQUIREMENTS The Department cannot process your application without accurate information showing the source of water and location of water use. You must include a map with this application form that clearly indicates the township, range, section and quarter/quarter section of the proposed reservoir location and place of use. The map must provide tax lot numbers. See the map guidelines sheet for detailed map specifications.

12. SIGNATURE

By my signature below I confirm that I understand:

- I am asking to use water specifically as described in this application.
- Evaluation of this application will be based on information provided in the application packet.
- I cannot legally use water until the Water Resources Department issues a permit to me.
- If I get a permit, I must not waste water.
- If development of the water use is not according to the terms of the permit, the permit can be canceled.
- The water use must be compatible with local comprehensive land use plans.
- Even if the Department issues a permit, I may have to stop using water to allow senior water right holders to get water to which they are entitled.

I certify that the information I have provided in this application is an accurate representation of the proposed water use and is true and correct to the best of my knowledge:

Applicant: _____

Signature (If more than one applicant, all must sign.)

Date

6-24-17

Before you submit your application be sure to:

- Answer each question completely.
- Attach a legible map that includes township, range, section, quarter/quarter and tax lot.
- Include a Land Use Information Form or receipt stub signed by a local official.
- Include the legal description of all the property involved with this application. You may include a copy of your deed land sales contract or title insurance policy to meet this requirement.
- Include a check payable to the Oregon Water Resources Department for the appropriate amount. The Department's fee schedule can be found at www.wrd.state.or.us or call (503) 986-0900.

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Storage Water/4

R-88922

Application for a Permit to Store Water in a Reservoir

(Standard Review)



Oregon Water Resources Department
725 Summer Street NE, Suite A
Salem, Oregon 97301-1266
(503) 986-0900
www.wrd.state.or.us

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Water-Use Permit Application Processing

SALEM, OR

1. Completeness Determination

The Department evaluates whether the application and accompanying map contain all of the information required under OAR 690-310-0040 and OAR 690-310-0050 (www.oregon.gov/owrd/law.our). The Department also determines whether the proposed use is prohibited by statute. If the Department determines that the application is incomplete, all fees have not been paid, or the use is prohibited by statute, the application and all fees submitted are returned to the applicant.

2. Initial Review

The Department reviews the application to determine whether water is available during the period requested, whether the proposed use is restricted or limited by rule or statute, and whether other issues may preclude approval of or restrict the proposed use. An Initial Review (IR) containing preliminary determinations is mailed to the applicant. The applicant has 14 days from the mailing date to withdraw the application from further processing and receive a refund of all fees paid minus \$225. The applicant may put the application on hold for up to 180 days and may request additional time if necessary.

3. Public Notice

Within 7 days of the mailing of the initial review, the Department gives public notice of the application in the weekly notice published by the Department at www.oregon.gov/owrd. The public comment period is 30 days from publication in the weekly notice.

4. Proposed Final Order Issued

The Department reviews any comments received, including comments from other state agencies related to the protection of sensitive, threatened or endangered fish species. Within 60 days of completion of the IR, the Department issues a Proposed Final Order (PFO) explaining the proposed decision to deny or approve the application. A PFO proposing approval of an application will include a draft permit, and may request additional information or outstanding fees required prior to permit issuance.

5. Public Notice

Within 7 days of issuing the PFO, the Department gives public notice in the weekly notice. Notice includes information about the application and the PFO. Protest must be received by the Department within 45 days after publication of the PFO in the weekly notice. Anyone may file a protest. The protest filing fee is \$350.00 for the applicant and \$700.00 for non-applicants. Protests are filed on approximately 10% of Proposed Final Orders. If a protest is filed the Department will attempt to settle the protest but will schedule a contested case hearing if necessary.

6. Final Order Issued

If no protests are filed, the Department can issue a Final Order within 60 days of the close of the period for receiving protest. If the application is approved, a permit is issued. The permit specifies the details of the authorized use and any terms, limitations or conditions that the Department deems appropriate.

FIGURES

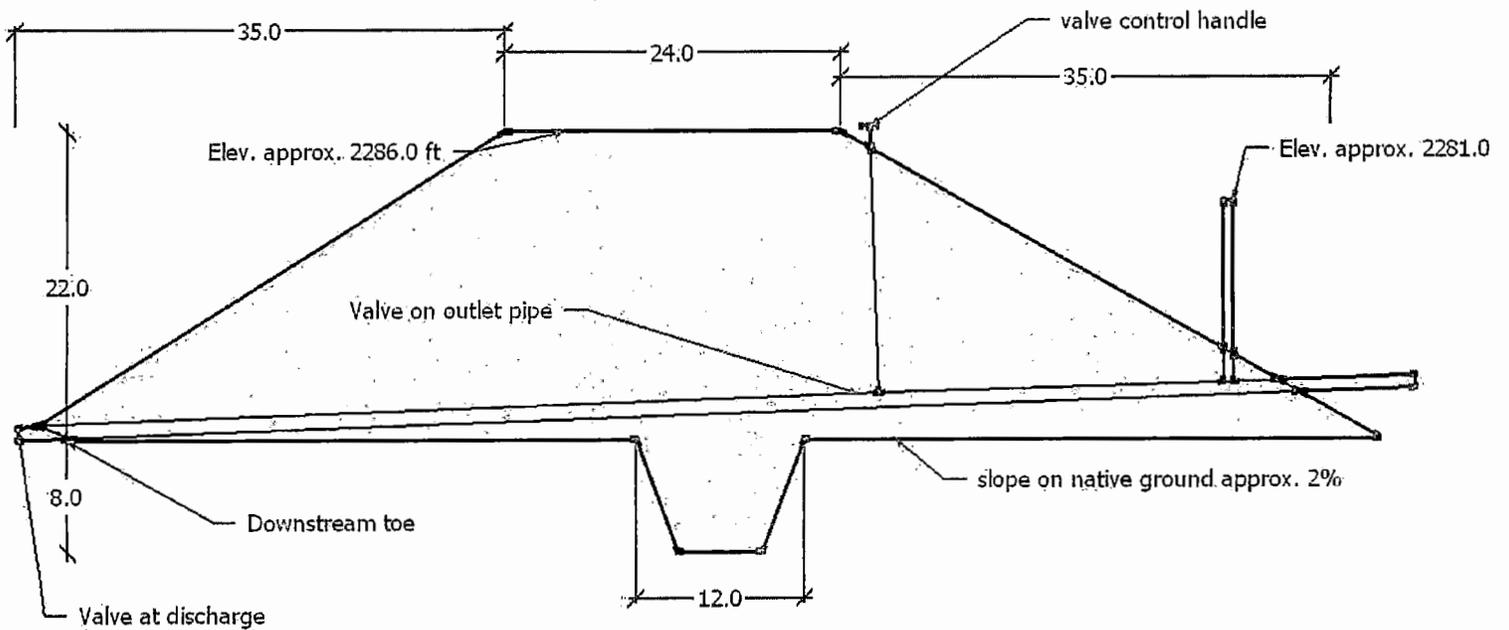
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Figure 2: Dam Profile Dimensions



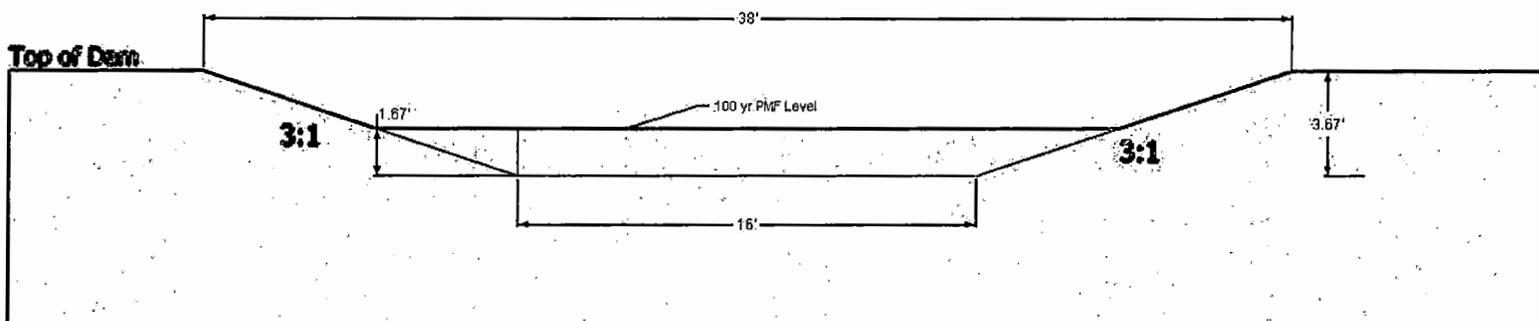
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R-98422

Figure 3: Spillway



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R-88422

PROPERTY OWNERSHIP

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R-00422

Until a change is requested, all tax statements shall be sent to the following address:

Terence E. Long
0704 SW Palatine Road
Portland, Oregon 97219

After recording, return to:

Lon P. Dufek
Providence Foundations – Oregon
3975 SW Mercantile Drive, Suite 205
Lake Oswego, OR 97035

BARGAIN AND SALE DEED

TERENCE E. LONG and PEGGY A. LONG, husband and wife, Grantors, convey to PROVIDENCE ST. VINCENT MEDICAL FOUNDATION, an Oregon nonprofit corporation, Grantee, the real property situated in Wheeler County, Oregon, described as follows:

IN TOWNSHIP 11 SOUTH, RANGE 20 EAST OF THE WILLAMETTE MERIDIAN:

- Section 3: SW $\frac{1}{4}$ SW $\frac{1}{4}$
- Section 4: E $\frac{1}{2}$ SE $\frac{1}{4}$
- Section 5: SW $\frac{1}{4}$; S $\frac{1}{2}$ NW $\frac{1}{4}$
- Section 6: Lots 6, 7; E $\frac{1}{2}$ SW $\frac{1}{4}$; SE $\frac{1}{4}$
- Section 7: All (fractional)
- Section 8: All
- Section 9: All
- Section 10: All
- Section 15: NW $\frac{1}{4}$; W $\frac{1}{2}$ NE $\frac{1}{4}$; N $\frac{1}{2}$ SW $\frac{1}{4}$; NW $\frac{1}{4}$ SE $\frac{1}{4}$
- Section 16: All
- Section 17: E $\frac{1}{2}$ NW $\frac{1}{4}$; NE $\frac{1}{4}$; NE $\frac{1}{4}$ SW $\frac{1}{4}$; N $\frac{1}{2}$ SE $\frac{1}{4}$; SE $\frac{1}{4}$ SE $\frac{1}{4}$

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SUBJECT to the following restrictions and obligations:

1. Grantors reserve to themselves the exclusive use, possession, and enjoyment of the Property and the rents, issues, and profits therefrom during their natural lifetimes.

2. In making this conveyance, Grantors intend to make an irrevocable contribution to Grantee of a vested remainder interest in their property within the meaning of section 170(f)(3)(B)(i) of the Internal Revenue Code of 1986 and the regulations promulgated thereunder, and to obtain the full benefit of any income gift and estate tax charitable deductions to which Grantors or their estates may be entitled. This deed and the conveyance, rights and obligations set forth herein shall be interpreted consistent with Grantors' intent.

3. Consistent with Grantors' intent to contribute to Grantee an irrevocable remainder interest in the Property, reserving a life estate therein, Grantors agree to keep the Property in good condition and repair, to refrain from committing or permitting waste, to pay all taxes, liens, and assessments promptly when due, to keep the Property insured against loss or damage by fire or other casualty, to make all reasonable efforts to retain all existing water rights and generally to comply with all the obligations of a life tenant.

LAND USE FORM

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SALEM, OR

R-88422

Land Use Information Form



Oregon Water Resources Department
 725 Summer Street NE, Suite A
 Salem, Oregon 97301-1266
 (503) 986-0900
 www.wrd.state.or.us **RECEIVED BY OWRD**

JUN 28 2017

Applicant: Terry Long
First Last

SALEM, OR

Mailing Address: 704 SW Palatine Hill RD

Portland OR 97219 Daytime Phone: 541-462-3222
City State Zip

A. Land and Location

Please include the following information for all tax lots where water will be diverted (taken from its source), conveyed (transported), and/or used or developed. Applicants for municipal use, or irrigation uses within irrigation districts may substitute existing and proposed service-area boundaries for the tax-lot information requested below.

Township	Range	Section	¼ ¼	Tax Lot #	Plan Designation (e.g., Rural Residential/RR-5)	Water to be:			Proposed Land Use:
T11S	R20E	16	SW-NW	200		<input checked="" type="checkbox"/> Diverted	<input checked="" type="checkbox"/> Conveyed	<input type="checkbox"/> Used	Storage
T11S	R20E	16	E-NW	200		<input type="checkbox"/> Diverted	<input checked="" type="checkbox"/> Conveyed	<input type="checkbox"/> Used	Storage
T11S	R20E	9	SE-SW	200		<input type="checkbox"/> Diverted	<input checked="" type="checkbox"/> Conveyed	<input type="checkbox"/> Used	Storage
T11S	R20E	9	W-SE	200		<input type="checkbox"/> Diverted	<input checked="" type="checkbox"/> Conveyed	<input checked="" type="checkbox"/> Used	Storage

List all counties and cities where water is proposed to be diverted, conveyed, and/or used or developed:

Water is to be diverted from Bear Creek and into Long Reservoir, all of which are located in Wheeler County.

B. Description of Proposed Use

Type of application to be filed with the Water Resources Department:

- Permit to Use or Store Water
 Water Right Transfer
 Permit Amendment or Ground Water Registration Modification
 Limited Water Use License
 Allocation of Conserved Water
 Exchange of Water

Source of water: Reservoir/Pond
 Ground Water
 Surface Water (name) Bear Creek

Estimated quantity of water needed: Additional 97 Ac-Ft
 cubic feet per second
 gallons per minute
 acre-feet

Intended use of water: Irrigation
 Commercial
 Industrial
 Domestic for _____ household(s)
 Municipal
 Quasi-Municipal
 Instream
 Other Fish life, fire protection, wildlife, recreation

Briefly describe:

New storage permit application is being sought from the Oregon Water Resources Department to authorize an additional 97 acre-feet of storage in the existing Long Reservoir. Water will be diverted from Bear Creek and conveyed to Long Reservoir thru an existing diversion, fish screen with bypass, and buried pipeline.

Note to applicant: If the Land Use Information Form cannot be completed while you wait, please have a local government representative sign the receipt at the bottom of the next page and include it with the application filed with the Water Resources Department.

See bottom of Page 3. →

For Local Government Use Only

The following section must be completed by a planning official from each county and city listed unless the project will be located entirely within the city limits. In that case, only the city planning agency must complete this form. This deals only with the local land-use plan. Do not include approval for activities such as building or grading permits.

Please check the appropriate box below and provide the requested information

- Land uses to be served by the proposed water uses (including proposed construction) are allowed outright or are not regulated by your comprehensive plan. Cite applicable ordinance section(s): Not regulated
- Land uses to be served by the proposed water uses (including proposed construction) involve discretionary land-use approvals as listed in the table below. (Please attach documentation of applicable land-use approvals which have already been obtained. Record of Action/land-use decision and accompanying findings are sufficient.) **If approvals have been obtained but all appeal periods have not ended, check "Being pursued."**

Type of Land-Use Approval Needed (e.g., plan amendments, rezones, conditional-use permits, etc.)	Cite Most Significant, Applicable Plan Policies & Ordinance Section References	Land-Use Approval:	
		<input type="checkbox"/> Obtained <input type="checkbox"/> Denied	<input type="checkbox"/> Being Pursued <input type="checkbox"/> Not Being Pursued
		<input type="checkbox"/> Obtained <input type="checkbox"/> Denied	<input type="checkbox"/> Being Pursued <input type="checkbox"/> Not Being Pursued
		<input type="checkbox"/> Obtained <input type="checkbox"/> Denied	<input type="checkbox"/> Being Pursued <input type="checkbox"/> Not Being Pursued
		<input type="checkbox"/> Obtained <input type="checkbox"/> Denied	<input type="checkbox"/> Being Pursued <input type="checkbox"/> Not Being Pursued
		<input type="checkbox"/> Obtained <input type="checkbox"/> Denied	<input type="checkbox"/> Being Pursued <input type="checkbox"/> Not Being Pursued
		<input type="checkbox"/> Obtained <input type="checkbox"/> Denied	<input type="checkbox"/> Being Pursued <input type="checkbox"/> Not Being Pursued

Local governments are invited to express special land-use concerns or make recommendations to the Water Resources Department regarding this proposed use of water below, or on a separate sheet.

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SALEM, OR

Name: Rhonda Morrow Title: Planning Director
 Signature: [Signature] Phone: 541-763-2126 Date: 6/8/17
 Government Entity: Wheeler County

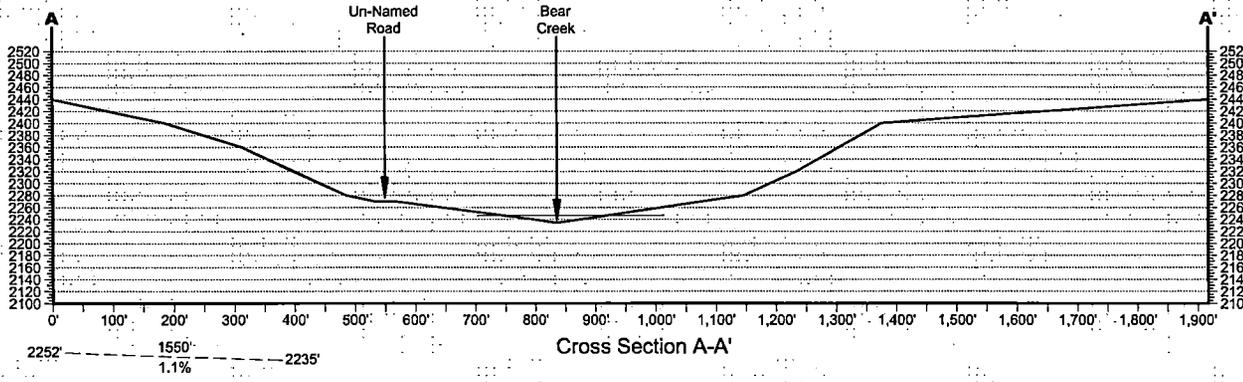
Note to local government representative: Please complete this form or sign the receipt below and return it to the applicant. If you sign the receipt, you will have 30 days from the Water Resources Department's notice date to return the completed Land Use Information Form or WRD may presume the land use associated with the proposed use of water is compatible with local comprehensive plans.

Receipt for Request for Land Use Information

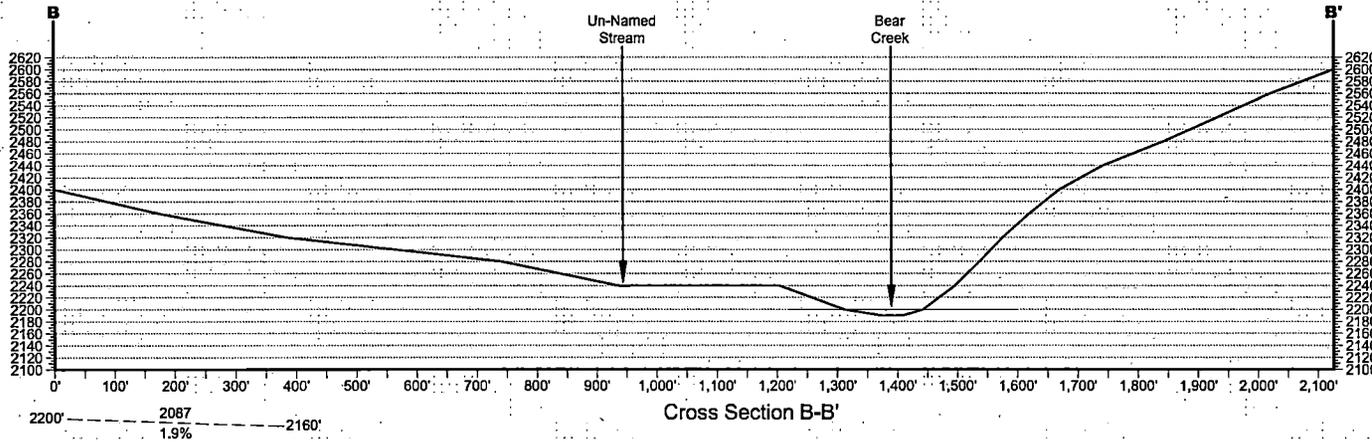
Applicant name: _____
 City or County: _____ Staff contact: _____
 Signature: _____ Phone: _____ Date: _____

R.00422

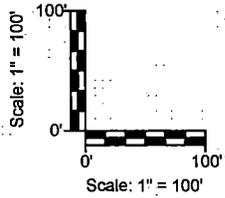
D:\1100\1179 Breach Analysis\101\Coad Water\1179\01_505_WtrStd_09_50_02/23/2016_SS



Hgt	Area	Dist
13'	1318.50	196.4
12'	1131.17	181.8
11'	958.25	167.3
10'	799.81	152.7
9'	655.69	138.2
8'	525.98	123.6
7'	410.67	109.1
6'	309.76	94.5
5'	223.25	80.0
4'	150.88	66.0



Hgt	Area	Dist
13'	1,251.1	147.4
12'	1,109.5	142.9
11'	971.9	138.3
10'	838.4	133.8
9'	711.6	124.0
8'	594.3	114.3



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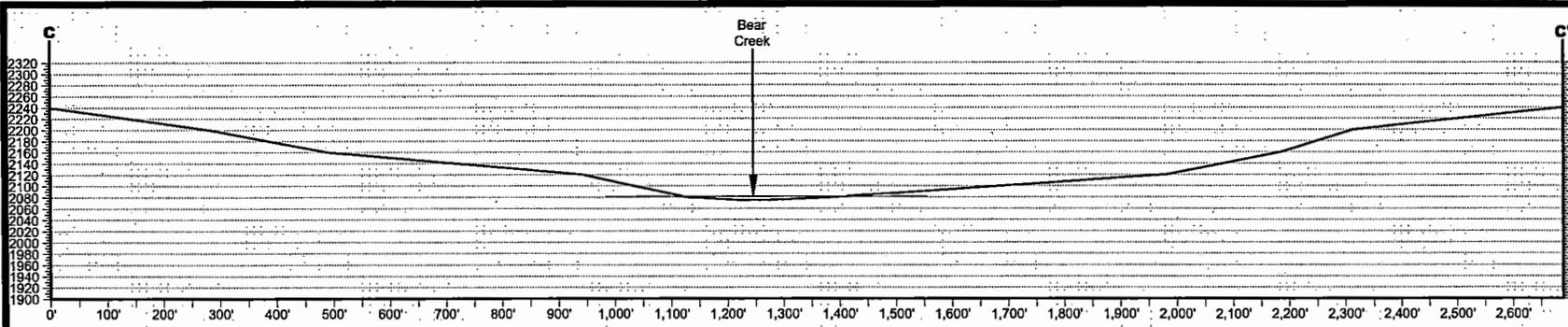


Cross Sections A-A' and B-B'
 Long Reservoir - Breach Analysis
 Wheeler County, Oregon

DESIGNED BY:	J. Bammon
DRAWN BY:	S. Schenck
DATE:	March 2016
PROJECT NO.:	1179-101
FIGURE:	5

R-08422

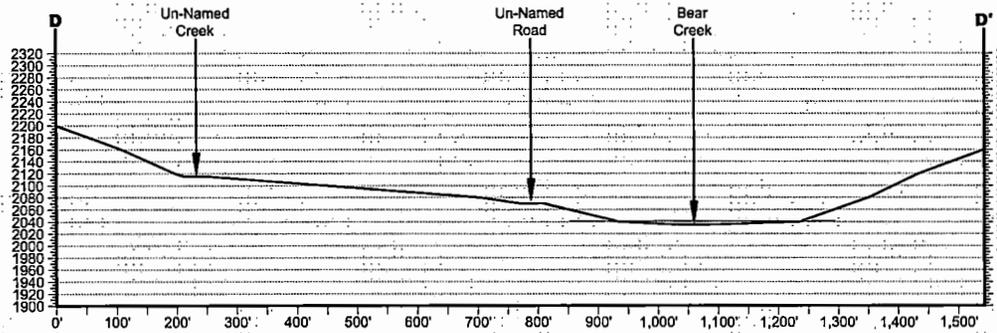
D:\1100A\179_Breach_Analysis\101_Cad\Work\51179101_S05_WrkShd_09:50_02/23/2016_SS



Cross Section C-C'

2085' --- 3985' --- 2014'
1.8%

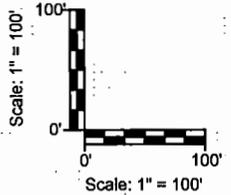
Hgt	Area	Dist
11'	2732.86	383.2
10'	2356.75	363.8
9'	2003.52	344.4
8'	1669.54	324.9
7'	1354.85	305.6
6'	1059.43	286.2
5'	783.29	266.7
4'	538.75	222.8



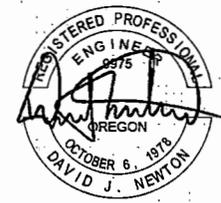
Cross Section D-D'

2013' --- 2090' --- 1979'
1.6%

Hgt	Area	Dist
11'	2760.79	343.1
10'	2423.16	335.6
9'	2092.68	328.2
8'	1769.37	320.7
7'	1453.22	313.3
6'	1144.24	305.8
5'	842.42	298.4
4'	570.14	246.5



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SALEM, OR



EXPIRES: 12/31/2016

Cross Sections C-C' and D-D'
Long Reservoir - Breach Analysis
Wheeler County, Oregon

NEWTON CONSULTANTS INC.
Earth, Water and Rock Specialists
PH: 541-504-9560 Fax: 541-504-9981

DESIGNED BY: J. Bannott	DRAWN BY: S. Schenck	DATE: March 2016	PROJECT NO.: 11179-101	FIGURE 6
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R-88422

DAM BREACH EVALUATION

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JUN 28 2017

SALEM, OR

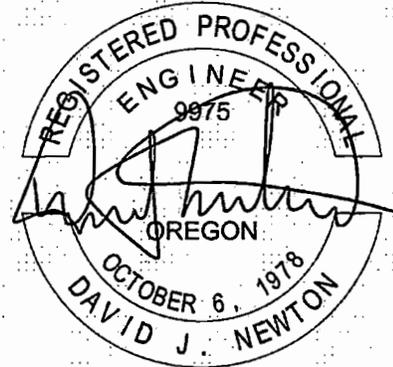
R-98422



Memorandum

Date:

To: Mr. Keith Mills, P.E.
Oregon Water Resources Department
Dam Safety Division
725 Summer Street, NE, Suite A
Salem, OR 97301



EXPIRES: 12/31/2016

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From: David Newton, P.E., C.E.G. **Project No.:** 1179-101

Subject: Dam Breach Evaluation **Project Name:** Breach Analysis

JUN 28 2017

SALEM, OR

INTRODUCTION

The characteristics of the dam surrounding the Long Reservoir (Reservoir) require that the Reservoir be evaluated for safety and potential damage due to breach failure. Downstream hazards must be identified and assessed for loss of life, property damage and other detrimental effects.

The hazard classification of the Reservoir to be determined by the Oregon Water Resources Department, Dam Safety Division (OWRD-DS) requires these considerations in the event of a breach of the dam and release of stored water into Bear Creek downstream of the Reservoir.

PURPOSE

This memorandum was prepared to present the results of a dam breach evaluation by Newton for use by the OWRD-DS in assigning the hazard classification to the Reservoir.

PROJECT LOCATION

The Reservoir is located 9.8 miles WNW of Mitchell, Oregon adjacent to Bear Creek. Along Bear Creek it is 4.5 miles SW (upstream) from the confluence of Bridge Creek. The Reservoir location is in the NW of the SE of Section 9, T 11 S, R 20 E, W.M. The location of the Reservoir, Bear Creek and Mitchell, OR are shown on the Figure 1.

MAN-MADE STRUCTURES DOWNSTREAM OF THE RESERVOIR

Man-Made Structures – Bear Creek Downstream of Reservoir

Observations for the presence of man-made structures downstream of the Reservoir were conducted by review of Google Earth satellite imagery (imagery date August 17, 2014) and U.S.

Geological Survey (U.S.G.S.) Quadrangle maps (Lawson Mountain 20140815 and Painted Hills 20140725). Man-made building structures were not observed in the immediate Bear Creek drainage feature downstream of the Reservoir. However, man-made structures are visible downstream. At 3.3 miles along the creek there is a storage structure elevated 40 feet above the drainage and at 3.9 miles along the creek there is a house with storage structures very near to the creek as seen in Figure 2. In Figure 3, dirt roads can be seen which cross the creek or come very near to it. Figures 3 and 4 show the conditions in the Bear Creek drainage downstream from the Reservoir as reflected by the imagery and maps.

Dwellings for Living/Shelter Purposes – Bear Creek Downstream of Reservoir

A dwelling for human living and shelter purposes was observed during the review of satellite imagery at 3.9 miles downstream on Bear Creek. At this distance, considering the topography and creek channel characteristics, this site does not appear to be in danger as a result of breach failure of this dam. Possible structures for animal shelter were also observed near that location. Dwellings or other building structures are not shown on the reviewed U.S.G.S. maps.

Man-Made Structures Summary – Bear Creek Downstream of Reservoir

The observations for man-made structures in the Bear Creek drainage downstream of the Reservoir revealed no structures for the purpose of human occupancy, living or shelter in immediate proximity to the dam. There are two unpaved, dirt roads (Figure 3) which only service local, occasional traffic and the rest of the visible items are safely removed from the flood impact area.

BREACH ANALYSIS APPROACH

The Reservoir site is remote in terms of human population, access and concentration. Entrance to the property is impeded by a locked gate. Occasional human presence in the area below the Reservoir is possible via unnamed unpaved dirt roads. No structures for human inhabitation were observed immediately downstream of the Reservoir in the Bear Creek drainage.

Based on the existing conditions downstream of the Reservoir, the breach analysis was conducted in a “simplistic” manner. The analysis was conducted by use of U.S.G.S. topographic information relative to the Bear Creek watershed and calculation of flow velocities and depths based on the Manning equation and Manning coefficients for the floodway. The analysis also included consideration of dam breach case histories summarized in the Journal of Dam Safety, Volume 13, Issue 2, 2015 (Feinberg, Engemoen, Fiedler, Osmun) and Bureau of Reclamation’s RCEM – Reclamation Consequence Estimating Methodology. These case histories provide information relative to the time frame for actual breach events to fully drain the reservoir. An empirical model was used to verify the legitimacy of a breach time estimate and peak flow.

BEAR CREEK DRAINAGE – TOPOGRAPHIC CONDITIONS RELATIVE TO HAZARD POTENTIAL

Topography of the Bear Creek drainage was evaluated by use of U.S.G.S. quadrangle maps. Google Earth imagery was used as an approximate cross-check on elevation difference and distance. Topographic evaluation focused on areas where topographic variations in the drainage result in a narrowing of the creek floodway. These locations constrain flood flows to narrower

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channels which can result in increased flow depths and increased velocities. Cross sections were also chosen for investigation of attenuating features in the drainage, such as wide, flat sections with long reaches and low slope.

Cross-sections were prepared for four sites which are shown on attached Figures 5 and 6. Wetted perimeter (P_w), cross-sectional flow area (A) and water depth (Y) were determined for each of the cross-sections. These measurements were used as inputs to the breach analysis.

ANALYSIS

Breach Flow Condition

The breach analysis was conducted on the basis of a steady flow condition. Although a peak wave is the most probable condition with a wave magnitude dependent on the time over which a dam breach and reservoir release occurs, this simplified approach intends to illustrate a flow rate which will likely endure for a significantly longer period of time. Considering the unmeasurable population at risk (PAR) downstream, which is considered to be zero, along with the absence of habitable structures and recreational sites, this investigation does not require a highly rigorous approach.

Time Span for Full Reservoir Drawdown

Hydrologic conditions that develop to the point of dam breach failure occur over some time span which can lead to an overtopping event. When a dam is overtopped, flow over the crest and down the downstream embankment slope can erode the embankment, opening a cut which then grows into a larger breach over time. Considering cross-sectional dimensions, length and configuration of dam, it is conceivable that a breach which could drain the entire reservoir could occur over a period of 10 minutes or more. The time period for complete drawdown of the Reservoir was estimated by considering the BOR case history information and calculations using the Froehlich 2008 Method.

Based on the case history information, empirical model and the probable hydrologic failure mode, the calculation for the resulting drawdown flow was based on a 10 minute interval of time. This is considered conservative in an effort to produce the "worst case" breach failure of the Reservoir dam and takes into consideration the length and configuration of the dam. For reference, the Froehlich 2008 Method estimated the breach time at roughly 21 minutes.

Hydraulic Analysis Parameters

Cross-sections were developed for each noteworthy section along Bear Creek. For each section, the cross-section was divided into horizontal segments of one foot vertical increments.

Corresponding wetted perimeters and cross-sectional areas were calculated for each segment and slopes measured through the section profile. Finally, the hydraulic radius was calculated for each cross-sectional area with increasing elevation of the water surface using AutoCAD-created profiles from U.S.G.S. topography. Satellite imagery along with site knowledge provided terrain characteristics useful in determining Manning coefficients.

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Hydraulic Calculations

The flow rate exiting the Reservoir was calculated from the estimated drawdown time and maximum possible volume of stored water in the Reservoir. It was estimated at 12,100 cfs based on a 10 minute drawdown time with the Reservoir filled to the top of dam. The Reservoir is estimated to contain 167 ac-ft when filled to the top of the dam.

The velocity of flow for the various flood water elevations at the sections was calculated with the Manning equation. This velocity was then compared to the estimated steady flow rate based on draw down time (10 min) and the cross sectional area required to convey that flow. This 'required area' was graphically compared to the 'measured area' and a solution for each estimated flowrate was determined. This solution for cross sectional area provides the necessary information to estimate inundation depths.

The Froehlich 2008 method uses empirical data to estimate breach formation time and peak flow resulting from a failure mode and dam characteristics such as height and width. Using the proposed dimensions and storage possibilities of the Reservoir's dam, the results for drawdown time were estimated. At a three feet deep overtopping event, a breach failure peak flow was estimated at 8,440 cfs. This flow value is 30% less than the 10 minute draw down time flow estimate (12,100 cfs) and is considered to be a conservative, yet realistic estimate of a failure for this dam. For the purposes of this investigation, the 10 minute drawdown time remained the chosen event for flowrate estimation. Considering the length of the dam in relation to storage volume, this is a reasonable and still highly conservative choice.

Table 1 below shows inundations characteristics for each cross-section location. Values given for each are as follows:

y= depth of inundation from creek bed (ft).

V= velocity of flow in that cross section (ft/s).

D= distance from reservoir downstream (miles).

A		B	
10.6	V	14.0	V
12.1	y	10.1	y
0.13	D	0.81	D

C		D	
10.2	V	9.6	V
6.5	y	6.4	y
2.14	D	2.56	D

Table 1: Results at cross sections.

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CONCLUSIONS

None of the sections are considered high risk or pose a severe threat to inhabitants of structures or structures themselves. Humans or other animals in the flood path could be in danger if they are unaware of the incoming wave. The depths and velocities during this worst case scenario would be hazardous if one were within 100 feet of Bear Creek. The maximum velocity of the water will be less than 14 ft/s (10 mph) which offers ample notice to vacate the immediate area.

Considering the features of this flood zone, it most likely that this wave event will attenuate very quickly in the first two miles and is estimated to be reduced about 40% within 3 miles of the dam due to floodway storage effects. To illustrate this, a section similar to Section D will experience reduced flows and inundation estimated by:

Attenuation Example	
7.8 ft/s	V
5.2 ft	y
3 miles	D

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