CITY of CASCADE LOCKS
AGENDA

CITY COUNCIL MEETING, Monday, July 27, 2015, 7:00 PM, CITY HALL

Purpose: The City Council meets on the 2nd and 4th Mondays of each month to conduct city business.

1. **Call to Order/Pledge of Allegiance/Roll Call.**
2. **Additions or amendments to the Agenda.** (The Mayor may add items to the agenda after it is printed and distributed only when required by business necessity and only after an explanation has been given. The addition of agenda items after the agenda has been printed is otherwise discouraged.)
3. **Adoption of Consent Agenda.** (Consent Agenda may be approved in its entirety in a single motion. Items are considered to be routine. Any Councilor may make a motion to remove any item from the Consent Agenda for individual discussion.)
   - a. **Approval of June 22, 2015 Minutes.**
   - b. **Approval of June 25, 2015 Town Hall Minutes.**
   - c. **Approval of CH2M Contract to Operate the Wastewater Treatment Plant.**
   - d. **Approval of Mid-Columbia Home Repair Program IGA.**
   - e. **Approval of Mid-Columbia Community Action Heating Assistance.**
   - f. **Approval of CGRA Tourism Grant.**
   - g. **Ratification of the Bills in the Amount of $249,928.69.**
4. **Public Hearings.**
5. **Action Items:**
   - a. **Appointment to Committees.**
   - b. **Appointment to City Council for Vacant Position.**
   - c. **Approve Ordinance No. 439 Regulating the Operation of Marijuana Facilities.**
   - d. **Approve Aquifer Study.**
   - e. **Approve Fire Captain Leave of Absence.**
   - f. **Approve Res. 1334 for SCA Grant for Forest Lane.**
6. **Appearance of Interested Citizens to Share a Variety of Perspectives on Issues Facing Our Community.** (Comments on matters not on the agenda or previously discussed.)
7. **Reports and Presentations.**
   - a. **City Committees.**
   - b. **City Administrator Zimmerman Report.**
8. **Mayor and City Council Comments.**
9. **Other matters.**
10. **Executive Session per ORS 192.660 (2) (i) Performance Evaluations of Public Officers and Employees.**
11. **Adjournment.**

The meeting location is accessible to persons with disabilities. A request for an interpreter for the hearing impaired, or for other accommodations for person with disabilities, should be made at least 48 hours in advance of the meeting by contacting the City of Cascade Locks office at 541-374-8484.

1. **Call to Order/Pledge of Allegiance/Roll Call.** Mayor Cramblett called the meeting to order at 7:00 PM. CM's Groves, Fitzpatrick, Randall, Busdieker, Helfrich and Mayor Cramblett were present. CM Walker was excused. Also present were City Administrator Gordon Zimmerman, City Recorder Kathy Woosley, Finance Officer Marianne Bump, Station Captain Jesse Metheny, Kathy Tittle, Dave Palais, Aurora delVal, Katelin Stuart, Caroline Park, Jackson Vanderpool, and Camera Operator Betty Rush.

2. **Additions or amendments to the Agenda.** Mayor Cramblett said he would move to **Other Matters.** CM Helfrich said he is no longer a resident of Cascade Locks and resigned from Council. He said it has been an honor and pleasure serving the citizens of this community. He said whether opinions differed the decisions were made for the benefit of the community. He said there are economic opportunities before the Council, whether they are small companies or large, push forward and be positive. Jeff said he respects each and every Councilor for what they believe in and what they do. He said the ways to get to the decisions may have been different but in the end the decisions were made. Jeff said the staff does an incredible job for the City.

   Mayor Cramblett presented Jeff with a certificate of appreciation. He said he appreciated Jeff and his volunteer effort that he has given to the City.

3. **Adoption of Consent Agenda.**
   a. **Approval of May 21, 2015 Joint City/Port Minutes.**
   b. **Approval of June 8, 2015 Minutes.**
   c. **Ratification of the Bills in the Amount of $69,213.66.**
   d. **Approval of Emergency Reporting Contract.**

   Mayor Cramblett read the list of items on the Consent Agenda. **Motion:** CM Randall moved, seconded by CM Groves, to approve the Consent Agenda. The motion passed unanimously by CM's Groves, Fitzpatrick, Randall, Busdieker, and Mayor Cramblett.

4. **Public Hearings.** None.

5. **Action Items:**

   a. **Appointment to Committees.** Mayor Cramblett appointed Joel Koch to the Tourism Committee and the Architectural Committee. There was consensus of Council.

   b. **Approve Res. No. 1333 Year End Adjustments.** CA Zimmerman explained that the budget is a forecast and was a little off. This resolution makes the necessary adjustments. CM Busdieker asked for the three accounts in the Emergency Service Funds and the accounts in the Sewer Fund Personnel Services. FO Bump said EMS Funds were equipment and vehicle maintenance, intern scholarship, and building maintenance. She said the Sewer Fund was Field Supervisor and Utility Worker 1. **Motion:** CM Busdieker moved, seconded by CM Fitzpatrick, to approve Resolution No. 1333. The motion passed unanimously by CM's Groves, Randall, Fitzpatrick, Busdieker, and Mayor Cramblett.

   c. **Approval of Hood River County Library District Lease Agreement.** CA Zimmerman explained that the Library still plans to move to the school building but they are waiting on funding. He said this just continues the agreement they have with the City until they vacate the space. **Motion:** CM Randall moved, seconded by CM Busdieker, to approve the Hood River

County Library District Lease Agreement. The motion passed unanimously by CM's Groves, Randall, Fitzpatrick, Busdieker, and Mayor Cramblett.

d. Approve Municipal Judge Agreement. <u>Motion</u>: CM Fitzpatrick moved, seconded by CM Randall, to approve the Municipal Judge Agreement. The motion passed unanimously by CM's Groves, Randall, Fitzpatrick, Busdieker, and Mayor Cramblett.

e. Approve First Amendment to City of Springfield Intergovernmental Agreement. SC Metheny said the fee for billing has gone from $38.00 to $40.00 per bill. Kathy Tittle, from the audience, asked if this was per time billed. SC Metheny and CA Zimmerman explained it was a fee to bill per incident. **<u>Motion</u>**: CM Fitzpatrick moved, seconded by CM Randall, to renew the contract with the City of Springfield.

CM Busdieker asked why there is an option listed to search elsewhere. SC Metheny said for due diligence. CA Zimmerman said the City of Springfield bills for most cities in Oregon. The motion passed unanimously by CM's Groves, Randall, Fitzpatrick, Busdieker, and Mayor Cramblett.

f. Command Vehicle Options. CA Zimmerman said staff is looking for Council direction and specific guidelines. He said if Council would give an allowable amount then staff could seek a vehicle and negotiate. Mayor Cramblett asked if the $20,000 mentioned in the staff report is a good number. SC Metheny said he would look at service vehicles with quite a bit of service life left and already equipped. He said $20,000 looks like they could get a vehicle with some life left in it for that much money. CA Zimmerman said staff would be looking for a financing package to get the monthly payments down. CM Fitzpatrick asked how much mileage reimbursement is being paid to him per month. SC Metheny said $300 - $400 per month. He said there is also a liability risk to the City with him driving his personal vehicle.

CM Busdieker asked how many miles would the City likely get out of one of the vehicles shown in the staff report. SC Metheny said the mileage rates here in the City are fairly low. He explained that most cities will surplus their vehicles at 150,000 miles. CM Busdieker asked if the service life would run out before it was paid off if we were to purchase the 2010 Tahoe. SC Metheny said the City would probably have eight to ten years of useful life out of that vehicle.

CM Busdieker asked if a vehicle was purchased from Alabama how would he determine that the engine would be good. SC Metheny said the City would hire an independent evaluator. CM Busdieker said there would also be a charge to get the vehicle here. CM Groves said there has to be some vehicles locally. SC Metheny said he included these examples as these are large companies. He said that he would look locally and negotiate below sticker price on the vehicle.

CM Groves asked if everything would be set up for the vehicle. SC Metheny said the vehicles wouldn't include everything. He said most agencies pull their radio equipment and lighting. CM Groves asked if we already have the lighting. SC Metheny said we have some lighting and there are standards that have to be met for lighting. CM Groves said her experience has been that paint, logos, etc. has to be added so then the price is goes beyond what was approved. She said she considers the $20,000 to include everything. CM Groves said she didn't think the City needed a command vehicle.

SC Metheny said he has spent months searching for low cost options from other agencies and there wasn't anything available. CM Groves asked if the command vehicle would be housed at the fire station or would it be his personal vehicle. SC Metheny said it would not be his personal vehicle. He said they have run a program where the vehicle would be with the duty officer. He said they may try a different program where the vehicle would stay at the fire station and be equipped with rescue equipment. He said the command vehicle goes out with most ambulance calls and has the lowest cost impact.

CM Groves asked if the City has two fire engines and two ambulances. SC Metheny said one structure fire engine and two ambulances. CM Groves asked how often those vehicles are used. SC Metheny said in the last two weeks the ambulances have been out about five times with the second ambulance only one time. He said there are many factors considered when sending out vehicles. CM Groves said we are a small community and we have asked citizens to help fund this department and now we want to buy a vehicle. CM Groves asked how many volunteers there were. SC Metheny said there are ten volunteers with six or seven being very active.

Katelin Stuart, from the audience, said this has been argued several times over the last few years. She said it was decided that we wanted the fire department so we should fund them the way they need to be funded. She said, as a citizen, she is tired of them purchasing second grade items and later having to throw more money at it. She said we are nickel and diming them to death. She said to fund them the way they need to be funded.

Mayor Cramblett said the City came in to this knowing that they would have to operate on a bare bones budget. Katelin said there are other ways to fund this. She said if we're going to do this we need to do it right.

CM Randall said there are a lot of good thoughts about how all this should play out. He said he agrees with some of the comments. He said he is also tired of throwing good money after bad. He said he thought the general consensus of Council was to get a command vehicle. He said the vehicle should be a good value for the money.

Motion: CM Fitzpatrick moved, seconded by CM Randall, to empower SC Metheny and CA Zimmerman to make a deal on a command vehicle that will fit the needs of the City to include parameters listed in the staff report (Option 1) not to exceed $25,000. The motion passed unanimously by CM's Groves, Randall, Fitzpatrick, Busdieker, and Mayor Cramblett.

CA Zimmerman said SC Metheny just passed his practical skills test and SC Metheny said he would be testing more tomorrow.

g. **First Reading of Ordinance No. 439 (marijuana sales).** Aurora delVal said she was disturbed by the discussion at the last Council meeting and wondered how Nestlé could be promoted for economic development and this not be considered for economic development. She said she was here to ask Council to make an informed decision and not a moralistic or arbitrary one. She asked why Council would turn away an opportunity for increased tax revenue. Aurora said she thought the market would be customers off of the Pacific Crest Trail. She said we have a liquor store right in the middle of town that also sells cigarettes. She said anyone suffering chronic pain would be a customer. She asked Council to consider who would be using this.

Aurora said she was confused about the acceptable locations. She said placing on the outskirts of town to limit minor access seemed strange. She said she went to a dispensary in Hood River and it was pretty low key. She said marijuana is going to be legal pretty soon and the City could make some money on this. She said she is concerned with safety and how this would affect customers on the outskirts of town. She said it would make more since to have this type of business in town in order to keep an eye on it.

Aurora submitted an article from The New York Times comparing alcohol to marijuana (Exhibit A).

Jackson Vanderpool said he was the one to bring up the question on dispensaries. He wanted to know the possibility of future business. He said he is concerned with such a quick decision from Council as to the direction they wanted to go. He said he brought this up a month ago and almost instantaneously there is an Ordinance drawn up that is going to eliminate the downtown corridor and completely eliminate the industrial property also. He said the industrial park has the bike trail and disc golf course. He said the Council is taking a viable tax based business and not even going to consider it. Jackson said the Measure passed in this County by a majority of the voters.

Jackson said safety might be more of an issue when located outside of the downtown area. He said he would feel like a second class citizen by being forced to go out of town. He said the State of Oregon isn't even going to start accepting applications until January and think this is an injustice for the Council to go above and beyond what the State is doing.

CA Zimmerman gave the first reading of Ordinance No. 439.

CM Busdieker said Jackson said everything she planned to say. CM Fitzpatrick said he wished the voters would have given this another five years to see what was going to happen with labs across the river. He said people can get marijuana wherever they want and it doesn't mean people aren't going to smoke it.

Mayor Cramblett said most cities are taking the same approach and following some of the guidelines of the State of Oregon. He explained that any resolution or ordinance can be changed. He said the Council is treading lightly. He said property on Herman Creek Lane would fit the criteria. Mayor Cramblett said you can grow your own for medical purposes.

Aurora said she is a hospice volunteer and works with someone who is in a lot of pain. She said this patient would not be in any shape to get this on her own. She said this is a business opportunity and doesn't understand shutting the door on this type of business.

Katelin said she didn't understand the immediate need to put an ordinance in place. Mayor Cramblett explained that the State of Oregon requires cities to have something in place. Jackson said the State of Oregon will not accept applications until January 1, 2016. He asked why the Council wouldn't wait to see what the State of Oregon's regulations are going to be. He said Council could regulate more than the State but why not wait to see what those regulations are.

CM Busdieker asked how the Council could possibly think that banning from almost everywhere in town is treading lightly. She said the Measure passed 55% to 45% and this is what the people said they want. Mayor Cramblett said Council's job is the how, when and where to locate dispensaries.

Motion: CM Fitzpatrick moved, seconded by CM Groves, to approve Ordinance No. 439 regulating the operation of marijuana facilities. The second reading and vote will take place at the next meeting.

h. **Approve Tourism Committee Support Contract.** CM Busdieker said she would be recusing herself from this item. CA Zimmerman said the Tourism Committee has selected Sofia Urrutia-Lopez for the contract support for the Tourism Committee. **Motion**: CM Groves moved, seconded by CM Fitzpatrick, to approve the contracted vendor program to support the Tourism Committee operations.

Caroline Park said the Tourism Committee voted for Sofia for the position. She said Deanna has done a lot of work for the Committee and thanked her. The motion passed with CM's Groves, Randall, Fitzpatrick, and Mayor Cramblett voting in favor.

i. **Determine Process for City Administrator Evaluation.** CA Zimmerman said the evaluation form in the packet is what has been used in the past. He said Council could choose another one or develop another one. He said if this is the process chosen then they would need to complete the forms, turn them in to CR Woosley or FO Bump. He said the evaluations would be forwarded to the City Attorney. CM Busdieker asked for a copy of the job description.

6. **Appearance of Interested Citizens to Share a Variety of Perspectives on Issues Facing Our Community.** Kathy Tittle said Hood River County will be holding a drought declaration meeting this Wednesday and asked if any Councilors would be attending that meeting. She said if and when Hood River County is declared a drought emergency would the City ask to not be included. Kathy asked if there would be scientific water mapping to prove the City is not low on water and done by an independent researcher.

Dave Palais distributed a copy of a Technical Memorandum with information that Councilor Busdieker had requested (Exhibit B). He said this document and additional data tables will be posted to the Nestlé Project website.

Katelin said she attended a meeting in the very beginning where citizens were assured that Cascade Locks would protect itself, due diligence, independent data, no trucks down Forest Lane. She said she isn't seeing any of that. She suggested due diligence is not having Nestlé suggest the facilitator and not paying for hydrogeology studies that we need. She said we are supposed to be independent, the pioneer spirit, and protecting our citizens. She said the people elected to Council are doing what they want. Katelin said she doesn't see any protection. She asked if anyone is paying attention that this is a drought year. She said the tests should be run now and not when there is plenty of water. Katelin reported that a rain gage is not in Cascade Locks but at Bonneville. She said Cascade Locks data is not being tracked. Katelin said she is disappointed as she thought she was trusting people that were independent, who could think for themselves, and look through the data. She said she is just hearing, "This is going to happen." She said this is not what I call representing the people and protecting ourselves. She said shoving a town hall on the end of another thing doesn't count. Katelin said we need to talk to people and among ourselves and decide what is best for us as a community. She reminded Council that they were elected to represent the citizens.

CM Busdieker said the original facilitator was suggested by the attorneys contracted to represent the Nestlé issues.

Caroline Park said she was trying to understand where everyone is coming from and hears contradictions regarding the marijuana issues. She said the Council is preemptively making decisions to protecting the community from this industry and its products.

Caroline said she attended a Port Commission meeting recently and asked the Commission how we were going to protect ourselves from not getting taken advantage of. She asked the Council how we were going to protect ourselves. She said Nestlé does not have a good reputation. She said she has a business here and wants to be on the main street. She said she doesn't want to be on the main street if there are tons of trucks coming through on a daily basis. Caroline hoped the Council would consider and address how the community will not get taken advantage of.

7. Reports and Presentations.

a. City Committees.

b. City Administrator Zimmerman Report. CA Zimmerman gave his report (Exhibit C). He asked Council if the City would grant approval for a temporary liquor license for Cascade Locks Ale House. There was consensus of Council. CA Zimmerman said there was a request for a waiver of the noise ordinance to allow music to 11:00 PM at the Scot Sullenger residence. CM Busdieker said she thought the neighbors should be notified. Mayor Cramblett said there will be a lot of noise all around on the 4th of July. CM Randall said he thought the ordinance stated that the neighbors would have to be notified. CA Zimmerman said there is nothing in the ordinance to that effect. Council directed CA Zimmerman to notify Sullengers to have them inform neighbors.

8. Mayor and City Council Comments. CM Busdieker thanked Katelin for reminding everyone of the drought meeting on Wednesday. CM Busdieker said she wanted to inform the citizens as to how the facilitator was changed for the upcoming Town Hall. She said the original person chosen to facilitate was a public relations guy and that means that this would be used to rewrite the fact sheet in Nestlé's favor. She said the facilitator was not a mediator to create a real conversation. She said he is known for his method of marginalizing critics and he worked for those who are primarily funded by Nestlé. CM Busdieker said there is no way that he could be considered independent.

CM Busdieker thanked all the citizens that jumped on this and got City Hall to drop him within 24 hours. She said when she received her council packet she noticed that he was in attendance at the Nestlé negotiating team meeting. She said this was another concrete indication that there was no way that he could have been independent on this issue. She said the City had no business recommending him in the first place.

CM Busdieker reported crime was down 10% in Colorado.

CM Fitzpatrick thanked Jeff Helfrich for his time and dedication while on the Council. He said they started in different places but admired the position that he took and then came together for the benefit of the citizens. He said he would miss working with him. CM Fitzpatrick congratulated staff on the work being done on the shop.

CM Randall congratulated SC Metheny for finishing the paramedic training. He said this takes a lot of dedication to see it through especially with a family. He said he hopes SC Metheny stays with the City for many years.

CM Groves thanked Jeff Helfrich for his dedication to the City. She said Jeff gave her all the encouragement when she decided to join Council and knew that she and Jeff would be able to work together. She said she appreciated him.

Mayor Cramblett said when volunteering you are putting in a lot of time. He said there have been meetings that last until midnight. He said Jeff has been through this. He said he has a brand new family and appreciates him and his family for giving of his time.

Mayor Cramblett thanked SC Metheny for doing such a good job and thanked Council for providing for these programs.

Mayor Cramblett said it should be easy for the City to track how the aquifer is holding up. He said tests were done on recovery time when well water was pulled down and run for 24 hours straight. He said droughts come and go and a lot of water in Cascade Locks comes from rain fall. He said he remembers when water was restricted to low levels in the reservoir.

Mayor Cramblett reminded everyone of Sternwheeler Days this weekend.

CA Zimmerman asked Council how the Council wanted to proceed with the vacancy. Council decided to advertise asking for applications.

9. **Other matters.**

10. **Executive Session as may be required**. None.

11. **Adjournment. <u>Motion</u>:** CM Busdieker moved, seconded by CM Randall, to adjourn. The motion passed unanimously by CM's Groves, Randall, Fitzpatrick, Busdieker, and Mayor Cramblett. The meeting was adjourned at 8:45 PM.

Prepared by
Kathy Woosley, City Recorder

APPROVED:

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Tom Cramblett, Mayor

The New York Times | http://nyti.ms/1DrncgC

Edited by David Leonhardt

The Upshot
THE NEW HEALTH CARE

Alcohol or Marijuana? A Pediatrician Faces the Question

MARCH 16, 2015

Aaron E. Carroll

As my children, and my friends' children, are getting older, a question that comes up again and again from friends is this: Which would I rather my children use — alcohol or marijuana?

The immediate answer, of course, is "neither." But no parent accepts that. It's assumed, and not incorrectly, that the vast majority of adolescents will try one or the other, especially when they go to college. So they press me further.

The easy answer is to demonize marijuana. It's illegal, after all. Moreover, its potential downsides are well known. Scans show that marijuana use is associated with potential changes in the brain. It's associated with increases in the risk of psychosis. It may be associated with changes in lung function or long-term cancer risk, even though a growing body of evidence says that seems unlikely. It can harm memory, it's associated with lower academic achievement, and its use is linked to less success later in life.

But these are all associations, not known causal pathways. It may be, for instance, that people predisposed to

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psychosis are more likely to use pot. We don't know. Moreover, all of these potential dangers seem scary only when viewed in isolation. Put them next to alcohol, and everything looks different.

Because marijuana is illegal, the first thing I think about before answering is crime. In many states, being caught with marijuana is much worse than being caught with alcohol while underage. But ignoring the relationship between alcohol and crime is a big mistake. The National Council on Alcoholism and Drug Dependence reports that alcohol use is a factor in 40 percent of all violent crimes in the United States, including 37 percent of rapes and 27 percent of aggravated assaults.

No such association has been found among marijuana users. Although there are studies that can link marijuana to crime, it's almost all centered on its illegal distribution. People who are high are not committing violence.

People will argue that casual use isn't the issue; it's abuse that's worrisome for crime. They're right — but for alcohol. A recent study in Pediatrics investigated the factors associated with death in delinquent youth. Researchers found that about 19 percent of delinquent males and 11 percent of delinquent females had an alcohol use disorder. Further, they found that even five years after detention, those with an alcohol use disorder had a 4.7 times greater risk of death from external causes, like homicide, than those without an alcohol disorder.

When I'm debating my answer, I think about health as well. Once again, there's no comparison. Binge drinking accounted for about half of the more than 80,000 alcohol-related deaths in the United States in 2010, according to a 2012 report by the Centers for Disease Control and Prevention. The economic costs associated with excessive alcohol consumption in the United States were estimated to be about $225 billion. Binge drinking, defined as four or more drinks for women and five or more drinks for men on a single occasion, isn't rare either. More than 17 percent of all people in the United States are binge drinkers, and more than 28 percent of people age 18 to 24.

Binge drinking is more common among people with a household income of at least $75,000. This is a solid middle-class problem.

Marijuana, on the other hand, kills almost no one. The number of deaths attributed to marijuana use is pretty much zero. A study that tracked more than 45,000 Swedes for 15 years found no increase in mortality in those who used marijuana, after controlling for other factors. Another study published in the American Journal of Public Health followed more than 65,000 people in the United States and found that marijuana use had no effect at all on mortality in healthy men and women.

I think about which is more dangerous when driving. A 2013 case-control study found that marijuana use increased the odds of being in a fatal crash by 83 percent. But adding alcohol to drug use increased the odds of a fatal crash by more than 2,200 percent. A more recent study found that, after controlling for various factors, a detectable amount of THC, the active ingredient in pot, in the blood did not increase the risk of accidents at all. Having a blood alcohol level of at least 0.05 percent, though, increased the odds of being in a crash by 575 percent.

I think about which substance might put young people at risk for being hurt by others. That's where things become even more stark. In 1995 alone, college students reported more than 460,000 alcohol-related incidents of violence in the United States. A 2011 prospective study found that mental and physical dating abuse were more common on drinking days among college students. On the other hand, a 2014 study looking at marijuana use and intimate partner violence in the first nine years of marriage found that those who used marijuana had lower rates of such violence. Indeed, the men who used marijuana the most were the least likely to commit violence against a partner.

Most people come out of college not dependent on the substances they experimented with there. But some do. So I also consider which of the two might lead to abuse. Even there, alcohol fares poorly compared with marijuana. While 9 percent of pot users eventually become dependent, more than 20 percent of alcohol users do.

An often-quoted, although hotly debated, study in the Lancet ranked many drugs according to their harm score, both to users and to others. Alcohol was clearly in the lead. One could make a case, though, that heroin, crack cocaine and methamphetamine would be worse if they were legal and more commonly used. But it's hard to see how pot could overtake alcohol even if it were universally legal. Use of marijuana is not rare, even now when it's widely illegal to buy and use. It's estimated that almost half of Americans age 18 to 20 have tried it at some point in their lives; more than a third of them have used it in the last year.

I also can't ignore what I've seen as a pediatrician. I've seen young people brought to the emergency room because they've consumed too much alcohol and become poisoned. That happens thousands of times a year. Some even die.

And when my oldest child heads off to college in the not-too-distant future, this is what I will think of: Every year more than 1,800 college students die from alcohol-related accidents. About 600,000 are injured while under alcohol's influence, almost 700,000 are assaulted, and almost 100,000 are sexually assaulted. About 400,000 have unprotected sex, and 100,000 are too drunk to know if they consented. The numbers for pot aren't even in the same league.

I'm a pediatrician, as well as a parent. I can, I suppose, demand that my children, and those I care for in a clinic, never engage in risky behavior. But that doesn't work. Many will still engage in sexual activity, for instance, no matter how much I preach about the risk of a sexually transmitted infection or pregnancy. Because of that, I have conversations about how to minimize risk by making informed choices. While no sex is preferable to unprotected sex, so is sex with a condom. Talking about the harm reduction from condom use doesn't mean I'm telling them to have sex.

Similarly, none of these arguments I've presented are "pro pot" in the sense that I'm saying that adolescents should go use marijuana without worrying about consequences. There's little question that marijuana carries with it risks to people who use it, as well as to the nation. The number of people who will be hurt from it, will hurt others because of it, begin to abuse it, and suffer negative consequences from it are certainly greater than zero. But looking only at those dangers, and refusing to grapple with them in the context of our society's implicit consent for alcohol use in young adults, is irrational.

When someone asks me whether I'd rather my children use pot or alcohol, after sifting through all the studies and all the data, I still say "neither." Usually, I say it more than once. But if I'm forced to make a choice, the answer is "marijuana."

Aaron E. Carroll is a professor of pediatrics at Indiana University School of Medicine. He blogs on health research and policy at The Incidental Economist, and you can follow him on Twitter at @aaronecarroll.

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PACIFIC groundwater GROUP

Technical Memorandum

To: Dave Palais, Nestlé Waters North America

From: Dan Matlock, Pacific Groundwater Group

Re: Hydrogeologic Data and Information Used to Develop the *Hydrogeology and Water Resources of Cascade Locks, Oxbow Springs, and the Lower Herman Creek Basin* November 2010 Town Hall Presentation

Date: June 19, 2015

As requested, this memorandum presents data and technical information used to prepare the *Hydrogeology and Water Resources of Cascade Locks, Oxbow Springs, and the Lower Herman Creek Basin* slide presentation given by Nestlé Waters North America (NWNA) in an open house meeting in November 2010. In addition, related data collected subsequent to the presentation are included in this memo. We understand the presentation material was also referenced in recent discussions between Deanna Busdieker, Cascade Locks City Council member, and yourself, and that discussion topics of particular interest included:

- The groundwater system and aquifer interactions (Sections 1 and 2)
- Aquifer storage and recharge, including the unsaturated, or vadose zone (Section 2)
- City of Cascade Locks wellfield groundwater level data, including data collected during the 1977 drought if available (Section 2.2.1)
- Input sources for the Oxbow Springs water balance (Section 2.2.2)
- Oxbow Springs flow data, including data collected during the 1977 drought if available (Section 3)
- Data used to construct trilinear diagram shown in the November 2010 slide presentation (Section 4)

Throughout this memo are references to the related November 2010 slide numbers and the discussion topics listed above. Time-series plots of groundwater level, Columbia River level, water temperature, air temperature, and spring/stream flow data are included in this memo. These plots present data collected at high frequencies (e.g. 1 measurement/15 minutes) or over long periods (e.g. 50 years), which preclude reasonable presentation in tables included with this memorandum. Citations are provided on time-series plots for data that are not tabulated in this memo.

This work was performed, and this memorandum prepared, in accordance with hydrogeologic practices generally accepted at this time and in this area for the exclusive use of Nestlé Waters

North America, for specific application to the project site. No other warranty, express or implied, is made.

1.0 HYDROGEOLOGIC FRAMEWORK

Information in this section provides context for Slide 4/16. This hydrogeologic discussion is based on the following references, supplemented by field reconnaissance by Pacific Groundwater Group (PGG) between 2008 and 2015:

- A Reconnaissance of the Ground-water Resources of the Hood River Valley and the Cascade Locks Area, Hood River County, Oregon (Sceva, 1966)
- Geologic Hazards of Parts of Northern Hood River, Wasco and Sherman Counties, Oregon (Beaulieu, 1977)
- Oxbow Fish Hatchery Preliminary Hydrogeologic Assessment (Squier / Kleinfelder, 2005)
- Report of Dam Sites on Lower Columbia River (Hodge, 1932)

The cross section in Slide 4/16 was based on published surficial geology maps (Beaulieu, 1977 and Sceva, 1966), well logs publically available from Oregon Water Resources Department (OWRD), and a technical report prepared for the Oxbow Fish Hatchery (Squier / Kleinfelder, 2005).

After the November 2010 Town Hall presentation, additional cross sections in the vicinity of Oxbow Springs and the City of Cascade Locks' (City) wellfield were prepared for NWNA's investigations, which are presented in this memo. Again, these cross sections are based on published surficial maps (Beaulieu, 1977 and Sceva, 1966), well logs available from OWRD, and site reconnaissance.

1.1 GEOLOGIC AND HYDROGEOLOGIC UNITS

The City of Cascade Locks was developed on a terrace adjacent to the Columbia River. To the south of this terrace, deep bedrock slides have created irregular topography and complex stratigraphy referred to as the Old Slide Block in Sceva (1966), and the Cascade Locks landslide in Beaulieu (1977).

Surficial geology in the Cascade Locks area is presented in Figure 1, which has been modified from Beaulieu in the following ways:

- Intrusive rock outcrops mapped by Sceva (1966) and observed during field reconnaissance near the Columbia River were added.
- Surficial deposits between Oxbow Springs and Dry Creek Falls were generally mapped by Beaulieu as Eagle Creek Formation; however, field reconnaissance indicated materials in this area are more consistent with talus deposits, which is how they are presented in Figure 1.

For these investigations, major geologic units exposed in the vicinity include the Quaternary Alluvium, Quaternary Thick Talus, Cascades Formation (High Cascades Volcanics and Wind River Flows), Intrusive Igneous Rocks, Rhododendron Formation, Columbia River Basalt Group, and the Eagle Creek Formation. These are described below, in order of youngest to oldest.

In terms of their hydrogeologic properties, or capacity to transmit water, an important distinction is whether the units are unconsolidated—like sand or gravel where the particles are loosely arranged and not cemented together—or consolidated—like sandstone where the particles are bound to one another, or basalt where the rock mass is fused together.

1.1.1 Quaternary Alluvium (Qal), unconsolidated

The City of Cascade Locks is underlain by unconsolidated gravel, sand, silt, and clay, classified as Quaternary Alluvium.

Most of the Quaternary Alluvium within the Cascade Locks vicinity was laid down during the late Pleistocene (18,000 to 15,000 years ago) from a series of catastrophic flood events known as the "Missoula floods." The floods swept across eastern Washington and down the Columbia River Gorge at the end of the last ice age as a result of periodic ruptures of an ice dam on the Clark Fork River that created Glacial Lake Missoula. Given the high energy of deposition, these deposits are typically very coarse grained and highly permeable.

The same catastrophic flood events from Glacial Lake Missoula that deposited material in the Cascade Locks vicinity also deposited the Spokane Valley Rathdrum Prairie aquifer in northeastern Washington (Hsieh et.al., 2007). The Spokane Valley Rathdrum Prairie aquifer has been extensively studied and modeled by the U.S. Geological Survey (USGS). In the central part of this aquifer, available data indicate that horizontal hydraulic conductivity, or permeability, values are very high and range from about 1,000 feet per day (ft/d) to several tens of thousands of feet per day (Hsieh et. al., 2007). Further downstream from Cascade Locks in the Vancouver Washington area, horizontal hydraulic conductivity values of 2,000 to 29,500 ft/d were assigned to an aquifer within Missoula flood deposits in a peer-reviewed numeric groundwater flow model (Parametrix et. al., 2008). The hydraulic conductivity values used in the Vancouver model were based on extensive field testing of local wells.

1.1.2 Quaternary Thick Talus (Qtc), unconsolidated

Quaternary Thick Talus (Qtc) consists of the unconsolidated rock and soil debris that is accumulating at the base of cliffs south of Cascade Locks due to rock fall and rock slides. Soil permeability is highly variable, based on characteristics of the parent material. The Quaternary Thick Talus locally has a thickness greater than 50 feet.

1.1.3 Cascades Formation (Qtv/Qvw1), consolidated

The Cascades Formation consists of basaltic and andesitic flow rock, agglomerate, tuff breccia, and debris flows of High Cascades volcanic peaks (Qtv). The formation locally occupies ridge top positions overlying the Columbia River Basalts and the Rhododendron Formation. The Wind

River (Qvwl) Basalt is made up of relatively young vent and intra-canyon flows, which occur locally just east of lower Herman Creek.

1.1.4 Intrusive Igneous Rock (QTi), consolidated

A wide variety of basaltic and dioritic rocks of the Quaternary and Pliocene are mapped by Beaulieu (1977) as intrusive igneous rock, including numerous outcrops of andesite and diorite exposed in the Cascade Locks area. Near Government Cove, these exposures are hard, fresh, and coarsely jointed and are used for quarry rock.

1.1.5 Rhododendron Formation (Tpr), consolidated

The Rhododendron Formation is composed of Pliocene-aged tuff breccia, agglomerate, and ash forming benches between the massive Columbia River Basalts and the High Cascades volcanics in the cliffs of the Columbia River Gorge.

1.1.6 Columbia River Basalt Group (Tcr), consolidated

The Columbia River Basalt Group (CRBG) is made up of multiple Miocene-aged flood-basalt formations. These formations consist of extensive flows of dense, dark-gray basaltic lava, which commonly display columnar fracturing in the cliffs and bluffs of the Columbia River Gorge. Groundwater aquifers are found in the broken contact zones between individual flows, and also within the pillow lava deposit facies of the CRBG.

1.1.7 Eagle Creek Formation (Tme), consolidated and semi-consolidated

The Eagle Creek Formation is both consolidated and semi-consolidated. The consolidated portions are described as hard, stream-deposited sandstone and conglomerate, and semi-consolidated portions are debris flows and tuff breccias (Beaulieu, 1977). Sceva (1966) included relatively impermeable andesitic lava flow layers in this formation.

2.0 GROUNDWATER FLOW SYSTEM

Information in this section is provided in response to inquiries regarding the groundwater system, aquifer interactions, and aquifer recharge. Section 2.2.1 includes groundwater level information related to the statement on Slide 10/16 of the November 2010 presentation, and related to inquiries regarding the 1977 drought. The discussion in Section 2.2.2 includes inputs to the water budget presented on Slide 5/6, and Section 2.3 presents information related to the productivity of the aquifer that supports the City's wellfield.

2.1 PRINCIPAL AQUIFERS

Where sufficient well logs and other subsurface information are available, regional hydrogeologic studies published by the USGS and other agencies may include maps depicting the lateral extent of aquifers. To date, a published map of aquifers in the vicinity of Cascade Locks has not been identified. However, the surficial geology map (Figure 1) presents the geologic units that the principal aquifers occur within.

The principal aquifers in the study area for NWNA Investigations are the Landslide and Talus Slope (LSTS) aquifer and the Pleistocene Alluvial Aquifer (PAA). A conceptual model of groundwater movement through the aquifers is discussed in Section 2.2.

The LSTS aquifer occurs within the Quaternary Thick Talus (Qtc) deposits that overly the older Cascade Volcanics Deposits and Eagle Creek Formation. The Qtc materials have accumulated at the base of the cliffs that form the south wall of the Columbia River Gorge. The permeability of the landslide/talus slope (LSTS) aquifer is expected to vary depending on how the landslide and talus materials were deposited through mass wasting (movement of soil and rock material downslope under the influence of gravity) as well as how intervening erosional processes may have created channels for preferential water movement.

The PAA occurs in the coarse-grained alluvial sand and gravel deposits (Qal) that underlie the City (Figure 1)[1]. The City of Cascade Locks' municipal wellfield produces water from the PAA and pumping tests indicate the aquifer is very permeable (Section 2.3). This is consistent with the well-characterized, very permeable Spokane Valley Rathdrum Prairie aquifer that also occurs in Missoula flood deposits (Section 1.1.1).

2.2 GROUNDWATER MOVEMENT THROUGH OXBOW SPRINGS AND THE CITY WELLFIELD

Discussions in the following sections describe how groundwater flows through the hydrogeologic system that supports Oxbow Springs and the City wellfield. The discussion begins with a conceptual hydrogeologic model of the system. This is followed by descriptions of key elements used to develop the conceptual model, including a water budget for the Oxbow Springs topographic recharge basin, and seepage studies of Herman Creek and Little Herman Creek.

2.2.1 Conceptual Hydrogeologic Model

A conceptual hydrogeologic model was developed from previous studies cited in Section 1 and field observations made by PGG during site visits. The conceptual model is presented to describe the hydrogeologic systems that support Oxbow Springs and the City of Cascade Locks wellfield. The following discussion is graphically supported by a surficial geologic map (Figure 1) and hydrogeologic profiles (Figures 2 and 3) developed for the area along traces A-A' and B-B' (Figure 1). Driller's well logs used to produce the cross sections are presented in Appendix A.

A number of springs emanate from cliffs south of the City of Cascade Locks at generally comparable elevations, which form a line of springs or "spring line" that includes Oxbow Springs, Williams Springs, Crystal Springs, and Moody Springs (Figure 1). These springs represent discharge from the LSTS aquifer. The watershed upgradient (south) of the spring line is undeveloped and is

[1] Regionally the aquifer in the Quaternary alluvial deposits, and specifically the Missoula flood deposits, is referred to as the PAA.

within the Mt Hood National forest. A portion of precipitation that falls in the watershed infiltrates the Qtc deposits and is one source of recharge for the LSTS aquifer. Other sources of recharge to the LSTS aquifer are infiltration of surface water from the overlying bluffs, and inflow of groundwater that originates in the Cascades Formation, Rhododendron Formation, and Columbia River Basalt Group but flows below ground surface into the LSTS aquifer (Figure 1).

LSTS Aquifer

LSTS aquifer recharge from surface water infiltration is supported by observations made by PGG during field reconnaissance of Dry Creek on numerous visits in both wet and dry seasons between fall 2008 and spring 2015. Dry Creek flows to the northwest over Dry Creek Falls. During field reconnaissance in seasonally dry months, there was no observed stream flow between approximately 1,500 feet downstream of Dry Creek Falls and Dry Creek Springs, even though an estimated 2 cubic feet per second (cfs) of water was flowing over the falls (based on visual estimates). During these site visits, the coarse sand, gravel, cobbles, and boulders in this reach of the streambed were observed to be dry. In contrast, during field reconnaissance in seasonally wet months, there was significant stream flow (visually several cfs or more) in the reach between about 1,500 feet downstream of Dry Creek Falls and Dry Creek Springs.

These field observations suggests that during the dry seasons, the water that flows over Dry Creek Falls infiltrates the LSTS aquifer and provides recharge that supports the springs. In addition, during the wet seasons there is sufficient water flowing over Dry Creek Falls that some surface flow stays within the stream bed that is in excess of water that infiltrates the LSTS aquifer.

Currently there are insufficient wells completed in the LSTS aquifer to measure groundwater flow directions. Conceptually, groundwater within the LSTS aquifer would generally be expected to flow topographically downhill and to the north. In addition to discharging at the springs, the LSTS aquifer also contributes subsurface discharges (subflows) to the PAA north of the spring line.

PAA

The PAA is another productive aquifer in the vicinity of Cascade Locks found in the alluvial sand and gravel deposits (Qal) that underlie the City (Figure 1). Municipal water for the City of Cascade Locks is supplied by two wells located on the northeast end of the City near the mouth of Herman Creek (Figure 4). Both wells are completed in the PAA at depths of about 75 to 103 feet below ground (Appendix A).

Recharge sources to the PAA include subflow from the LSTS aquifer, infiltration of precipitation where the Qal deposits are exposed at ground surface, and infiltration of stream flow from Herman Creek and Little Herman Creek to the underlying aquifer (Section 2.2.3).

Groundwater flow directions within the PAA are generally toward the north or northwest with discharge to the Columbia River. In the vicinity of Cascade Locks, water levels in the Columbia River are regulated by the Bonneville Dam, located approximately 5 miles south-west of Oxbow Springs. Figure 5a presents a comparison of groundwater elevations measured at the City wellfield and Columbia River elevations measured at the USGS monitoring station located in Stevenson, Washington (14128600). The USGS gage is directly across the river from the City's wellfield. The data cover the period from about September 2011 to January 2012. Figure 5b provides a more detailed comparison for October 2011.

The water level plots indicate that water levels in the PAA are highly correlated with Columbia River trends. Groundwater levels rise and fall with fluctuating river conditions (Figures 5a and 5b). However, as described below, the river is not a source of recharge to the City's wellfield. Water level changes at the wellfield tend to be lagged behind river changes by about three to four hours (Figure 5b). The short lag times also indicate that the aquifer is very permeable. The long-term data indicate that aquifer water levels are very stable and almost completely controlled by river stage. Annual variations in river and aquifer water levels are on the order of 1 to 2 feet with the highest levels occurring in late spring and the lowest levels in mid-winter.

The City's supply wells intercept a portion of groundwater that is naturally flowing through the PAA and discharging to the Columbia River. During non-pumping conditions at the wellfield, all groundwater from upgradient recharge sources (e.g. seepage from Herman Creek) flows northward through the wellfield area and discharges to the Columbia River (Figure 6a). The direction of the gradient, or slope of the water table, is maintained towards the river at all times, although the value of the slope changes as river levels change. This is analogous to a floating boat dock on a tidally influenced river with access from shore via an inclined ramp (Figure 6b). As the tides cause the river level to rise, the dock also rises and correspondingly the bottom of the ramp rises and the angle of the ramp becomes less steep. As the tides cause the river level to drop, the dock also drops and correspondingly the bottom of the ramp drops and the angle of the ramp becomes steeper. Regardless of the level of the river and the boat dock, the ramp always slopes toward the river and a ball at the top of the ramp would always roll towards the boat dock.

The same is true of the relationship between groundwater and the Columbia River at the City's wellfield during non-pumping conditions, although the magnitudes of the changes are relatively small. As the river level rises, the water levels in the City wells go up (bottom of the ramp in the analogy above) and the absolute value of the slope of the water table (steepness of ramp in the analogy above) decreases. As the Columbia River level drops, groundwater levels in the City wells also drop and the slope of the water table steepens. As with the boat ramp analogy, the water table always slopes in the direction toward the Columbia River because of considerable seepage from Herman Creek. Because the direction of the water table slope is always toward the river, groundwater always flows toward the river, much as a ball on the top of the ramp would always roll toward the boat dock. In reality, at Cascade Locks the river level is held quite stable by Bonneville Dam. Therefore, the changes in groundwater levels are small and the changes in the absolute value (steepness) of the slope of the water table are small. In addition, changes to the absolute value of the slope of the water table are small because the PAA is very permeable.

During pumping conditions, a portion of groundwater from upgradient sources (e.g. seepage from Herman Creek) is captured by the wellfield, while the majority of groundwater continues to discharge to the Columbia River. When the wells are pumped, the water table in the immediate vicinity is drawn down (Figure 6c). This creates a groundwater divide between the wellfield and the river, which is represented by a high point in the water table (Figure 6c). A groundwater divide is a hydraulic pressure boundary between two discharge points from which groundwater flows in different directions. Despite the relationship between water levels in the Columbia River and groundwater levels in the PAA described above, the river is not a source of recharge to the wellfield because of the groundwater divide. The groundwater divide is always maintained between the City wellfield and the Columbia River because the quantity of recharge to the PAA from Herman Creek seepage is at least double the quantity of groundwater the City is authorized to pump from the wellfield at full utilization of their water right (Section 2.2.3). Therefore, even when the wellfield is pumping, some groundwater continues to flow around the City wells and discharge to the Columbia River. This concept is supported by results of stream flow and water quality monitoring on behalf of NWNA (Sections 2.2.3 and 4.1).

Groundwater levels for the City's wellfield during the 1977 drought were not included in data obtained from the City. However, water levels in the Columbia River provide some insights because the river and groundwater levels at the wellfield are highly correlated. Long-term water level elevations in the Bonneville Pool measured at the Bonneville Dam were obtained from the U.S. Army Corps of Engineers and are presented in Figure 7. The data indicate that between 1965 and 2015 water levels in the Bonneville Pool have been very stable; the average pool elevation from 1965 and mid 1975 was approximately 72.5 to 73 feet (U.S. Corps of Engineers Bonneville Datum), and has been approximately 74 feet since. Regulating the Columbia River maintains relatively stable groundwater levels in the PAA, and therefore a relatively stable saturated aquifer thickness.

2.2.2 Oxbow Springs Water Budget

This section presents underlying assumptions and inputs for the water budget calculation presented in Slide 5/6 of the November 2010 presentation. The water budget was a key component in developing the conceptual model of the recharge area that supports Oxbow Springs.

A water budget, or water balance, is a tool used to account for the amount of recharge (inputs) and discharge or withdrawal (outputs) through a watershed. They are often used by regulators or planning agencies to evaluate if there is sufficient water in a basin to develop a new source of supply. For the Cascade Locks project, a water budget was developed to assess the concept that the LSTS aquifer supports Oxbow Springs and receives recharge from Dry Creek stream flow infiltration.

The recharge water basin upstream of Oxbow Springs is estimated to be 0.25 square miles based on topographic divides (Figure 8a). The water budget terms for this basin are precipitation (input), evapotranspiration (output), and runoff (output). Not all precipitation will become spring flow, as some will be lost back to the atmosphere via evapotranspiration, some will runoff via surface water drain courses, and other water may discharge directly to the down-gradient alluvial aquifer via subflow. Site reconnaissance indicates that there is no surficial runoff in the Oxbow Springs topographic catchment. Subflow quantities are not well defined but would represent additional unaccounted flow in the catchment.

Estimates of precipitation and evapotranspiration in the water budget were obtained from values published by Oregon State University and by the USGS.

The PRISM Climate Group with Oregon State University gathers climate observations from a wide range of monitoring stations, applies sophisticated quality control measures, and develops spatial climate data sets of short- and long-term patterns. The United States Department of Agriculture has a long-time partnership with the PRISM Climate Group. At the end of each decade, average values for temperature and precipitation are computed over the preceding 30 years by the PRISM Climate Group. Average annual precipitation contours generated by the PRISM Climate Group for 1971 - 2000 are presented in Figure 8a (Taylor, 1993).

The evapotranspiration estimate used in the Oxbow Springs water budget is consistent with preliminary USGS estimates of hydrologic components for Bull Run Lake and the Bull Run Lake Drainage Basin in Multnomah and Clackamas Counties (Snyder and Brownell, 1996). The Bull Run Lake watershed has been the subject of considerable study as the majority of Portland's potable water supply flows from the watershed. The Bull Run Lake evapotranspiration estimate was considered reasonable for the Oxbow Springs topographic recharge basin based on the comparable physiography, climate, and vegetation.

In the water budget, discharge estimates from Oxbow Springs are based on flow monitoring performed for NWNA investigations at the Little Herman Creek gage (Figure 9). The Little Herman Creek gage is located on the north side of I-84 about 500 feet northeast of the Oxbow Springs Hatchery rearing ponds (Figure 10). Oxbow Springs is the primary source of water to Little Herman Creek; therefore, the gage provides a continuous record of total spring discharge. Over the 2008-March 2015 monitoring period, the amount of water discharged by Oxbow Springs ranged from 1.8 to 10 cfs (Figure 9).

The water budget presented in Slide 5/6 of the November 2010 presentation is reproduced in Table 1a, and annotated with data source information. Subsequent to the 2010 presentation, the water budget was updated (Table 1b) when the average annual precipitation contours for the 1981-2010 period became available from PRISM (Figure 8b).

In both water budgets, the total discharge estimates from Oxbow Springs are significantly more than can be accounted for by recharge to the Oxbow Springs topographic basin. Therefore, a substantial amount of spring flow is unaccounted for by recharge in the Oxbow Spring basin and a larger watershed is likely contributing flow to the spring.

The Oxbow Springs topographic recharge basin is bounded by the Herman Creek and Dry Creek topographic recharge basins (Figures 8a and 8b). The boundary with the Herman Creek recharge basin to the east is well defined by topography. The lower portions of the Herman Creek channel south of the City Limits are at lower elevations than the Oxbow Springs recharge basin. Consequently, groundwater cannot move from this portion of the Herman Creek recharge basin to the Oxbow Springs recharge basin.

The boundary between the Oxbow Springs and Dry Creek recharge basins is not as well defined by topography. The Oxbow Springs and Dry Creek recharge basins are at comparable elevations and it is reasonable to conclude that the flows in Oxbow Springs that are unaccounted for by recharge in the Oxbow Springs basin originate within the Dry Creek basin to the west and southwest (Figures 8a and 8b). Recharge that is contributed to the LSTS aquifer from the stream below Dry Creek Falls (visually estimated to be several cfs or more based on PGG field reconnaissance during dry seasons) is much greater than observed flows at Dry Creek Springs, indicating that there are additional discharge points for water from this basin. As described in Section 2.2.1, during field reconnaissance in dry seasons, there was no observed stream flow between approximately 1,500 feet downstream of Dry Creek Falls and Dry Creek Springs. This observation suggests that the flow infiltrates the LSTS aquifer, which could subflow into the Oxbow Springs recharge basin and provide recharge that supports the springs. During the higher runoff winter months, some surface flow occurs within this reach of the stream.

The groundwater flow system upgradient of Oxbow Springs is a natural system that is controlled by recharge in the Oxbow Springs and Dry Creek topographic basins, and by discharges to springs, surface water, and evapotranspiration. Since moving to their present location in 1937, ODFW has been diverting a portion of the natural flow from Oxbow Springs to support hatchery operations (Section 3.1). However, this diversion has not increased the amount of water that is discharging naturally from the Oxbow Springs or Dry Creek basins since they only capture a portion of the natural flow that enters this area from upgradient recharge sources.

"Under predevelopment conditions, the ground-water system is in long-term equilibrium. That is, averaged over some period of time, the amount of water entering or recharging the system is approximately equal to the amount of water leaving or discharging from the system. Because the system is in equilibrium, the quantity of water stored in the system is constant or varies about some average condition in response to annual or longer-term climatic variations...Humans change the natural or predevelopment flow system by withdrawing (pumping) water for use, changing recharge patterns by irrigation and urban development, changing the type of vegetation, and other activities." (Alley et. al. 1999).

The hatchery diversion has not, nor will it, alter the water balance for the Oxbow Springs and Dry Creek topographic recharge basins because it has not changed the amount of recharge to the system, the amount of evapotranspiration, the amount of water removed from storage (e.g. pumping withdrawals), nor the amount of water discharging from Oxbow Springs.

2.2.3 Herman Creek, Little Herman Creek, and Groundwater Interactions

The following discussions, figures, and tables are related to the streamflow statement on Slide 7/16 of the November 2010 presentation. Understanding interactions between Herman Creek, Little Herman Creek and groundwater in the PAA contributed significantly to developing the conceptual hydrogeologic model.

Streams interact with groundwater in two fundamental and natural ways: streams gain water by the inflow of groundwater (gaining stream, Figure 11a), or they lose water to groundwater by outflow through the streambed (losing stream, Figure 11b). One stream may have both gaining and losing reaches. For groundwater to flow into a stream channel, the elevation of the water table in the vicinity of the stream must be greater than the elevation of water in the stream. In contrast, for surface water to seep through the stream bed into groundwater, the elevation of water in the stream must be greater than the elevation of the water table in the vicinity of the stream. Surface water – groundwater interactions for losing stream reaches can be further characterized as connected or disconnected. If sediments below a losing stream reach are saturated, the losing reach is connected to the groundwater system (Figure 11b). If sediments below a losing stream are unsaturated, the losing reach is disconnected from the groundwater system (Figure 11c). Again, both relationships occur naturally and in both cases water flows from the stream to groundwater. "*An important feature of streams that are disconnected from ground water is that pumping of shallow ground water near the stream does not affect the flow of the stream near the pumped wells*" (Winter et. al., 1998).

Several seepage studies were performed for the NWNA project to evaluate the interactions between Herman Creek, Little Herman Creek, and groundwater in the PAA. Seepage studies involve measuring stream flow at the endpoints of channel reaches (e.g. upstream of a tributary entering the main channel), which can be used to identify if flows are increasing (groundwater flowing in through the streambed) or decreasing (surface water flowing out through the streambed to the underlying aquifer). The seepage studies were performed by River Measurements of Vancouver, Washington. River Measurement staff involved in these studies include former USGS personnel, and they follow USGS protocols and quality assurance for stream gaging.

These seepage studies were conducted in September 2009, September and October 2010, and September and October 2011. The surveys involved measuring stream flow, or discharge, at select locations on Herman Creek and Little Herman Creek. The measurements were collected during the late summer and early fall when the streamflow rates were low, which minimizes error in seepage loss estimates. The seepage survey locations are identified in Figure 10 and discharge measurements are summarized in Table 2.

During the surveys, the amount of seepage from lower Herman Creek to the underlying aquifer between ODFW's upper and lower diversion dams (Figure 10) ranged from 3.6 to 10.8 cfs (Table 2, Survey #1-4). Surface water seepage below the lower ODFW diversion on the main Herman Creek channel (east channel) to the underlying aquifer was estimated during the October 2011 survey to be approximately 4.6 cfs (Table 2, Survey #5). Seepage along Little Herman Creek to the aquifer ranged between 0.13 and 0.35 cfs. Total seepage from Herman Creek and Little Herman Creek to the underlying aquifer is estimated to range between 8.3 to 15.7 cfs.

The City currently holds water rights that authorize withdrawal of 4 cfs from their wellfield. Based on the seepage studies, seepage of water from Herman Creek and Little Herman Creek to the underlying aquifer greatly exceeds the wellfield's potential rate of withdrawal from the same aquifer.

It is important to note that these seepage estimates likely represent the low end of actual recharge to the underlying aquifer from Herman Creek and Little Herman Creek seepage because they are based on flow measurements made in late summer and early fall when stream flows at the wetted perimeters of the streams are typically at their minimums. At wetter times of year the Herman Creek and Little Herman Creek channels occupy more area, which would increase the rate of seepage to the aquifer.

2.3 PAA PUMPING TEST

The following discussion is related to information on Slide 10/16 of the November 2010 presentation.

A pumping test is a field method used to estimate the capacity of an aquifer to transmit water. This is accomplished by pumping a well at a known, controlled rate and measuring how much water levels in the well draw down from the pre-test, or "static," condition. Water levels during pumping tests are often measured in nearby non-pumping wells, where available, which are commonly referred to as observation wells.

A short-term pumping test was completed in City Well 1 on August 1, 2011 to assess aquifer properties for the PAA. The Fish Tank Supply Well installed for NWNA investigations was used as an observation well during the test. The Fish Tank Supply Well (Figure 4) is located approximately 175 feet from City Well 1 and was constructed to produce water from approximately the center depth of the aquifer that supplies the City wellfield (Appendix A, log for Hood 50735).

Water levels were measured in City Well 1 and the Fish Tank Supply Well for approximately 1 day prior to the test and during the pumping period. The test consisted of operating Well 1 at approximately 440 gpm using the existing pump. Discharge water was conveyed into the City's supply system. The pumping period lasted for 12 minutes, at which time water levels in Well 1 appeared to have stabilized. There was no discernible drawdown in the Fish Tank Supply Well.

At the end of the pumping period, the water level in Well 1 had drawn down about 0.08 feet from the pre-test, or "static," water level. Based on the rate of drawdown in Well 1 and aquifer thickness of about 45 feet (Appendix A), the hydraulic conductivity, or permeability, of the PAA is estimated to be about 28,750 feet/day near the City wellfield. This represents a very productive aquifer. For reference, this is close to the maximum hydraulic conductivity value tabulated in Freeze and Cherry's range of values of hydraulic conductivity and permeability for rocks and unconsolidated deposits, and is within the range for open-framework gravel (Freeze et. al., 1979).

A longer term test completed during the construction of Well 1 in 1969 revealed a similar drawdown relationship, as reported on the driller's well log (Appendix A). During that test, Well 1 was pumped for 24 hours at a rate of 1,000 gpm and had only 0.2 feet of total drawdown. The initial 1969 pumping test in Well 2 involved pumping the well for 8 hours at a rate of 390 gpm, which resulted in 1 foot of total drawdown (Appendix A). The greater amount of drawdown at a lower pumping rate observed in the Well 2 test relative to drawdown observed in Well 1 tests is because Well 2 is less efficient due to a smaller well diameter (8 inch diameter in Well 2 vs. 14 inch diameter in Well 1) and fewer number of perforations in the well casing that allow water to flow into the well (600 perforations in Well 2 vs. 1200 perforations in Well 1).

2.4 GROUNDWATER IN THE UNSATURATED ZONE

The following discussion is provided in response to inquiries regarding aquifer storage in the unsaturated zone.

The portion of the subsurface between land surface and the water table is referred to as the unsaturated, or vadose zone. The pore spaces between soil grains and rock in this zone usually contain both air and water. In contrast, pore spaces beneath the water table are filled with water.

Water in the upper portions of the unsaturated zones is used by plants and can also evaporate directly to the atmosphere. Some water is held in the unsaturated zone by surface tension forces. Water in excess of evapotranspiration and surface tension forces infiltrates downward to the water table by gravity where it recharges underlying aquifer zones.

"The unsaturated zone is not always considered a major storage component of the hydrologic cycle because it holds only a minute fraction of the earth's fresh water and this water is usually difficult to extract. But it is of great importance for water and nutrients of the biosphere." (USGS, 2013).

Water content and therefore storage in the unsaturated zone is dynamic, shifting between high degrees of saturation following significant precipitation events, to very low degrees of saturation during drier seasons. The movement, or flux, of water through the unsaturated zone is complex because contributing physical properties such as hydraulic conductivity and pressures due to the soil-water attraction are dependent on water content, which again is highly variable and dynamic.

3.0 SURFACE WATER MONITORING

Discussions, figures, and tables in the following sections are related to the streamflow statement on Slide 7/16 of the November 2010 presentation, and are related to inquiries about the 1977 drought.

The surface water monitoring network consists of gaging stations installed for the NWNA project that are operated and maintained by River Measurements of Vancouver, Washington. As discussed above, River Measurement staff that established and maintain the surface water monitoring network are former USGS personnel, and follow USGS protocols and quality assurance for stream gaging.

Periodic stream flow surveys are made at each gaging station by River Measurements to maintain rating curves. Stage readings are collected at 15-minute intervals and converted to flow readings using the rating curves. Gaging stations for the Cascade Locks vicinity are presented in Figure 10.

The Little Herman Creek gage is located on the north side of I-84 about 500 feet northeast of the Oxbow Springs Hatchery rearing ponds. Oxbow Springs is the primary source of water to Little Herman Creek; therefore, the gage provides a continuous record of total spring discharge.

The Herman Creek gage is located just upstream of the Upper Herman Creek hatchery diversion dam.

3.1 OXBOW SPRINGS FISH HATCHERY

The Oregon Department of Fish and Wildlife (ODFW) operate the Oxbow Springs Hatchery in Cascade Locks for interim egg incubation and early rearing of coho and sockeye salmon. No adult fish are collected or spawned at Oxbow Springs Hatchery and there are no fish released at the facility.

The hatchery obtains its water supply from Oxbow Springs, which emanate from the hillside south of the hatchery property (Figure 10). There are two major springs that have been developed by ODFW as well as other smaller seeps and springs that contribute flow to the headwaters of Little Herman Creek, which is also used for supply. Upper Oxbow Springs (also known as the Middle Spring) is at an elevation of about 240 feet above sea level whereas Lower Oxbow Springs (also known as the East Spring) is at an elevation of about 230 feet. Covered concrete collection boxes have been installed at both of these larger springs. The collection box for Upper Oxbow Springs discharges directly into a small open reservoir that is formed by a sheet-pile dam. A portion of the water from the spring collection areas is piped to a hatchery building and used for egg incubation and rearing of small fry. The supply line intake for Upper Oxbow Springs is located in the small open reservoir, whereas the intake for Lower Oxbow Spring is located in the collection box. Overflow from both springs' collection systems flows into Little Herman Creek and a small reservoir near the west side of the hatchery (Figure 10). The small reservoir, which also acts as a settling pond, feeds water via a headbox into a series of raceways that are used for fish rearing (Figure 10 inset). Discharge water from the raceways is collected in a series of overflow pipes which transport the water back to the Little Herman Creek channel at the northeast corner of the property. During high recharge periods when water levels in the aquifer are elevated, field tests indicate that the small hatchery abatement pond south of the raceways contributes about 0.1 cfs of additional flow to Little Herman Creek upstream of the gaging station. Little Herman Creek cascades over a steep channel just north of I-84 before it reaches the Herman Creek floodplain.

3.2 WEIR MEASUREMENTS

Discharge from Oxbow Springs have been measured by hatchery personnel since 1969, including the period of the 1977 drought (Figure 12a). Discharge measurements by hatchery personnel relative to data from the Little Herman Creek gage are presented in Figure 12b. ODFW flow estimates include two time periods: one from 1969 to 1992 and the other from 2000 to present. The pre-1992 data were collected using a Cipolletti weir (trapezoidal shape in cross section perpendicular to water flow) located on the upstream side of the raceway headbox and the post-2000 data were collected using a sharp-crested weir (rectangular shape in cross section perpendicular to water flow) that is located on the downstream side of the headbox.

Discrepancies between flows measured at the hatchery weir and at the Little Herman Creek gage are likely due to differences in the frequency of measurements between the two stations and due to the way measurements are made at the hatchery weir as described below.

Overflow from the spring collectors flows into Little Herman Creek and a settling pond west of the raceways (Section 3.1). Flow is then piped to a headbox that bisects the raceways. During normal operation, there are stop logs on the south side of the headbox that forces water into the raceways and ultimately discharges through a series of pipes to Little Herman Creek. Since 2000, when hatchery staff measure Oxbow Spring flow they drop the stop logs, which cuts off flow to the raceways. In this configuration, all flow through the headbox discharges through a rectangular shaped weir on the south side of the raceways and is then piped to Little Herman Creek.

In recent years, measurements have been made by hatchery personnel at the weir approximately weekly. Data at the Little Herman Creek gage for NWNA investigations are collected at 15 minute intervals. The differences in measurement frequency at the two stations could translate to dampening of flow measurements made at the weir relative to flows recorded at the Little Herman Creek gage if peak and low flows aren't coincident with weekly weir measurements.

The hatchery measurement point appears to be located too close to the weir, which leads to an underestimation of actual flow rates. The head on a weir is a key term used in calculating discharge rates.

"The head on the weir, h, is the difference in elevation between the crest of the weir and the surface of the flowing stream, measured far enough upstream from the weir to eliminate the effect of the increase in velocity as the water spills over the weir. Because small errors in determining h can make a large error in calculating the discharge, it is essential to make the head measurements from 3 to 8 ft (0.9 to 2.1 m) upstream of the crest." (Driscoll, 1986).

Stream flow at the Little Herman Creek gage, described below, is believed to be the most accurate data for quantifying flow from Oxbow Springs because it is based on USGS data collection and quality control protocols.

3.3 STREAM FLOW GAGING AND OXBOW SPRINGS MEASUREMENTS

3.3.1 Little Herman Creek

Stream flow in Little Herman Creek has been monitored for NWNA investigations since 2008. As described above, Oxbow Springs is the primary source of water to Little Herman Creek; therefore, the gage provides a continuous record of total spring discharge. Flow in Little Herman Creek is influenced by upstream operations at the Oxbow Springs hatchery. Staff open and close fish raceway ponds and make adjustments when cleaning or performing related activities. These practices introduce short-term variability in data collected at the Little Herman Creek gage. Therefore, the flow data presented for Little Herman Creek in Figures 9 and 12b are 24-hour averaged data to reduce the short-term variability.

3.3.2 Herman Creek

Stream flow in Herman Creek has been monitored since 2009. The data set is not continuous because a landslide occurred on June 2, 2010 that temporarily affected the applicability of the Herman Creek rating curve for higher-end flows. Therefore, stream flow data recorded between

June 2010 and June 2011 that are greater than 115 cfs are not reported. A new rating curve was established by June 2011 that provides quantification of the more recent higher flows at this gage.

The maximum stream flow recorded at the Herman Creek gaging station was approximately 1,270 cfs in March 2014 (Figure 9). The seasonal low flows over the monitoring period are approximately 20 cfs and occur between late August and November.

4.0 WATER QUALITY

Information in this section is related to water quality statements on Slide 7/16 and the figures on Slides 8/16 and 9/16 of the November 2010 presentation.

4.1 MAJOR CATION/ANION CHEMISTRY

Trilinear diagrams are often used to classify the chemistry of natural waters and are useful tools to illustrate how the major ion composition of water varies between different hydrogeologic systems. The diagrams plot the percentage composition in a sample of major cations (positively charged ions) in one triangle and the percentage composition of major anions (negatively charged ions) in a second triangle. Graphically, the major cation and anion composition of a sample are both plotted on a single diamond shape, which allows the major ion chemistry of different water samples to be compared.

A trilinear diagram representing the major ion chemistry in water quality samples collected from Oxbow Springs, Dry Creek, Herman Creek, Cascade Locks Well 1, and Columbia River between 2003 and 2009 was presented in Slide 8/16 of the November 2010 presentation. The water quality data used to generate the plot is presented in Table 3. The 2003 Columbia River sample represented in Slide 8/16 was collected by the USGS at the Warrendale, OR station.

An updated trilinear diagram is presented in Figure 13 and the data used to generate the plot are included in Table 3. Columbia River samples represented in Figure 13 were collected by PGG.

The trilinear diagrams indicate that the major ion chemistry of the springs, creeks, and Well 1 samples are distinct from the major ion chemistry of the Columbia River samples. This supports the conceptual model that recharge to the alluvial aquifer that supplies the Cascade Locks wellfield originates as seepage losses from creeks flowing from the uplands, discharge from the LSTS aquifer, and infiltration of precipitation as opposed to induced recharge from the Columbia River. If the alluvial aquifer did receive a significant amount of recharge from the Columbia River, the major ion chemistry of Well 1 samples would be expected to be similar to that of the Columbia River, or to reflect some degree of mixing of Columbia River, springs, and creek water chemistry.

During water quality sampling for these investigations, laboratory prepared bottles were filled directly from the spring flow, creeks, and rivers; or from spigots closest to the wellheads. Samples were transported or shipped to the analytical labs in ice chests following standard chain-ofcustody procedures. Analytical services have been provided by certified labs throughout the United States.

4.2 DEUTERIUM AND OXYGEN-18 ISOTOPES

Much of the Columbia River basin is located in semi-arid to arid portions of Oregon and Washington located east of the Cascade Mountains. In general, precipitation becomes progressively lighter in the deuterium and oxygen-18 isotopes as it occurs farther from the ocean (Drever, 1988). As a result, water in the Columbia River is depleted in deuterium and oxygen-18 relative to precipitation that falls in the Cascade Locks area. These stable isotopes can be used as natural tracers to evaluate the hydraulic relationship between the Columbia River and adjacent aquifers (McCarthy et. al., 1991).

In May 2010 water quality samples were collected on behalf of NWNA for deuterium and oxygen-18 analyses from Oxbow Springs, Cascade Locks Fish Tank Well, Herman Creek, and the Columbia River. The samples were submitted to Isotech Laboratories, Inc. in Champaign, Illinois for analysis.

The global meteoric water line (GMWL) represents the average relationship between hydrogen and oxygen isotope ratios in global precipitation relative to standard mean ocean water. Precipitation samples will tend to group close to the GMWL. Deviations from the GWML can be interpreted as precipitation that occurred during a warmer or colder climate than at present or by geochemical changes that occurred during flow through the subsurface (Fetter, 2001).

The analytical results of isotope analyses in Cascade Locks area water samples were presented relative to the GMWL in Slide 9/16 of the November 2010 presentation. The data are reproduced graphically in Figure 14 and are summarized in Table 4. The isotopic compositions of water sampled from Oxbow Springs, the Cascade Locks Fish Well, and Herman Creek fall within a cluster that is isotopically distinct (heavier) than the Columbia River water sample.

This supports the conceptual model that recharge to the alluvial aquifer that supplies the Cascade Locks wellfield originates as seepage losses from creeks flowing from the uplands, discharge from the LSTS aquifer, and infiltration of precipitation; as opposed to recharge from the Columbia River. If the alluvial aquifer did receive a significant amount of recharge from the Columbia River, the isotopic composition of Well 1 would be expected to be similar to that of the Columbia River, or to reflect some degree of mixing of Columbia River, springs, and creek isotopic compositions.

5.0 SURFACE WATER TEMPERATURES AND MODEL

The discussions in this section are related to the figures presented in Slides 12/16, 13/16, and 16/16 of the November 2010 presentation.

5.1 SURFACE WATER TEMPERATURE MONITORING

The monitoring network established for these investigations includes continuous temperature monitoring in Oxbow Springs, Little Herman Creek (just above the confluence with Herman Creek), Herman Creek, and the City's wellfield (Figure 10).

Temperature data collected in Herman Creek at the upper diversion dam and in Lower Herman Creek above the confluence with Little Herman Creek between September 2009 and October 2010 were presented in the November 2010 presentation relative to OAR 340-041-0028 criteria. These criteria are protective of spawning, rearing, and migration. The Herman Creek temperature plot has been updated in Figure 15. This updated figure only shows values for the upstream monitoring station since data for the downstream station are almost exactly the same. Temperatures at both stations during the five year monitoring period have not exceeded the spawning, rearing, and migration criteria.

5.2 THERMAL FLUX MODEL

A thermal flux model was used to estimate temperature changes to lower Herman Creek during the low flow period that extends from early summer through late fall based on the proposed water exchange envisioned between ODFW (spring source) and the City (well source). The modeling analysis assumed there would be an equal water exchange of 0.5 cfs between ODFW and the City year round.

The thermal flux for any point in the system is a product of both water temperature and flow rate. Knowledge of thermal flux of Herman Creek, Little Herman Creek, and the City supply allows modeling of the changes in the thermal flux in the lower reaches of these streams due to changes in the source of water (i.e. wellfield versus springs).

The streamflow and surface water temperature data collected between June 18, 2010 and January 1, 2011 were used as a basis for this analysis (Figures 9 and 15). Temperatures measured in City Well 1 and Oxbow Springs were also incorporated in the analysis (Figure 16, update of Slide 13/16).

The thermal flux model was performed for two water year conditions: the 2010 water year and a simulated "drought" water year. Monthly precipitation data collected at a station at Bonneville Dam, approximately 5 miles downstream from Oxbow Springs, was used in the model. Monthly precipitation at the Bonneville Dam station in the 2010 water year was about 9-percent greater than long-term average conditions at the station, and was therefore selected to represent long-term average conditions. Annual precipitation in water year 1977 was 40-percent less than annual precipitation in water year 2010, and was therefore selected to represent drought conditions.

Results of the thermal flux model were presented in Slide 16/16 of the November 2010 presentation and are re-produced graphically in Figure 17 and tabulated in Table 5. A more complete discussion of the thermal flux model and results are included in the *Temperature Characteristics of Herman Creek Cove and Its Function as a Cool-Water Refuge for Adult Salmon and Steelhead in the Columbia River* (Cramer Fish Sciences, 2010).

6.0 CLOSING

PGG hopes the data and technical information in this memorandum meets your needs to provide information to the City Council as requested during your discussion with Councilor Deanna Busdieker. Please feel free to contact us with any questions or additional needs.

7.0 REFERENCES

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Table 1a. Oxbow Springs Basin Water Balance Presented in Slide 5/6

Input	Value	Source
Oxbow Springs Watershed Precipitation	89 in/year	PRISM Climate Group, Oregon State University average annual precipitation 1971-2000 (Figure 8a). Average in Oxbow Basin calculated by GIS analysis of precipitation contours.
Evapotranspiration	23 in/year	Snyder and Brownell, 1996. Hydrogeologic Setting and Preliminary Estimates of Hydrologic Components for Bull Run Lake and the Bull Run Lake Drainage Basin, Multnomah and Clackamas Counties, Oregon U.S. Geological Survey Water Resources Investigations Report 96-4064
Runoff	0 in/year	Field reconnaissance
Net Recharge	66 in/year	Calculation, Precipitation - Evapotranspiration - Runoff
Oxbow Springs Drainage Area	0.25 sq miles	Drainage area boundaries estimated from topographic divides; area calculated by GIS analysis
Total Recharge	1.2 cfs	Calculation, Net Recharge x Drainage Area
Average Oxbow Springs Flow	4.7 cfs	Average flow measurements at Little Herman Creek gage available at time Slide 5/16 was prepared

Table 1b. Updated Oxbow Springs Basin Water Balance (1981-2010 Precipitation Data)

Input	Value	Source
Oxbow Springs Watershed Precipitation	76 in/year	PRISM Climate Group, Oregon State University average annual precipitation 1981-2010 (Figure 8b). Average in Oxbow Basin calculated by GIS analysis of precipitation contours.
Evapotranspiration	23 in/year	Snyder and Brownell, 1996. Hydrogeologic Setting and Preliminary Estimates of Hydrologic Components for Bull Run Lake and the Bull Run Lake Drainage Basin, Multnomah and Clackamas Counties, Oregon U.S. Geological Survey Water Resources Investigations Report 96-4064
Runoff	0 in/year	Field reconnaissance
Net Recharge	53 in/year	Calculation, Precipitation - Evapotranspiration - Runoff
Oxbow Springs Drainage Area	0.25 sq miles	Drainage area boundaries estimated from topographic divides; area calculated by GIS analysis
Total Recharge	1 cfs	Calculation
Average Oxbow Springs Flow	5 cfs	Average flow measurements at Little Herman Creek gage October 2009 – September 2014 (Figure 8)

Table 2 - Summary of Herman Creek Seepage Surveys, 2009 - 2011

Survey #	Site	Site Description	Date	Time	Discharge (cfs)
1	A	Herman Creek near Mouth	9/14/2009	13:20	19.6
1	B	Herman Creek above Upper Hatchery Intake	9/14/2009	14:40	27.7
1	C	Little Herman Creek at Confluence	9/14/2009	13:15	2.72
1	D	Little Herman Creek at Gage.	9/14/2009	12:10	3.04
Seepage loss along lower Herman Creek: Loss = B - (A - C)					**10.82**
Seepage loss along Little Herman Creek: Loss = D - C					**0.32**
Survey #	**Site**	**Site Description**	**Date**	**Time**	**Discharge (cfs)**
2	A	Herman Creek near Mouth	9/2/2010	16:30	26.5
2	B	Herman Creek above Upper Hatchery Intake	9/2/2010	19:00	27.2
2	C	Little Herman Creek at Confluence	9/2/2010	15:50	2.95
2	D	Little Herman Creek at Gage.	9/2/2010	17:55	3.30
Seepage loss along lower Herman Creek: Loss = B - (A - C)					**3.65**
Seepage loss along Little Herman Creek: Loss = D - C					**0.35**
Survey #	**Site**	**Site Description**	**Date**	**Time**	**Discharge (cfs)**
3	A	Herman Creek near Mouth	10/6/2010	14:00	21.1
3	B	Herman Creek above Upper Hatchery Intake	10/6/2010	13:40	24.7
3	D	Little Herman Creek at Gage	10/6/2010	15:20	3.19
Seepage loss along lower Herman Creek: Loss = B - (A - D)					**6.79**
Survey #	**Site**	**Site Description**	**Date**	**Time**	**Discharge (cfs)**
4	A	Herman Creek near Mouth	9/8/2011	14:30	22.8
4	B	Herman Creek above Upper Hatchery Intake	9/8/2011	13:20	23.6
4	C	Little Herman Creek at Confluence	9/8/2011	14:30	3.10
4	D	Little Herman Creek at Gage.	9/8/2011	12:15	3.23
Seepage loss along lower Herman Creek: Loss = B - (A - C)					**3.90**
Seepage loss along Little Herman Creek: Loss = D - C					**0.13**
Survey #	**Site**	**Site Description**	**Date**	**Time**	**Discharge (cfs)**
5	A	Herman Creek near Mouth	10/27/2011	11:50	11.3
5	E	Herman Creek at RM 0.2	10/27/2011	13:00	9.45
5	F	Herman Creek at Mouth	10/27/2011	13:55	6.69
Seepage loss from lower diversion dam to mouth = A - F					**4.61**

Notes:
Seepage surveys completed by River Measurements of Vancouver Washington.

Table 3. Major Anion and Cation Concentration Summary for Oxbow Springs, City Wellfield, Dry Creek, Herman Creek, and Columbia River used to Generate Trilinear Diagrams

Sample Location	Date	Bicarbonate Alkalinity as CaCO3	Bicarbonate as HCO3	Carbonate Alkalinity as CaCO3	Carbonate as CO3	Chloride	Sulfate	Calcium, Total	Magnesium, Total	Potassium, Total	Sodium, Total
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ug/L	ug/L	ug/L	ug/L
Lower Oxbow Springs	6/7/08	25		2 U		1.1	0.9	4,440	1,870	1,370	2,690
Lower Oxbow Springs	**7/2/08**	26		2 U		1.1	0.8	4,610	1,920	2,000 U	2,780
Lower Oxbow Springs	1/28/09	20		1 U		0.55	1	4,600	1,800	1,300	3,000
Lower Oxbow Springs	4/23/09	20		1 U		1.5	1.1	4,300	1,800	1,400	3,300
Lower Oxbow Springs	7/20/09	24		1 U		1.8	0.08	4,700	1,800	1,100	3,200
Lower Oxbow Springs	11/4/09	23		2 U		1.22	0.95	4,720	1,950	1,350	2,750
Lower Oxbow Springs	5/19/10	25.7		2 U		1.2	0.87	4,470	1,810	1,360	2,710
Lower Oxbow Springs	11/18/10	24		9 U		1.01	0.79	4,590	1,870	1,260	2,850
Lower Oxbow Springs	9/21/11		30		2 U	1.0	0.88	4,700	2,000	1,400	3,000
Lower Oxbow Springs	7/30/12		29		2 U	1	0.85	4,600	2,000	1,500	3,200
Upper Oxbow Spring	**7/2/08**	24		2 U		1.1	0.8	4,680	1,940	2,000 U	2,830
Upper Oxbow Spring	3/12/13		29		2U	1	0.86	4,600	1,900	1,600	3,700
Cascade Locks Well 1	**1/28/09**	22		1 U		0.96	1	5,600	2,000	1,200	3,500
Cascade Locks Well 1	7/20/09	22		1 U		1.1	0.6	4,500	1,900	1,300	3,300
Cascade Locks Well 1	11/4/09	26		2 U		1.47	1.08	5,480	2,060	1,350	3,100
Cascade Locks Well 1	7/30/12		28		2 U	1.1	0.87	4,900	2,000	1,300	3,200
Cascade Locks Well 1	3/12/13		29		2 U	1.3	1	5,100	2,000	1,500	3,900
Cascade Locks Well 2	4/23/09	20		1 U		2	1.1	4,900	1,900	1,200	3,300
Columbia River at Warrendale*	12/16/03		74		0	2.97	11.5	20,000	5,650	1,390	6,390
Columbia River	11/3/09	61		2 U		3.08	12.4	18,100	5,110	1,340	5,970
Columbia River	5/18/10	65.3		2 U		2.49	10.7	16,400	4,880	1,320	5,630
Herman Creek	**11/3/09**	21.8		2 U		1.22	0.72	4420	1760	921	2400
Herman Creek	5/18/10	20.4		2 U		0.9	0.5	3440	1400	718	1980
Dry Creek Spring	9/19/08	23		10 U		1.1	1.1	6,790	2,650	2,150	4,290
Dry Creek	11/3/09	20.8		2 U		1.2	0.41	4670	1840	321	1810
Dry Creek	5/18/10	21.6		2 U		1.02	0.35	3800	1530	332	1730

Bold: sample represented in Trilinear Diagram on Slide 8/16 of November 2010 Presentation
U = non-detect at associated lab reporting limit
*Sample collected by USGS at Warrendale station, data available from NWIS; sample results reported as filtered; CO3 result reported as 0 mg/L

Table 4. Cascade Locks Area Isotope Chemistry, May 2010

Sample Name	Oxygen-18 $\delta^{18}O$ H_2O ‰	Deuterium δD H_2O ‰
Herman Creek	-11.23	-77.0
Columbia River	-16.47	-119.3
Oxbow Springs	-11.07	-76.2
CL Wellfield - Fish Tank	-10.99	-75.8

Table 5. Estimated Temperature Changes in Herman Creek Due to Water Exchange, Thermal Flux Model Results

Date	Estimated Temp. Changes (F) 2010 Conditions	Estimated Temp. Changes (F) 1977 Drought Conditions
6/17/10	0.008	0.013
6/18/10	0.009	0.015
6/19/10	0.010	0.017
6/20/10	0.010	0.018
6/21/10	0.012	0.020
6/22/10	0.012	0.020
6/23/10	0.013	0.023
6/24/10	0.015	0.026
6/25/10	0.014	0.025
6/26/10	0.016	0.028
6/27/10	0.017	0.030
6/28/10	0.016	0.028
6/29/10	0.018	0.031
6/30/10	0.020	0.035
7/1/10	0.020	0.036
7/2/10	0.018	0.033
7/3/10	0.021	0.037
7/4/10	0.022	0.039
7/5/10	0.022	0.039
7/6/10	0.025	0.045
7/7/10	0.023	0.041
7/8/10	0.024	0.044
7/9/10	0.026	0.048
7/10/10	0.028	0.051
7/11/10	0.027	0.050
7/12/10	0.029	0.053
7/13/10	0.030	0.055
7/14/10	0.030	0.055
7/15/10	0.031	0.058
7/16/10	0.035	0.066
7/17/10	0.033	0.061
7/18/10	0.035	0.064
7/19/10	0.036	0.068
7/20/10	0.038	0.071
7/21/10	0.037	0.069
7/22/10	0.040	0.076
7/23/10	0.040	0.076
7/24/10	0.040	0.075
7/25/10	0.043	0.082
7/26/10	0.045	0.086
7/27/10	0.043	0.082
7/28/10	0.046	0.088
7/29/10	0.048	0.093
7/30/10	0.050	0.097
7/31/10	0.048	0.092
8/1/10	0.049	0.095
8/2/10	0.051	0.098

Date	Estimated Temp. Changes (F) 2010 Conditions	Estimated Temp. Changes (F) 1977 Drought Conditions
8/3/10	0.053	0.104
8/4/10	0.049	0.096
8/5/10	0.056	0.110
8/6/10	0.058	0.113
8/7/10	0.056	0.110
8/8/10	0.056	0.110
8/9/10	0.064	0.126
8/10/10	0.063	0.125
8/11/10	0.062	0.123
8/12/10	0.066	0.130
8/13/10	0.069	0.138
8/14/10	0.070	0.140
8/15/10	0.069	0.139
8/16/10	0.075	0.151
8/17/10	0.078	0.159
8/18/10	0.076	0.153
8/19/10	0.079	0.161
8/20/10	0.083	0.169
8/21/10	0.084	0.172
8/22/10	0.083	0.170
8/23/10	0.091	0.187
8/24/10	0.087	0.179
8/25/10	0.089	0.184
8/26/10	0.092	0.190
8/27/10	0.089	0.184
8/28/10	0.091	0.190
8/29/10	0.101	0.211
8/30/10	0.097	0.202
8/31/10	0.096	0.199
9/1/10	0.066	0.127
9/2/10	0.085	0.169
9/3/10	0.096	0.198
9/4/10	0.108	0.224
9/5/10	0.114	0.239
9/6/10	0.108	0.226
9/7/10	0.102	0.211
9/8/10	0.104	0.214
9/9/10	0.109	0.225
9/10/10	0.112	0.233
9/11/10	0.120	0.252
9/12/10	0.119	0.249
9/13/10	0.121	0.254
9/14/10	0.129	0.273
9/15/10	0.125	0.264
9/16/10	0.115	0.237
9/17/10	0.098	0.192
9/18/10	0.062	0.114

Date	Estimated Temp. Changes (F) 2010 Conditions	Estimated Temp. Changes (F) 1977 Drought Conditions
9/19/10	0.070	0.132
9/20/10	0.053	0.096
9/21/10	0.085	0.163
9/22/10	0.103	0.204
9/23/10	0.112	0.225
9/24/10	0.110	0.220
9/25/10	0.119	0.243
9/26/10	0.125	0.255
9/27/10	0.120	0.243
9/28/10	0.128	0.263
9/29/10	0.132	0.272
9/30/10	0.127	0.263
10/1/10	0.140	0.288
10/2/10	0.139	0.288
10/3/10	0.139	0.290
10/4/10	0.147	0.306
10/5/10	0.143	0.300
10/6/10	0.153	0.321

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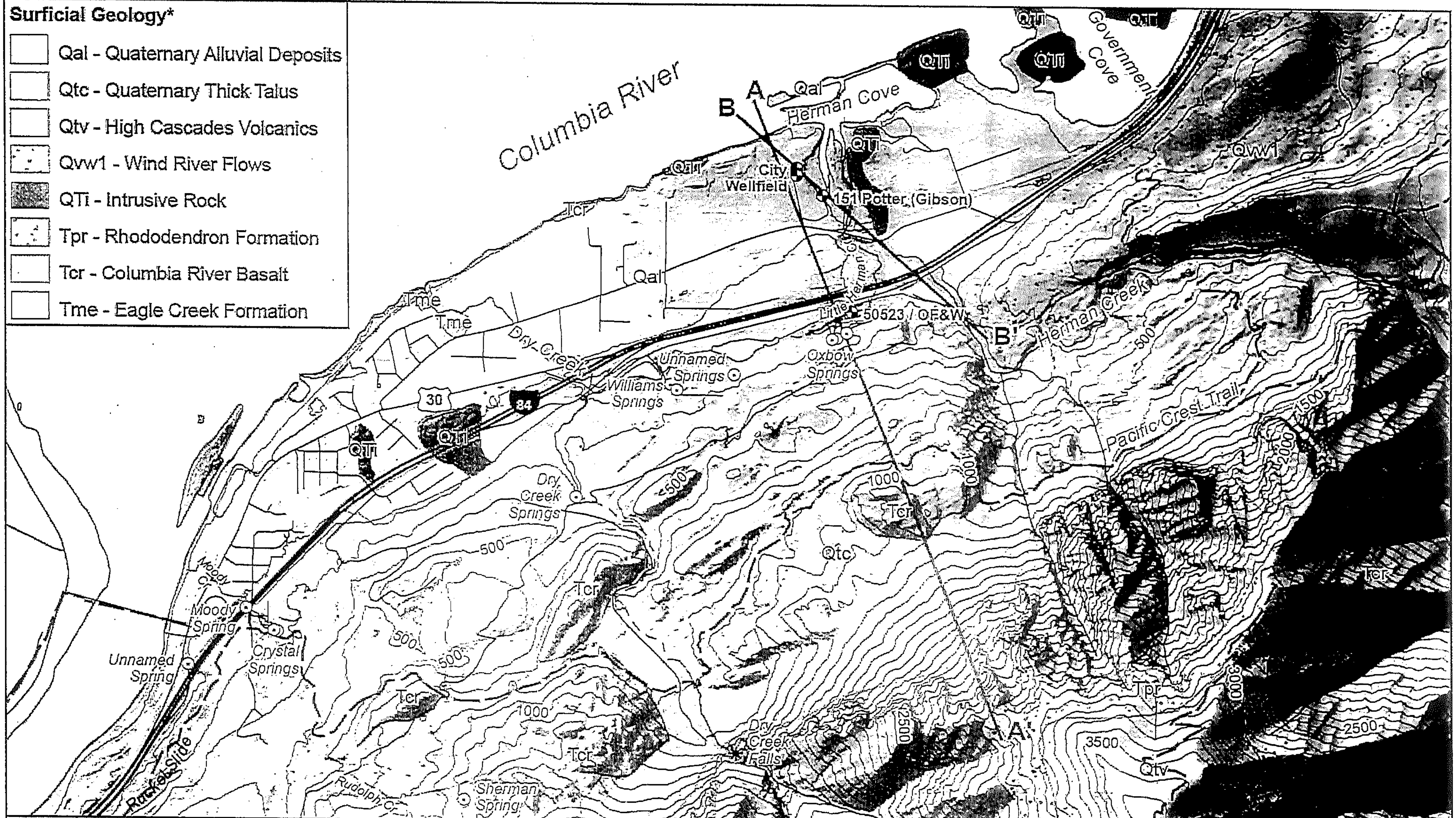

Wells

Spring Locations

Losing Stream Reaches

Trails

100-foot Land Surface Contours

Cross Section Profile

* Modified from:
Bulletin #91, Geologic hazards of parts of northern Hood River, Wasco, and Sherman Counties, Oregon by John D. Beaulieu, 1977

A Reconnaissance of the Ground-Water Resources of the Hood River Valley and the Cascade Locks Area, Hood River County, Oregon. State of Oregon Ground Water Report No. 10. by Jack E. Sceva, 1966

N

0 Feet 2,000

Figure 1

Surficial Geology of the Cascade Locks Vicinity

PGG

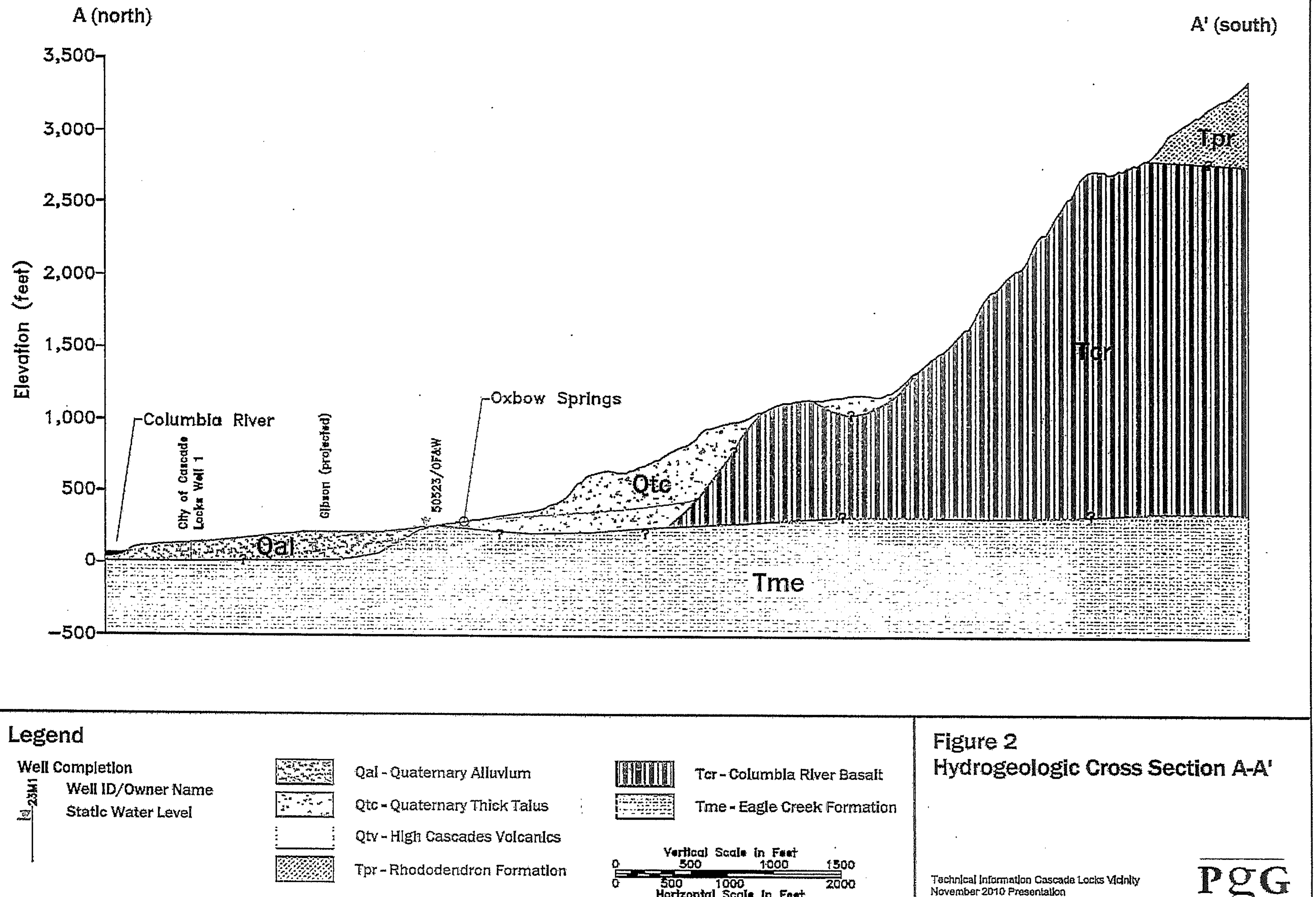

Figure 2
Hydrogeologic Cross Section A-A'

Technical Information Cascade Locks Vicinity
November 2010 Presentation
JE0705.41, XsecA.dwg

PGG

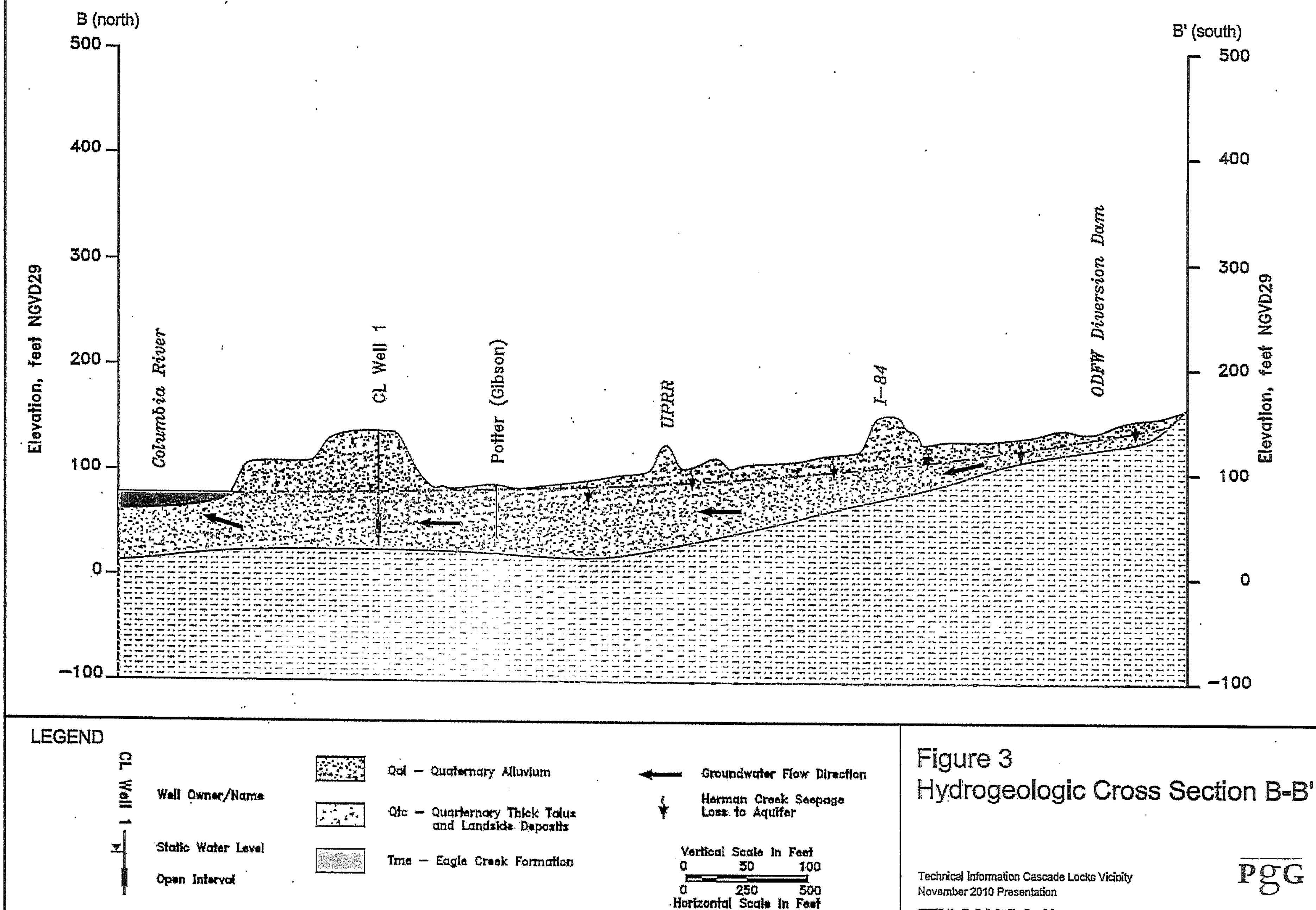

Figure 3
Hydrogeologic Cross Section B-B'

Technical Information Cascade Locks Vicinity
November 2010 Presentation

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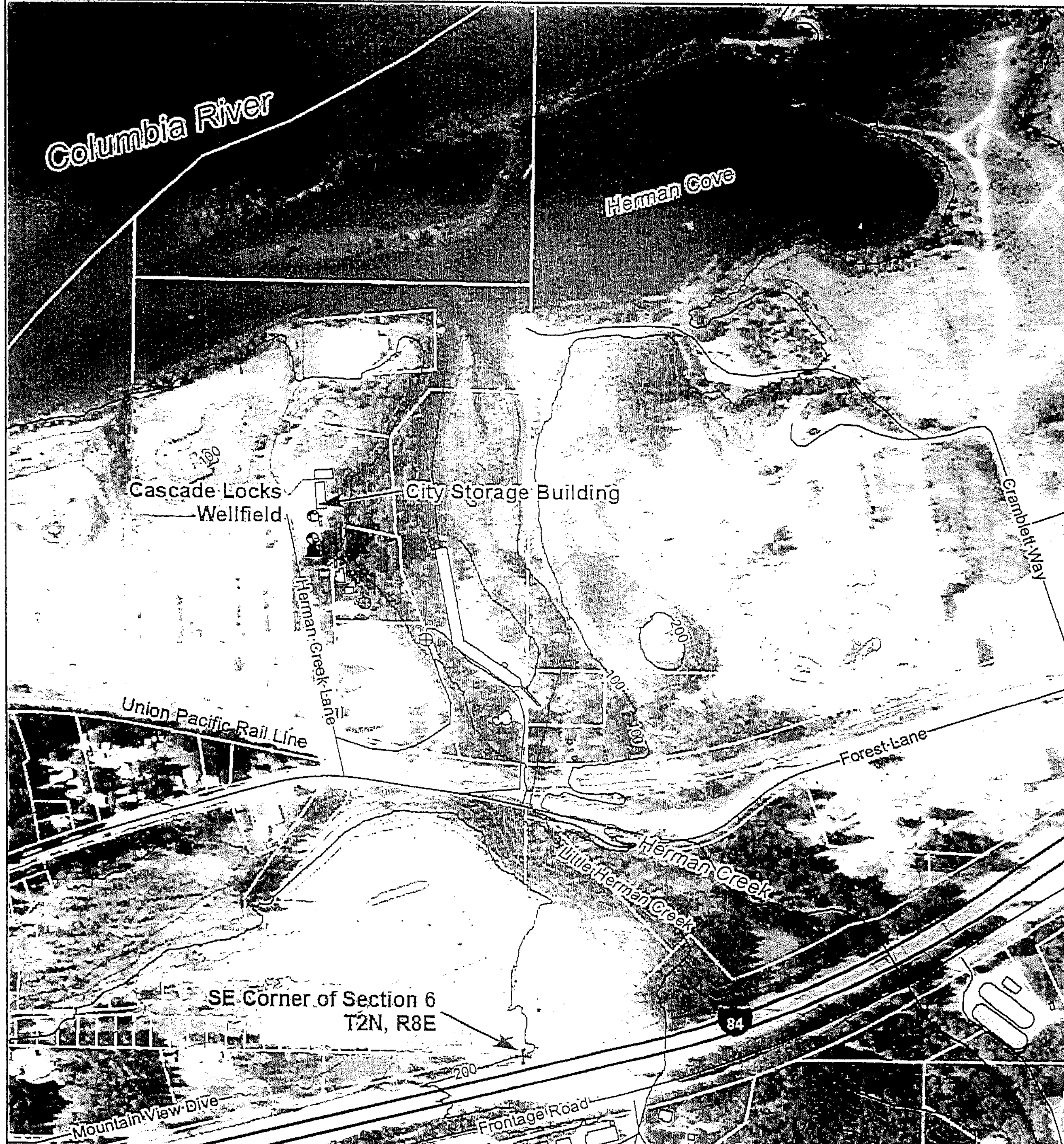


Figure 4
Cascade Locks Wellfield Site Map

PgG

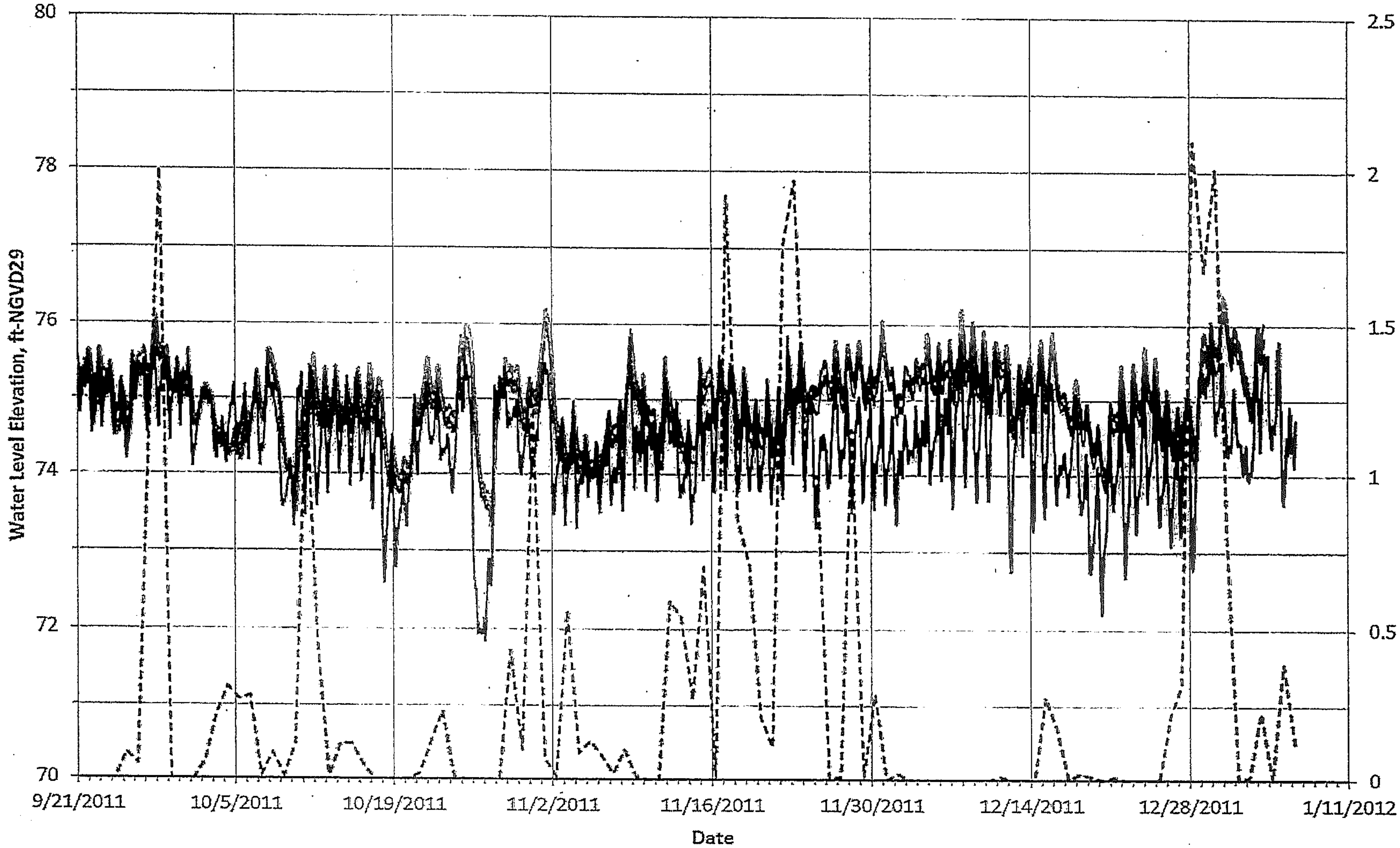
- Fish Tank Supply Well*
- Existing City Wells
- Potter (Gibson) Well
- Port of Cascade Locks Well
- Buildings & Structures
- City of Cascade Locks Parcel
- 100-foot Contours
- 20-foot Contours

* Well Location Information:

1720 feet North and 710 feet West of the southeast corner of Section 6, Township 2 North, Range 8 East
Easting: 963,808 Feet
Northing: 1,435,927 Feet
Projection: Oregon Statewide Lambert, NAD 83
Vertical Datum: NAVD88

0 Feet 500
1 inch = 500 feet
2005 Orthophoto

N

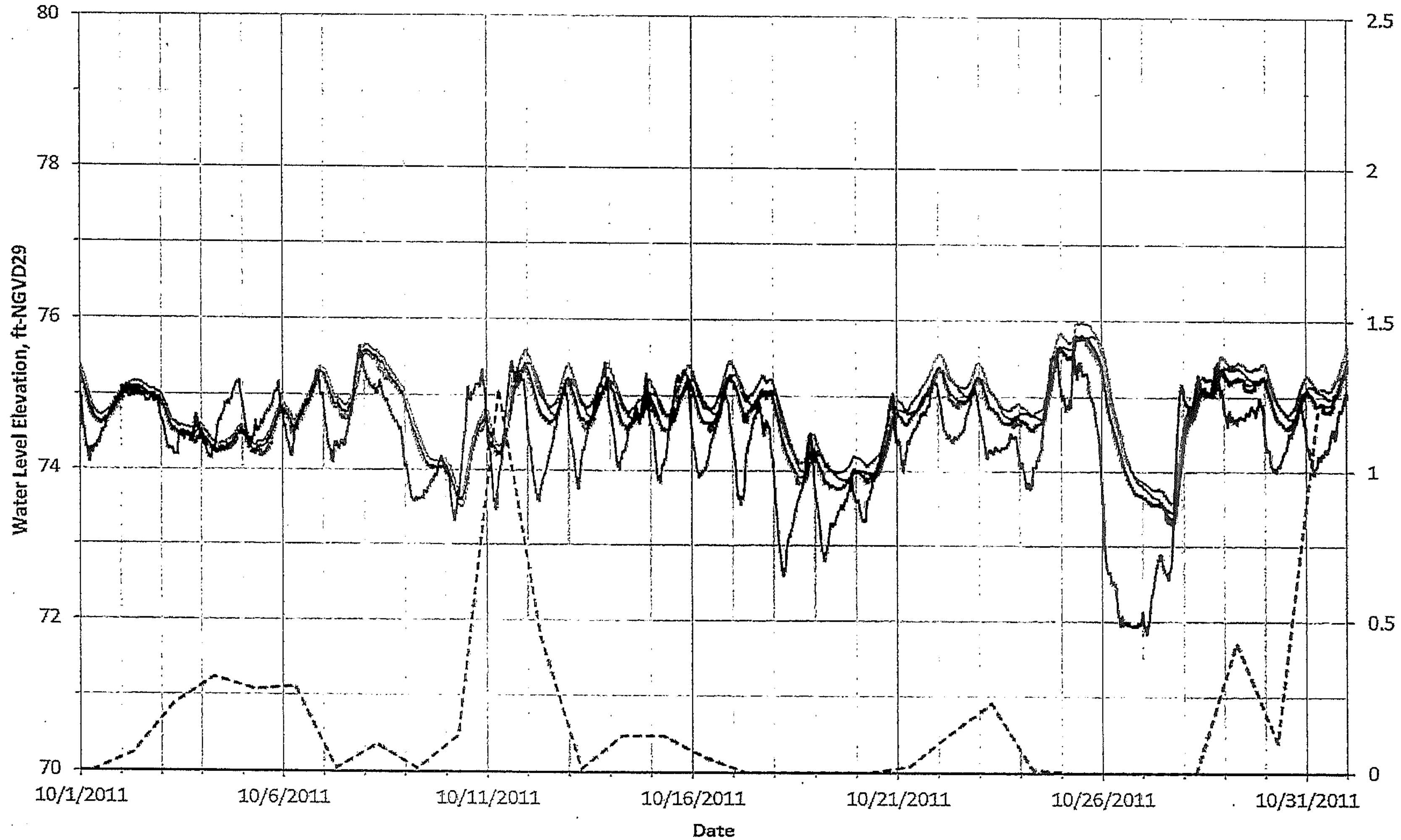


Groundwater Level data available at www.nestlewaterspnw.com
Columbia River Stevenson data available at http://waterdata.usgs.gov/nwis/inventory/?site no=14128600&agency cd=USGS
Bonneville Dam, Oregon (350897) precipitation data avilable from www.wrcc.dri.edu

Figure 5a
Water Level and Precipitation Trends for the Cascade Locks Wellfield Vicinity

Technical Information November 2010 Presentation
All_MW_Data_v1.xls

PGG



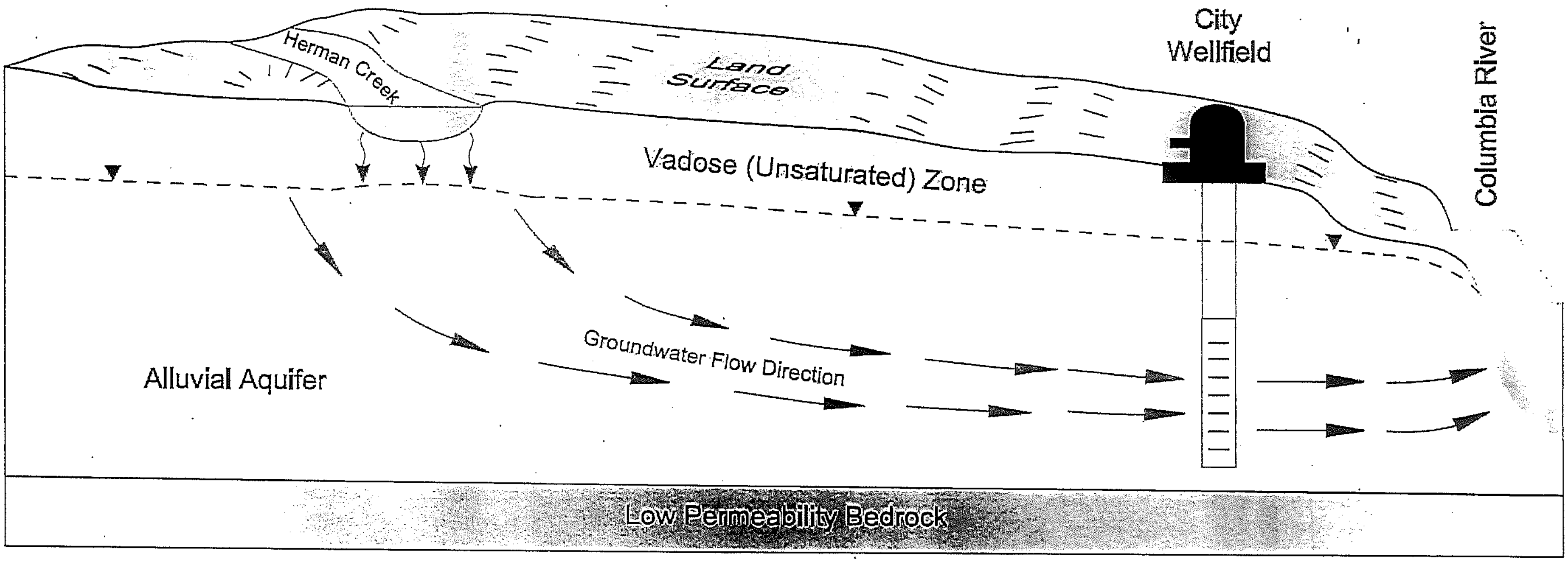
City Well 1
Port of CL
Columbia River - Stevenson
Fish Tank Well
Gibson
Bonneville Dam Daily Precipitation

Groundwater Level data available at www.nestlewaterspnw.com
Columbia River Stevenson data available at http://waterdata.usgs.gov/nwis/inventory/?site no=14128600&agency cd=USGS
Bonneville Dam, Oregon (350897) precipitation data avilable from www.wrcc.dri.edu

Figure 5b
Water Level and Precipitation Trends for the Cascade Locks Wellfield Vicinity, October 2011

Technical Information November 2010 Presentation
All_MW_Data_v1.xls

PgG



Modified from USGS Circular 1186, Sustainability of Ground-Water Resources. W.M. Alley, Thomas E. Reilly, and O.Lehn Franke. 1999.

Water Table

Conceptual Diagram, not to scale.

Figure 6a. Conceptual Model of Groundwater Flow from Herman Creek Seepage to City of Cascade Locks Wellfield under Non-Pumping Conditions

PgG

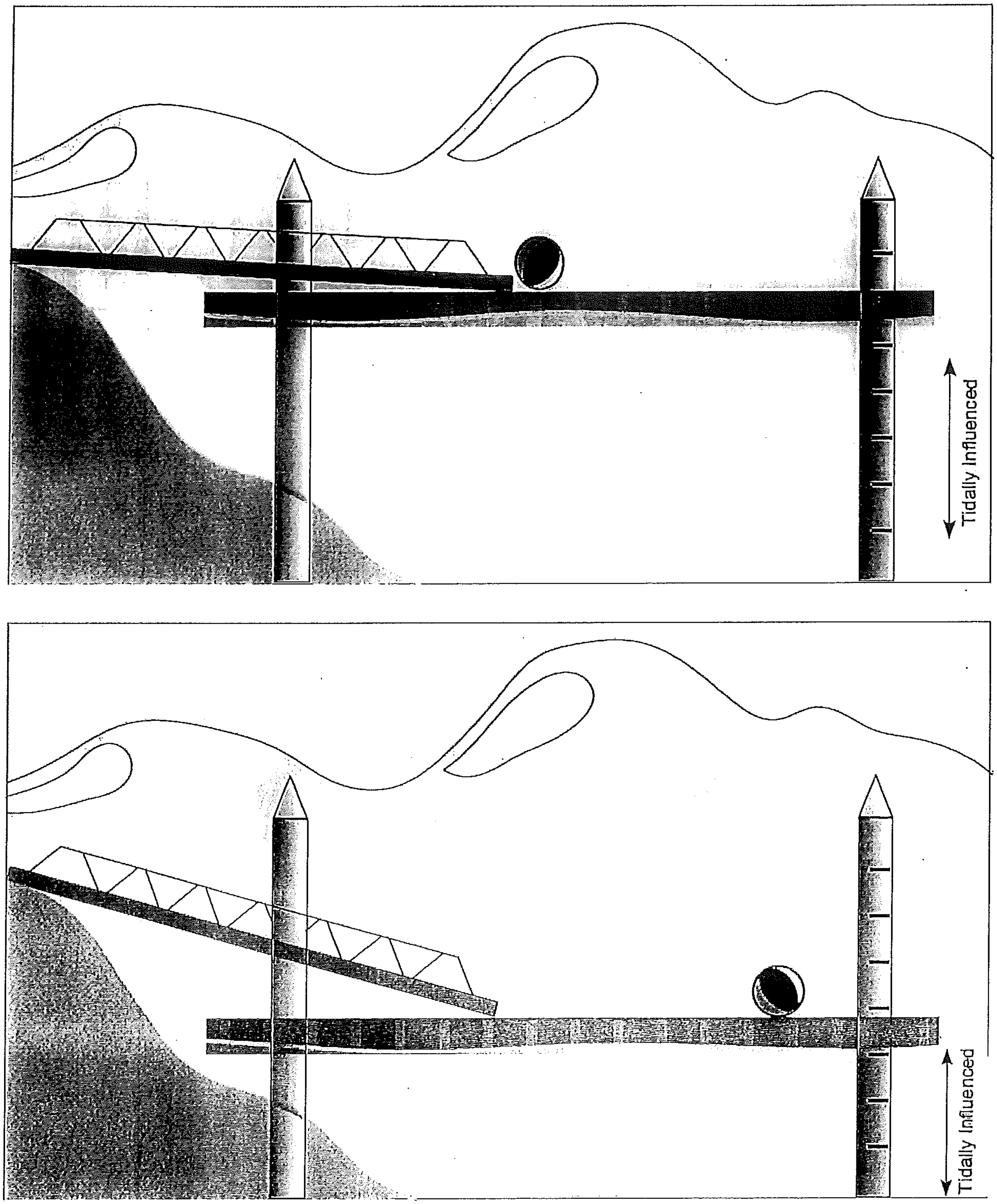
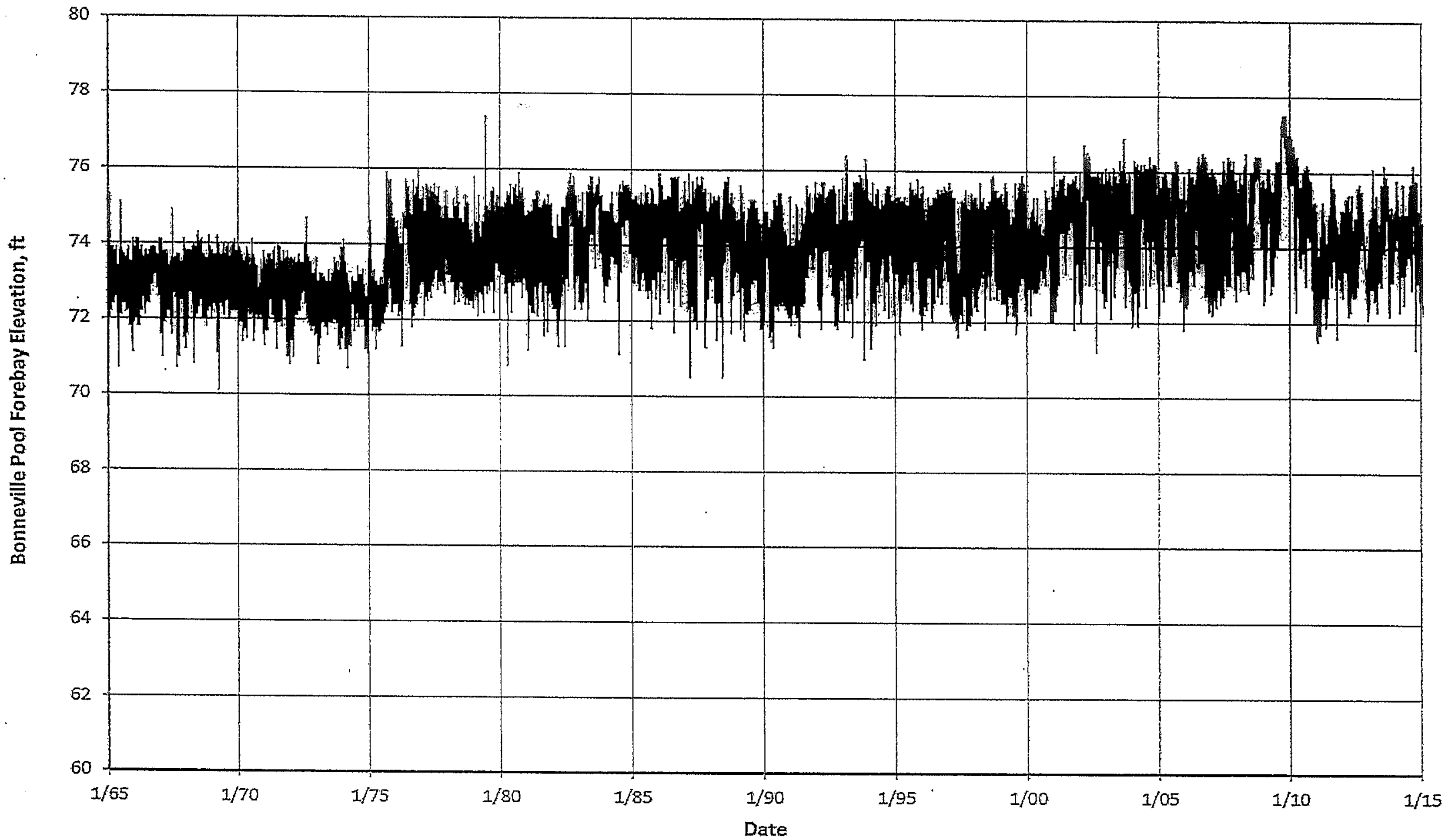


Figure 6b. Floating Boat Dock and Inclined Ramp Analogy to Columbia River and Water Table Slope in Cascade Locks Wellfield Vicinity

PGG

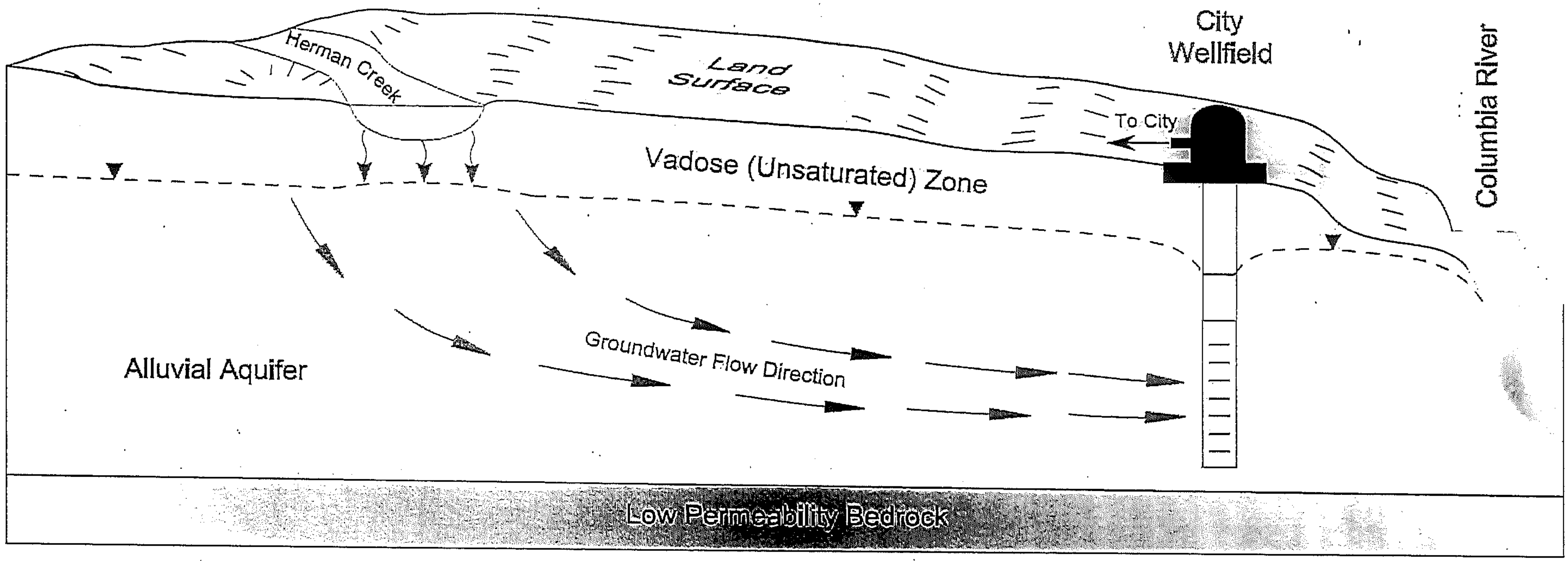


Columbia River at Bonneville Pool Forebay elevation daily, manual collection data available at :
http://www.nwd-wc.usace.army.mil/cgi-bin/dataquery.pl?k=columbia+river+at+bonneville

Figure 7
Bonneville Pool Elevation as Measured at Bonneville Dam

Technical Information November 2010 Presentation
Cascade Locks Vicinity

PgG



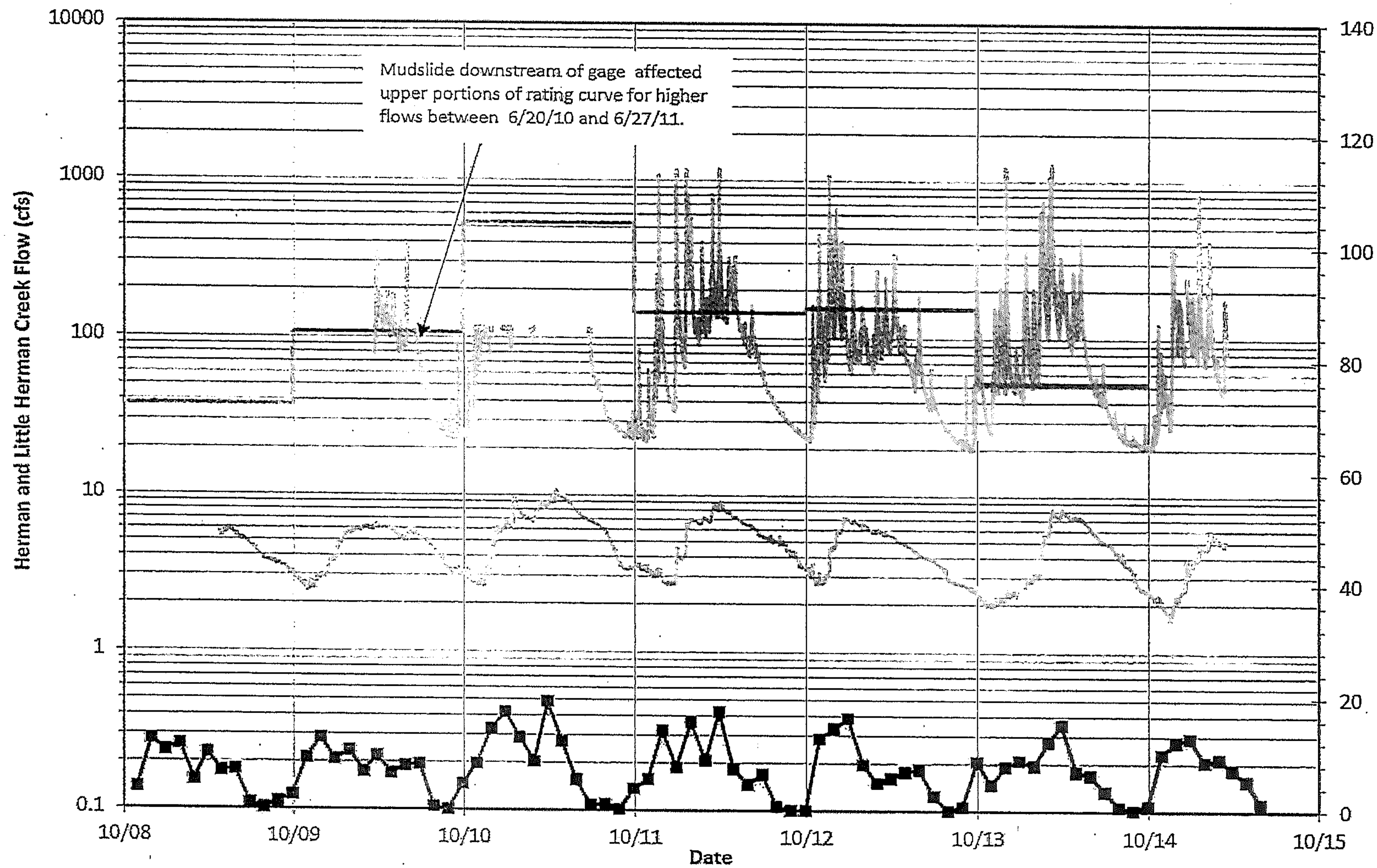
Modified from USGS Circular 1186, Sustainability of Ground-Water Resources. W.M. Alley, Thomas E. Reilly, and O.Lehn Franke. 1999.

Water Table

Conceptual Diagram, not to scale.

Figure 6c. Conceptual Model of Groundwater Flow from Herman Creek Seepage to City of Cascade Locks Wellfield under Pumping Conditions

PgG



Herman Cr. Flow above Upper Diversion Dam
Little Herman Cr. Flow Downstream of Hatchery (24 hour running average)
Total Monthly Precipitation at Bonneville Dam
Total Water Year Precipitation at Bonneville Dam

Herman Creek and Little Herman Creek flow data available at www.nestlewaterspnw.com
Bonneville Dam, Oregon (350897) precipitation data avilable from www.wrcc.dri.edu

Figure 9
Flow Hydrographs for Herman Creek and Little Herman Creek

Technical Information November 2010 Presentation
hermanflow_hydro_12_6_11.xlsx

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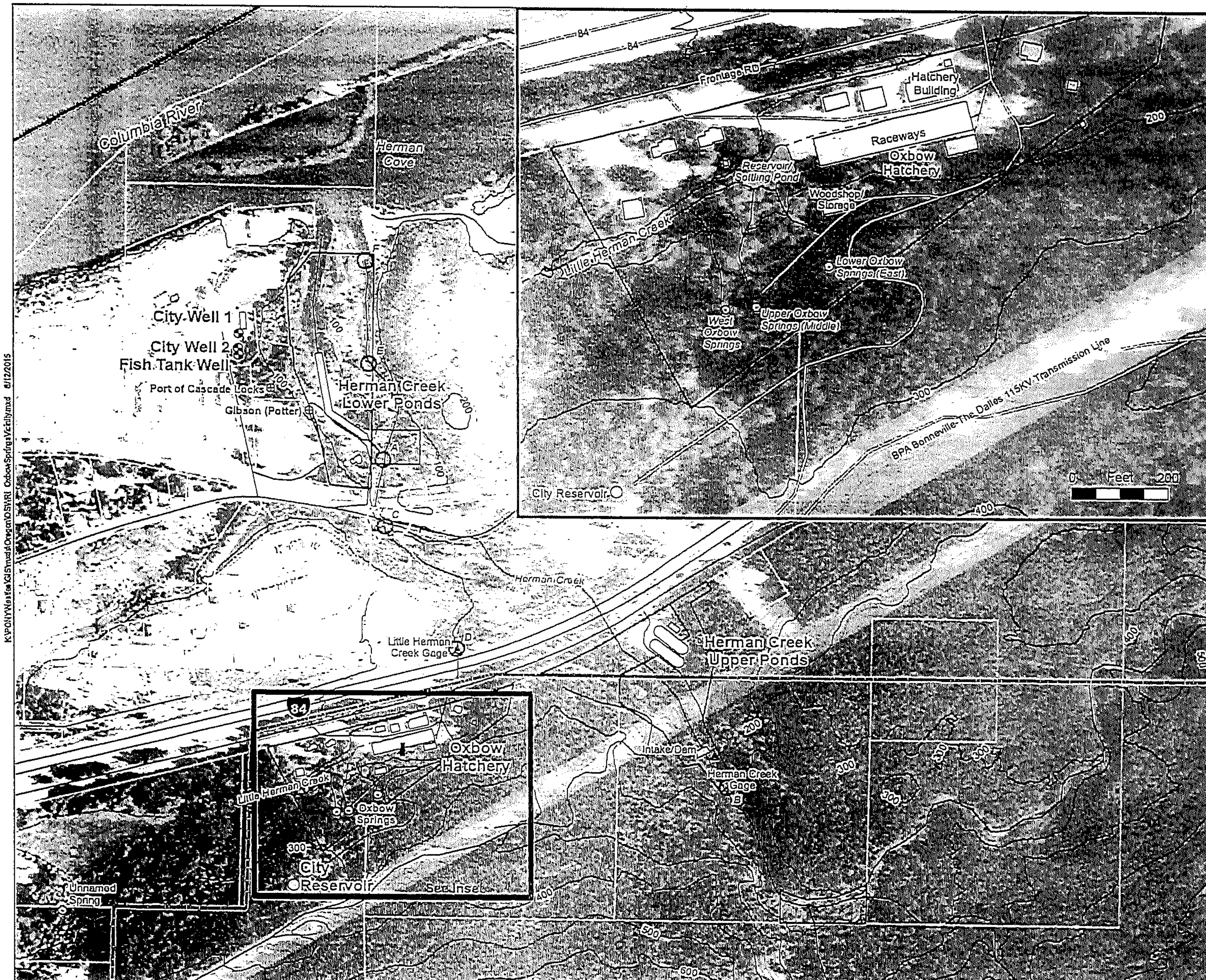

Figure 10

Focused Oxbow Springs Vicinity, Stream Gages, and Seepage Survey Locations

Cascade Locks
Water Resources Investigation
Summary Report

PgG

- Gaging Station
- City Well
- Other Nearby Wells
- City Reservoir
- ODFW Weir
- Spring
- Losing Stream Reaches (Based on seepage surveys)
- Seepage-Survey Sites
- Herman Creek & Little Herman Creek Confluence Area
- 20-foot Contour
- 100-foot Contour
- Fish Hatchery Parcels
- Building or Structure
- City Limits

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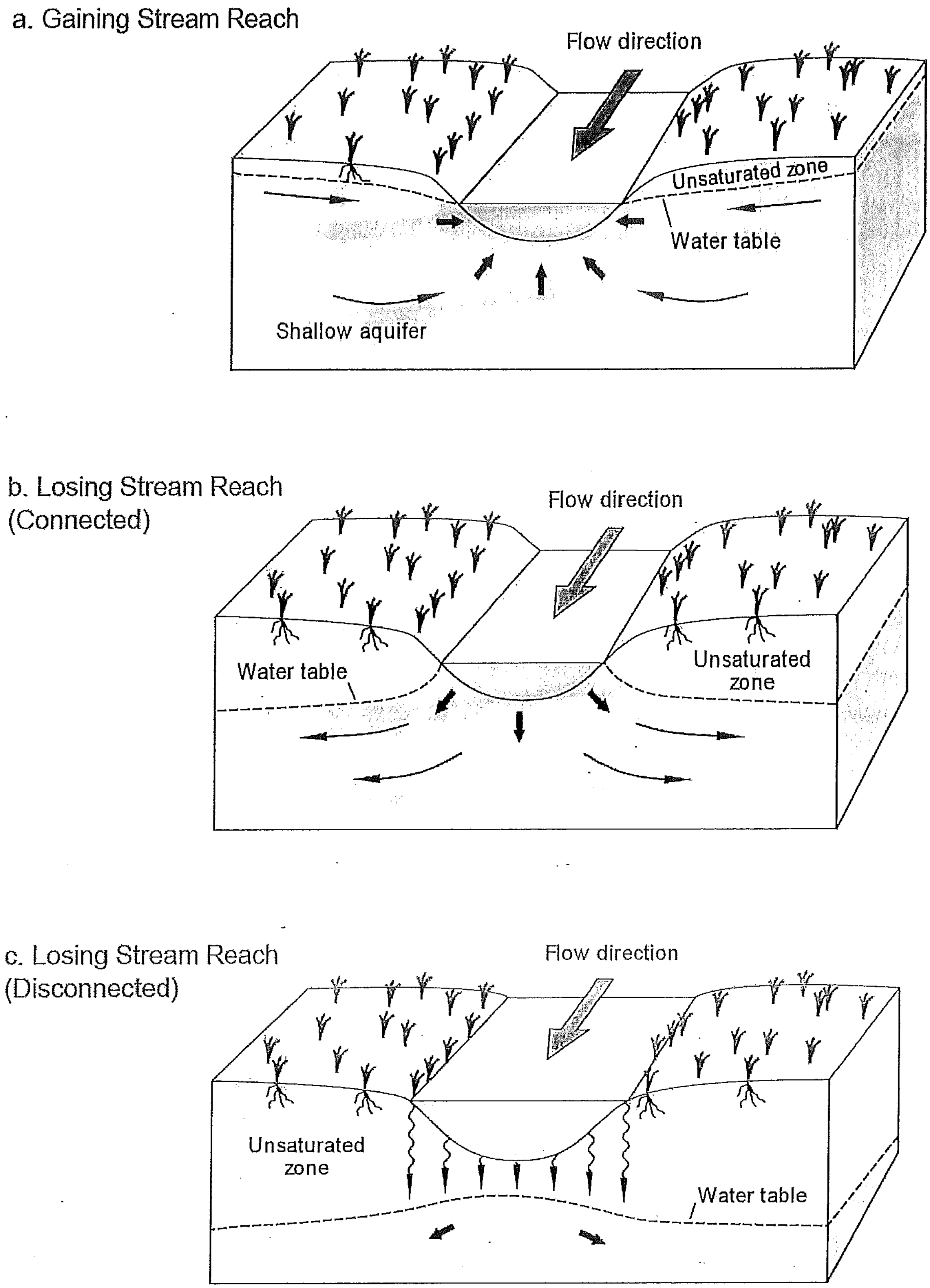
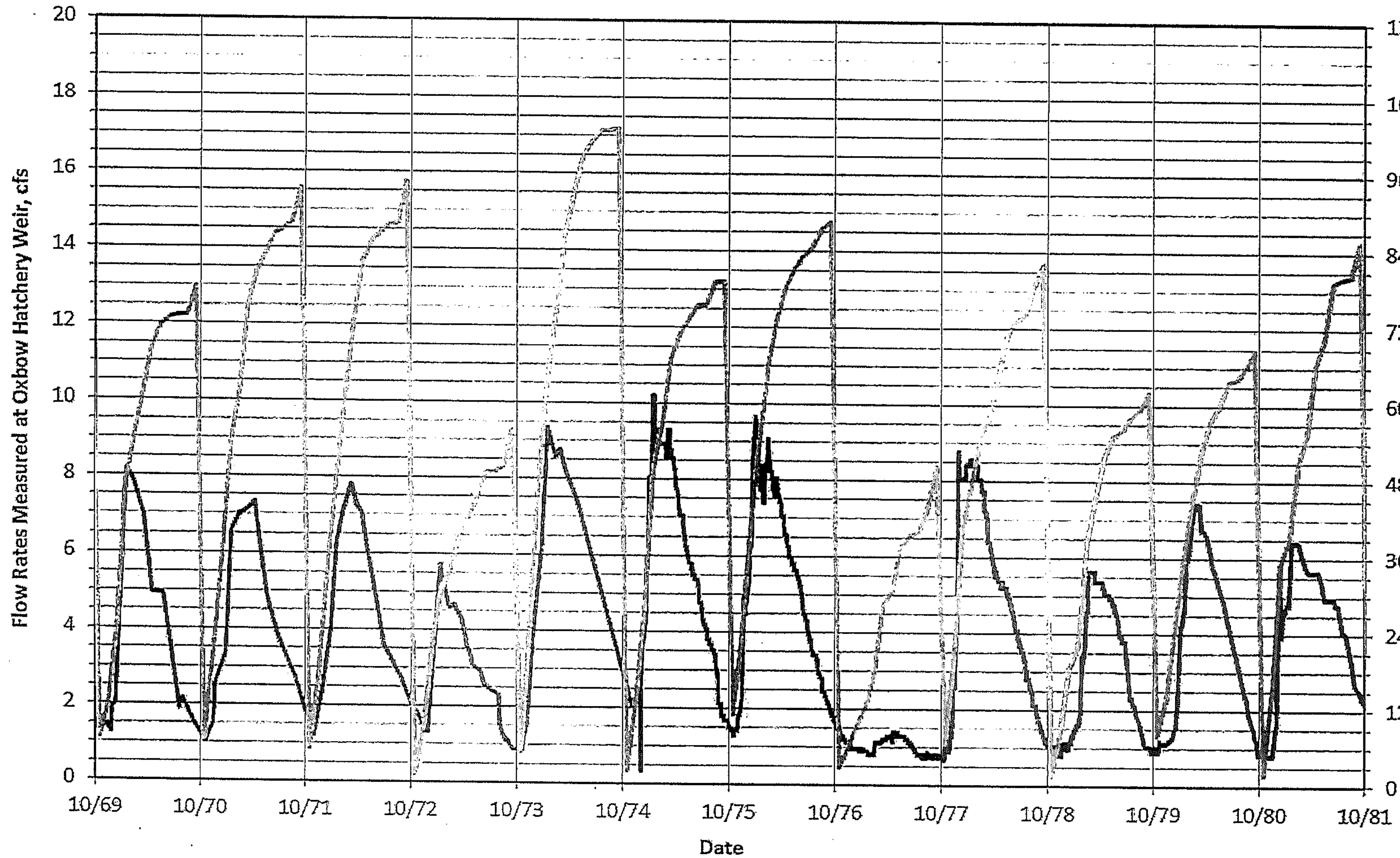


From USGS Circular 1139 Ground Water and Surface Water A Single Resource. Winter et. al., 1999.

Figure 11. Schematic Diagram of Gaining, Losing, and Disconnected Streams

PgG



ODFW Measurements of Spring Flow at Hatchery Weir

Water Year Cumulative Monthly Precipitation at Bonneville Dam

ODFW flow measurements available at www.nestlewaterspnw.com
Bonneville Dam, Oregon (350897) precipitation data avilable from www.wrcc.dri.edu

Figure 12a. Comparison of ODFW Flow Rates at Oxbow Hatchery and Precipitation at Bonneville Dam

Technical Information November 2010 Presentation
hermanflow_hydro_12_6_11.xlsx

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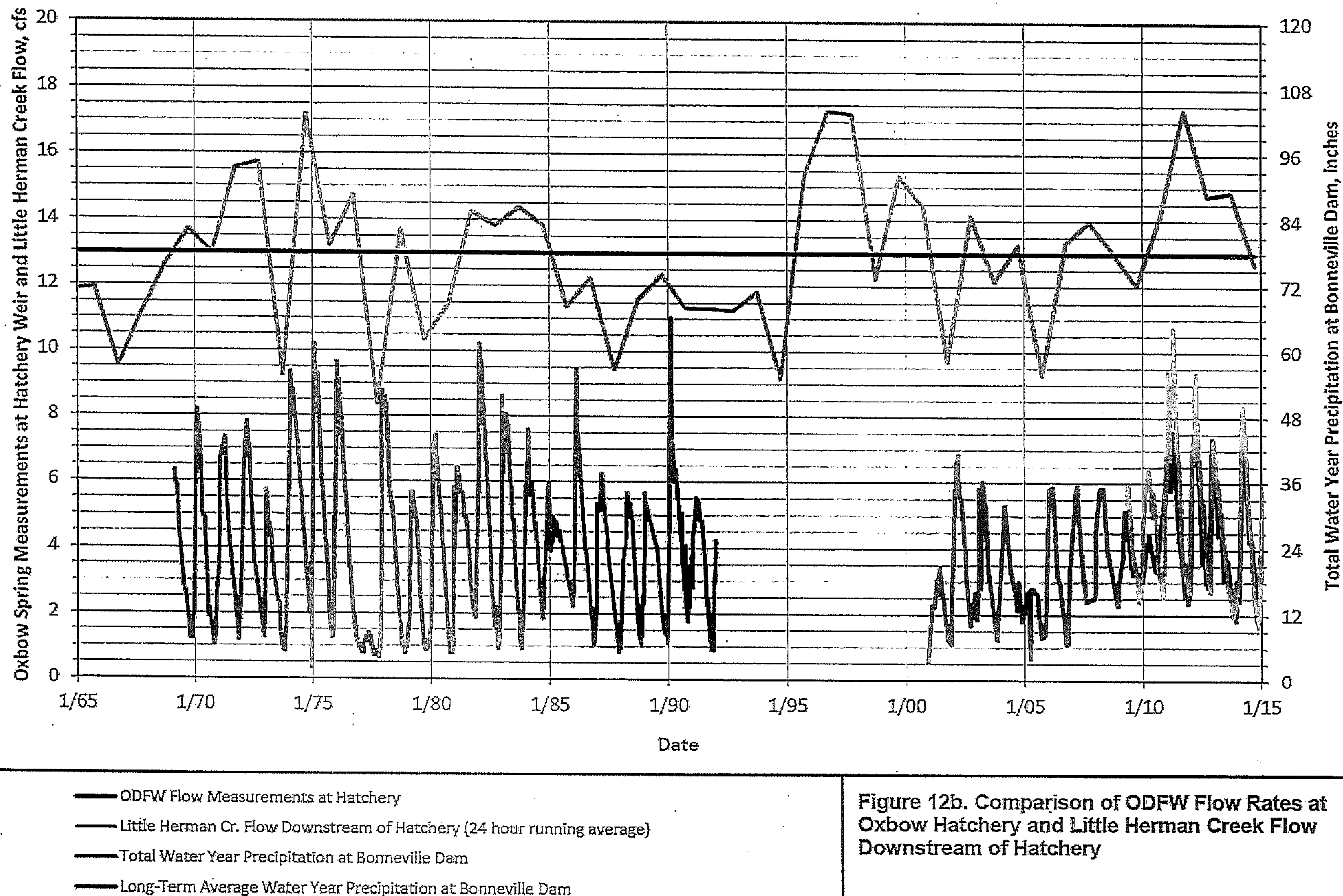
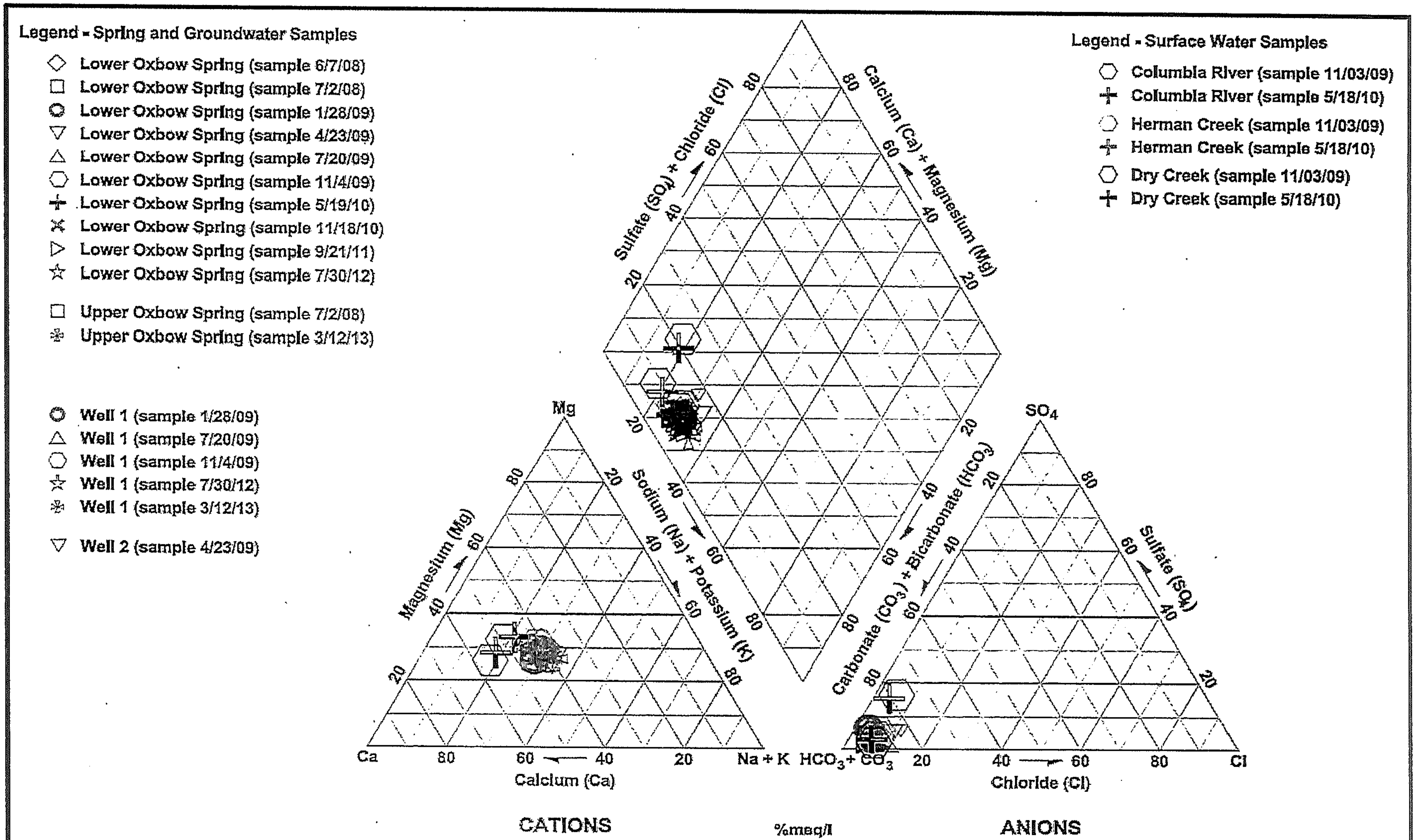


ODFW Weir Measurements and Little Herman Creek flow data available at www.nestlewaterspnw.com
Bonneville Dam, Oregon (350897) precipitation data avilable from www.wrcc.dri.edu

Figure 12b. Comparison of ODFW Flow Rates at Oxbow Hatchery and Little Herman Creek Flow Downstream of Hatchery

Technical Information November 2010 Presentation
hermanflow_hydro_12_6_11.xlsx

PgG



Non-detect results represented by 50-percent of the detection limit in calculations of milliequivalents per liter (%meq/l)

FIGURE 13. Trilinear Diagram Representing Oxbow Springs, Test Wells, City Wellfield, Herman Creek, Dry Creek, and Columbia River Samples Collected 2008 - 2013

Technical Information November 2010 Presentation
May 2015

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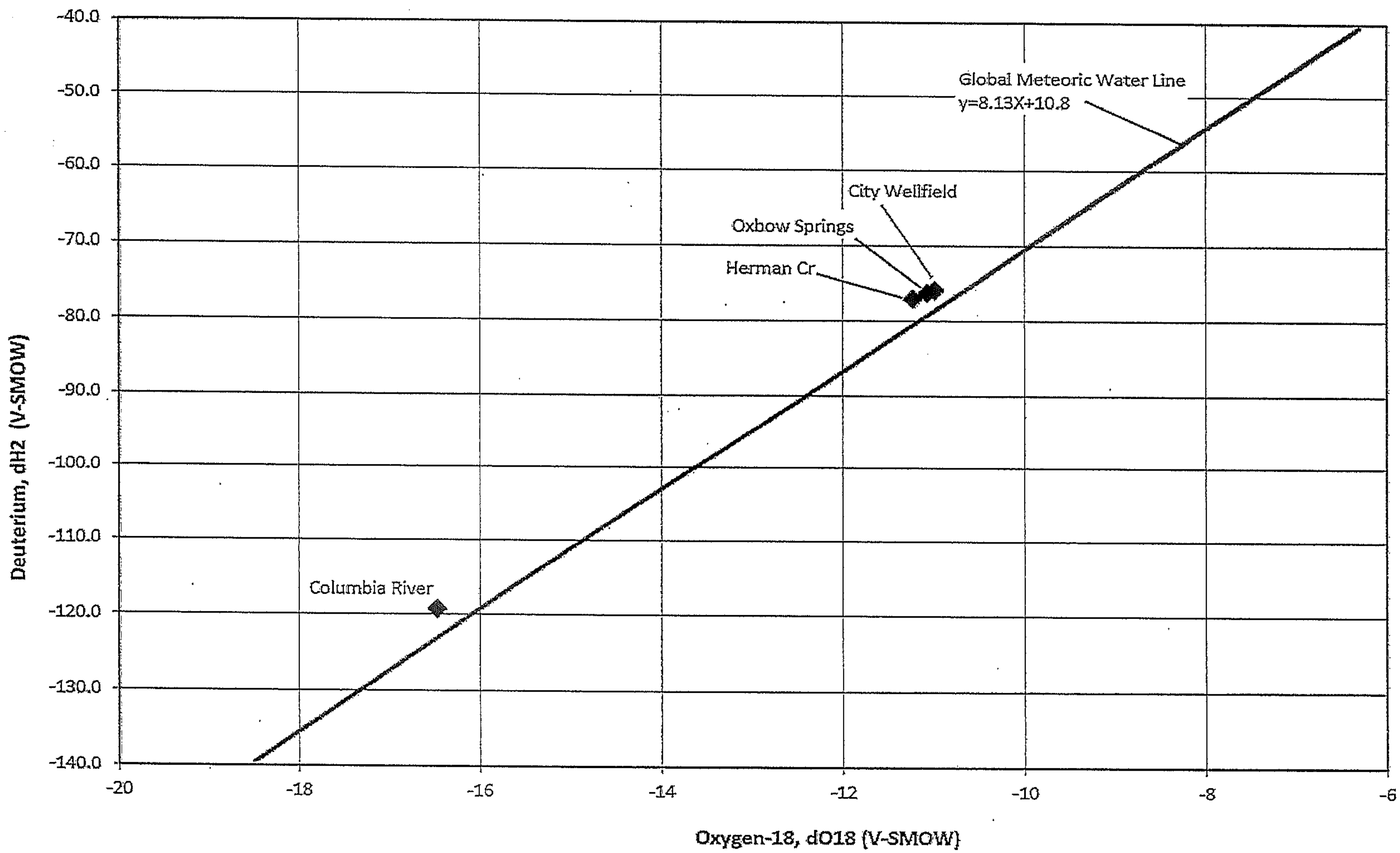

V-SMOW: Vienna Standard Mean Ocean Water (water standard defining the isotopic composiiton of fresh water)

Figure 14. Deuterium and Oxygen-18 Ratios of Cascade Locks Samples

Technical Information November 2010 Presentation
isotopedatasummary.xls

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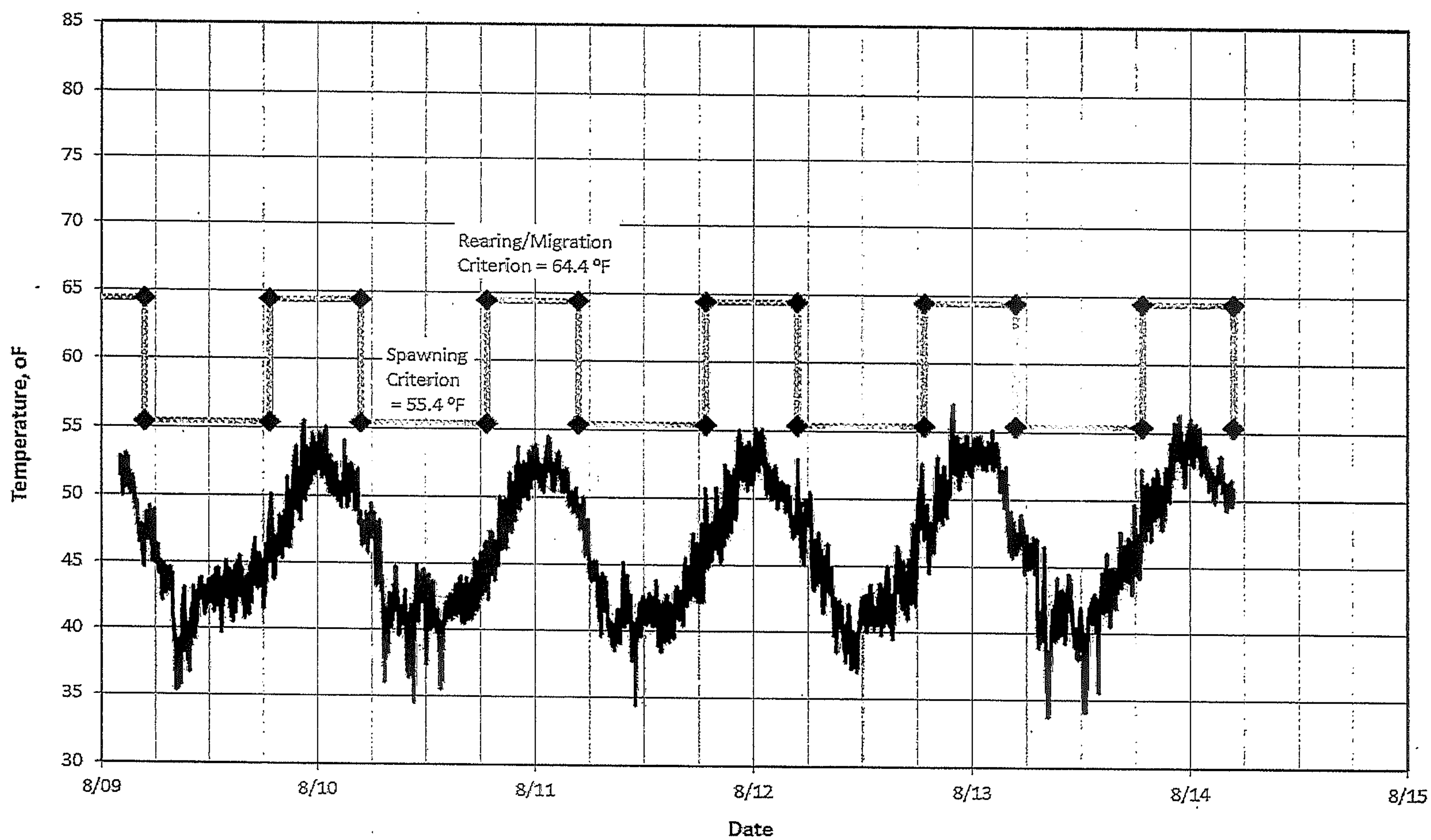


Herman Creek at Upper Diversion Dam

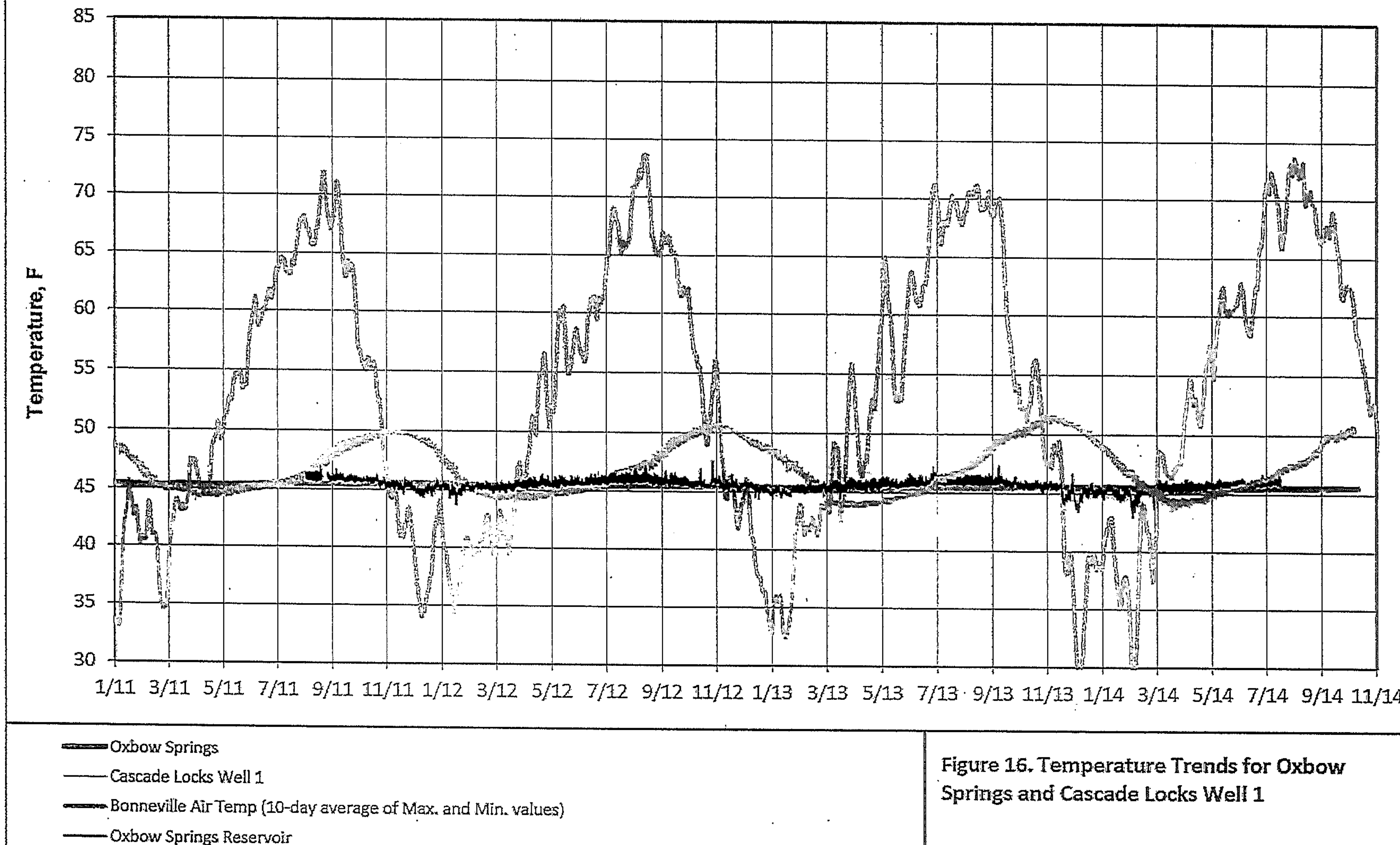
OAR 340-041-0028 Temperature Criteria

Herman Creek temperature data available at www.nestlewaterspnw.com

Figure 15. Temperature Trends for Herman Creek Relative to Regulatory Criteria

Technical Information November 2010 Presentation
temperaturetrends_lp_1_v052115.xls

PgG



Oxbow Springs, Well 1, and Oxbow Springs Reservoir temperature data available at www.nestlewaterspnw.com
Bonneville Dam air temperature data available at : www.nwd-wc.usace.army.mil/cgi-bin/dataquery.pl?k=Columbia+River+at+Bonneville

Figure 16. Temperature Trends for Oxbow Springs and Cascade Locks Well 1

Technical Information November 2010 Presentation
temperaturetrends_lp_1_v052115.xls

PgG

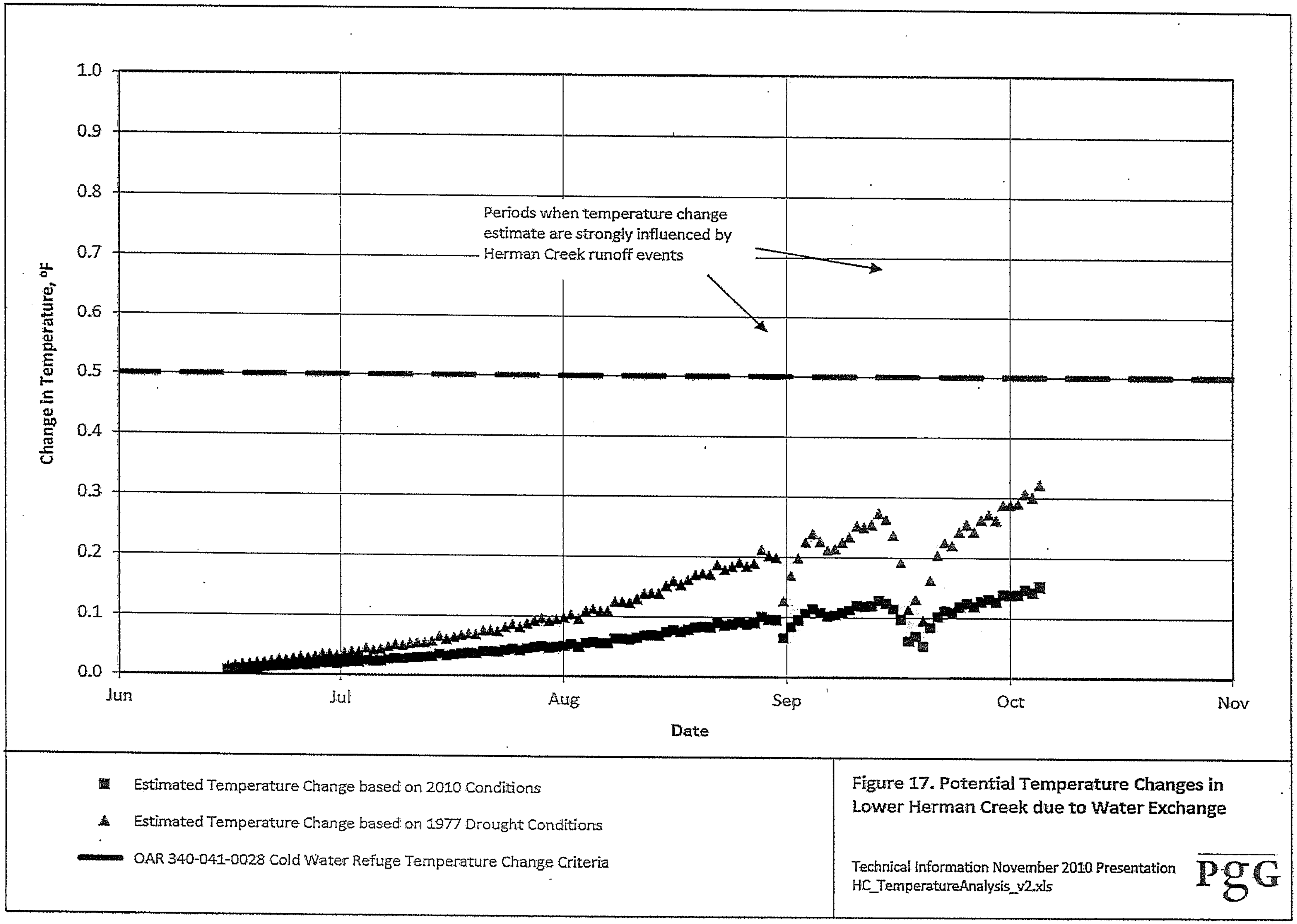


Figure 17. Potential Temperature Changes in Lower Herman Creek due to Water Exchange

Technical Information November 2010 Presentation
HC_TemperatureAnalysis_v2.xls

PgG

NOTICE TO WATER WELL CONTRACTORS
The original and first copy of this report are to be filed with the
STATE ENGINEER, SALEM, OREGON 97310 within 30 days from the date of well completion.

RECEIVED
MAR 13 1969
STATE ENGINEER
SALEM, OREGON

MULT

WATER WELL REPORT
STATE OF OREGON
(Please type or print)
(Do not write above this line)

002057

State Well No. 2N/8-6 da
State Permit No.

(1) OWNER:
Name CITY OF CASCADE LOCKS
Address CASCADE LOCKS, ORE.

(2) TYPE OF WORK (check):
New Well ☒ Deepening ☐ Reconditioning ☐ Abandon ☐
If abandonment, describe material and procedure in Item 12.

(3) TYPE OF WELL:
Rotary ☐ Driven ☐
Cable ☒ Jetted ☐
Dug ☐ Bored ☐

(4) PROPOSED USE (check):
Domestic ☐ Industrial ☐ Municipal ☒
Irrigation ☐ Test Well ☐ Other ☐

(5) CASING INSTALLED: Threaded ☐ Welded ☒
14" Diam. from +6 ft. to 110 ft. Gage .375
" Diam. from ft. to ft. Gage
" Diam. from ft. to ft. Gage

(6) PERFORATIONS: Perforated? ☒ Yes ☐ No.
Type of perforator used STAR
Size of perforations 3/8 in. by 1 1/4 in.
1200 perforations from 80 ft. to 103 ft.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.

(7) SCREENS: Well screen installed? ☐ Yes ☒ No
Manufacturer's Name
Type Model No.
Diam. Slot size Set from ft. to ft.
Diam. Slot size Set from ft. to ft.

(8) WATER LEVEL: Completed well.
Static level 61 ft. below land surface Date 2/27/69
Artesian pressure lbs. per square inch Date

(9) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? ☒ Yes ☐ No If yes, by whom? STRASSER
Yield: 1000 gal./min. with 2 ft. drawdown after 24 hrs.
" " "
" " "
Bailer test gal./min. with ft. drawdown after hrs.
Artesian flow g.p.m. Date
Temperature of water 43 Was a chemical analysis made? ☐ Yes ☒ No

(10) CONSTRUCTION:
Well seal—Material used SAND AND CEMENT GROUT
Depth of seal 20 ft.
Diameter of well bore to bottom of seal 20 in.
Were any loose strata cemented off? ☐ Yes ☒ No Depth
Was a drive shoe used? ☒ Yes ☐ No
Did any strata contain unusable water? ☐ Yes ☒ No
Type of water? depth of strata
Method of sealing strata off
Was well gravel packed? ☐ Yes ☒ No Size of gravel:
Gravel placed from ft. to ft.

(11) LOCATION OF WELL:
County MULT Driller's well number 4300
NE ¼ SE ¼ Section 6 T. 2N R. 8E W.M.
Bearing and distance from section or subdivision corner

(12) WELL LOG: Diameter of well below casing
Depth drilled 110 ft. Depth of completed well 110 ft.
Formation: Describe color, texture, grain size and structure of materials; and show thickness and nature of each stratum and aquifer penetrated, with at least one entry for each change of formation. Report each change in position of Static Water Level as drilling proceeds. Note drilling rates.

MATERIAL	From	To	SWL
TOP SOIL	0	2	
SAND, GRAVEL BOULDERS			
AND SOME CLAY	2	28	
SAND AND GRAVEL	28	61	
WATER BEARING			
GRAVEL	61	106	
CEMENTED GRAVEL	106	110	

Work started FEB 8 1969 Completed MAR 4 1969
Date well drilling machine moved off of well MAR 4 1969

Drilling Machine Operator's Certification:
This well was constructed under my direct supervision. Materials used and information reported above are true to my best knowledge and belief.
[Signed] Don ... (Drilling Machine Operator) Date MAR 12 1969
Drilling Machine Operator's License No. 57

Water Well Contractor's Certification:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.
NAME R.L. STRASSER DRILLING Co
(Person, firm or corporation) (Type or print)
Address 8110 SE SUNSET LANE PORTLAND OR
[Signed] Robert L. Strasser
(Water Well Contractor)
Contractor's License No. 70 Date MAR 12 1969

(USE ADDITIONAL SHEETS IF NECESSARY)

NOTICE TO WATER WELL CONTRACTOR
The original and first copy of this report are to be filed with the
STATE ENGINEER, SALEM, OREGON 97310, within 30 days from the date of well completion.

RECEIVED MAR 19 1969 STATE ENGINEER SALEM, OREGON

WATER WELL REPORT
STATE OF OREGON
(Please type or print)
(Do not write above this line)

HOOD
352

State Well No. 2N/8-6 da
State Permit No.

(1) OWNER:
Name CITY OF CASCADE LOCKS
Address CASCADE LOCKS, ORE.

(2) TYPE OF WORK (check):
New Well ☒ Deepening ☐ Reconditioning ☐ Abandon ☐
If abandonment, describe material and procedure in Item 12.

(3) TYPE OF WELL:
Rotary ☐ Driven ☐
Cable ☒ Jetted ☐
Dug ☐ Bored ☐

(4) PROPOSED USE (check):
Domestic ☐ Industrial ☐ Municipal ☐
Irrigation ☐ Test Well ☒ Other ☐

(5) CASING INSTALLED: Threaded ☐ Welded ☒
8" Diam. from 0 ft. to 104 ft. Gage .277
" Diam. from ft. to ft. Gage
" Diam. from ft. to ft. Gage

(6) PERFORATIONS: Perforated? ☒ Yes ☐ No.
Type of perforator used STAR
Size of perforations 3/8 in. by 1 1/4 in.
1000 perforations from 75 ft. to 100 ft.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.

(7) SCREENS: Well screen installed? ☐ Yes ☒ No
Manufacturer's Name
Type Model No.
Diam. Slot size Set from ft. to ft.
Diam. Slot size Set from ft. to ft.

(8) WATER LEVEL: Completed well.
Static level 61 ft. below land surface Date 1/29/69
Artesian pressure lbs. per square inch Date

(9) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? ☒ Yes ☐ No If yes, by whom? STRASSER
Yield: 340 gal./min. with 1 ft. drawdown after 8 hrs.
" " " "
" " " "
Bailer test gal./min. with ft. drawdown after hrs.
Artesian flow g.p.m. Date
Temperature of water 43 Was a chemical analysis made? ☐ Yes ☒ No

(10) CONSTRUCTION:
Well seal—Material used SAND AND CEMENT GROUT
Depth of seal 20 ft.
Diameter of well bore to bottom of seal 12 in.
Were any loose strata cemented off? ☐ Yes ☒ No Depth
Was a drive shoe used? ☒ Yes ☐ No
Did any strata contain unusable water? ☐ Yes ☒ No
Type of water? depth of strata
Method of sealing strata off
Was well gravel packed? ☐ Yes ☒ No Size of gravel:
Gravel placed from ft. to ft.

(11) LOCATION OF WELL:
County HOOD RIVER Driller's well number 4299
NE ¼ SE ¼ Section 6 T. 2N R. 8E W.M.
Bearing and distance from section or subdivision corner

(12) WELL LOG: Diameter of well below casing —
Depth drilled 104 ft. Depth of completed well 104 ft.

Formation: Describe color, texture, grain size and structure of materials; and show thickness and nature of each stratum and aquifer penetrated, with at least one entry for each change of formation. Report each change in position of Static Water Level as drilling proceeds. Note drilling rates.

MATERIAL	From	To	SWL
SANDY SILT	0	2	
GRAVEL AND BOULDERS	2	7	
SAND, GRAVE, BOULDERS, AND SOME CLAY	7	26	
SAND AND GRAVEL	26	40	
LOOSE SAND AND GRAVEL	40	104	

Work started JAN 7 1969 Completed FEB 6 1969
Date well drilling machine moved off of well FEB 7 1969

Drilling Machine Operator's Certification:
This well was constructed under my direct supervision. Materials used and information reported above are true to my best knowledge and belief.
[Signed] [signature] Date MAR 12 1969
(Drilling Machine Operator)
Drilling Machine Operator's License No. 57

Water Well Contractor's Certification:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.
NAME R.L. STRASSER DRILLING CO
(Person, firm or corporation) (Type or print)
Address 8110 SE SUNSET LANE PORTLAND ORE
[Signed] Robert L. Strasser
(Water Well Contractor)
Contractor's License No. 10 Date MAR 12 1969

(USE ADDITIONAL SHEETS IF NECESSARY)

RECEIVED
FEB 10 1961
STATE ENGINEER
SALEM, OREGON

HOOD
351

File Original and First Copy with the STATE ENGINEER, SALEM, OREGON

WATER WELL REPORT
STATE OF OREGON

State Well No. 2N/8-7R 6R(1)

State Permit No.

(1) OWNER:
Name Rodney Potter
Address Star Route
Cascade Locks, Ore.

(2) LOCATION OF WELL:
County Hood River Owner's number, if any—
¼ ¼ Section T. R. W.M.
Bearing and distance from section or subdivision corner
Cascade Locks, Ore.

(3) TYPE OF WORK (check):
New Well ☒ Deepening ☐ Reconditioning ☐ Abandon ☐
If abandonment, describe material and procedure in Item 11.

(4) PROPOSED USE (check):
Domestic ☒ Industrial ☐ Municipal ☐
Irrigation ☐ Test Well ☐ Other ☐

(5) TYPE OF WELL:
Rotary ☐ Driven ☐
Cable ☒ Jetted ☐
Dug ☐ Bored ☐

(6) CASING INSTALLED: Threaded ☐ Welded ☒
6 " Diam. from 0 ft. to 50 ft. Gage .280
" Diam. from ft. to ft. Gage
" Diam. from ft. to ft. Gage

(7) PERFORATIONS: Perforated? ☐ Yes ☒ No
Type of perforator used
SIZE of perforations in. by in.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.

(8) SCREENS: Well screen installed ☐ Yes ☒ No
Manufacturer's Name
Type Model No.
Diam. Slot size Set from ft. to ft.
Diam. Slot size Set from ft. to ft.

(9) CONSTRUCTION:
Was well gravel packed? ☐ Yes ☒ No Size of gravel:
Gravel placed from ft. to ft.
Was a surface seal provided? ☐ Yes ☒ No To what depth? ft.
Material used in seal—
Did any strata contain unusable water? ☐ Yes ☒ No
Type of water? Depth of strata
Method of sealing strata off

(10) WATER LEVELS:
Static level 7½ ft. below land surface Date 12/24/60
Artesian pressure lbs. per square inch Date

Log Accepted by:
[Signed] (Owner) Date , 19

(11) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? ☐ Yes ☒ No If yes, by whom?
Yield: gal./min. with ft. drawdown after hrs.
Bailer test 15 gal./min. with 14½ ft. drawdown after 4 hrs.
Artesian flow g.p.m. Date
Temperature of water Was a chemical analysis made? ☐ Yes ☒ No

(12) WELL LOG: Diameter of well 6 inches.
Depth drilled 50 ft. Depth of completed well 50 ft.
Formation: *Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation.*

MATERIAL	FROM	TO
Gravel	0	4
Large boulders	4	11
Heaving sand	11	46
Sandy clay	46	49
Course sand and gravel water bearing	49	50

Work started 12/3 19 60 Completed 12/24 19 60

(13) PUMP:
Manufacturer's Name
Type: H.P.

Well Driller's Statement:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME A. M. JANNSEN DRILLING CO.
(Person, firm, or corporation) (Type or print)
Address 21075 S. W. Tualatin Hwy., Aloha, Ore.

Driller's well number

[Signed] [signature] (Well Driller)

License No. 79 Date 1/23, 19 61

(USE ADDITIONAL SHEETS IF NECESSARY)

HOOD 50523

Hood 50523

STATE OF OREGON
MONITORING WELL REPORT P05-135-119
(as required by ORS 537.765 & OAR 690-240-095)
Instructions for completing this report are on the last page of this form.

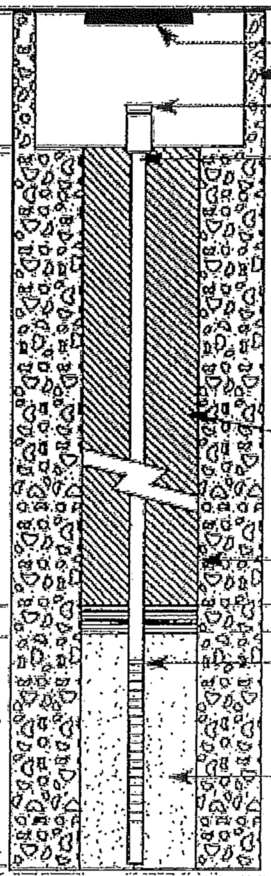
Well I.D. #: L 75186 √ a
Start Card #: 176191

(1) OWNER/PROJECT:
WELL NO. B-1
Name Oregon Dept of Fish & Wildlife
Address 3406 Cherry Ave NE
City Salem State OR Zip 97303

(2) TYPE OF WORK:
☒ New construction ☐ Alteration (Repair/Recondition)
☐ Conversion ☐ Deepening ☐ Abandonment

(3) DRILLING METHOD:
☐ Rotary Air ☐ Rotary Mud ☐ Cable
☐ Hollow Stem Auger ☒ Other Push Probe

(4) BORE HOLE CONSTRUCTION:
Special Standards Yes ☐ No ☒ Depth of completed well 15 ft.



Vault 0 ft. TO 1 ft.
Water-tight Cover
Surface flush vault
Locking cap
Casing diameter 2" in. material PVC
Welded ☐ Threaded ☒ Glued ☐
Liner diameter ______ in. material ______
Welded ☐ Threaded ☐ Glued ☐
Seal 1 ft. TO 8 ft.
Well Seal: Material Bent Chips
Amount 30 #'s
Grout Weight ______
Borehole diameter 4 in.
Bentonite Plug at least 3 ft. thick
Filter pack 8 ft. TO 12 ft.
Screen material PVC
Intervals: From 10 To 15
From ______ To ______
Slot size .010 in.
Filter Pack Material [illegible]
Size 10/20 in.

(5) WELL TEST:
Pump Bailer Air Flowing Artesian
Permeability ______ Yield ______ GPM
Conductivity ______ pH ______
Temperature of Water 54 °F Depth artesian flow found ______ ft.
Was water analysis done? Yes No
By whom? ______
Depth of strata to be analyzed. From ______ ft. to ______ ft.
Remarks ______

Name of supervising Geologist/Engineer ______

(6) LOCATION OF WELL By legal description
Well Location: County Hood River
Township 2 N Range 8 E Section 5
NW ¼ of NW ¼ of above section.
Street address of well location (Oxbow Fish Hatchery)
1200 NE Frontage Road - Cascade Locks, OR
Tax lot number of well location 500
ATTACH MAP WITH LOCATION IDENTIFIED. Map shall include approximate scale and north arrow.

(7) STATIC WATER LEVEL:
9 Ft. below land surface Date 6/30/05
Artesian Pressure ______ lbs/sq in. ______ Date ______

(8) WATER BEARING ZONES:
Depth at which water was first found ______

From	To	Est. Flow Rate	SWL
9	15	2 GPM	

(9) WELL LOG:
Ground elevation ______

Material	From	To	SWL
Asphalt	0	4"	
Fill	4"	2'	
Brown Silts & Sands	2'	15'	

RECEIVED JUL 25 2005 WATER RESOURCES DEPT SALEM, OREGON

RECEIVED AUG 15 2005 WATER RESOURCES DEPT SALEM, OREGON

Date started 6/30/05 Completed 6/30/05

(unbonded) Monitor Well Constructor Certification:
I certify that the work I performed on the construction, alteration, or abandonment of this well is in compliance with Oregon well construction standards. Materials used and information reported above are true to the best knowledge and belief.
MWC Number 1950
Signed ______ Date 6/30/05

(bonded) Monitor Well Constructor Certification:
I accept responsibility for the construction, alteration, or abandonment work performed on this well during the construction dates reported above. All work performed during this time is in compliance with Oregon well construction standards. This report is true to the best of my knowledge and belief.
MWC Number 10024
Signed ______ Date 7.6.05

HOOD 50523

Cascade Project No P05-135-119

Oregon Water Resources Department (OWRD) requires completion of a Geotechnical Hole Report if any of the following apply

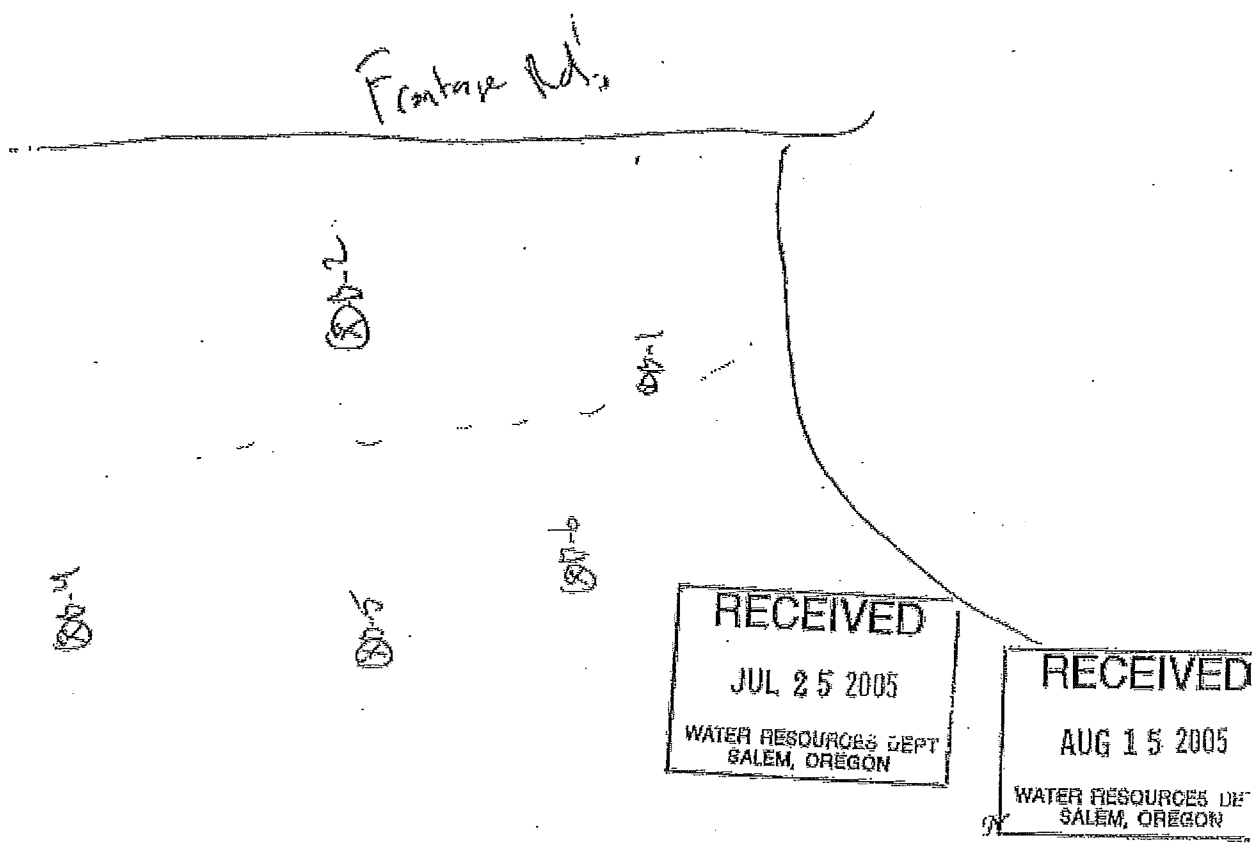
- Geotechnical hole is greater than 18 feet deep
- Within 50 feet of a water supply or monitoring well
- Used to make a determination of water quality.
- Constructed in an area of known or reasonably suspected contamination

In order to comply with OWRD requirements please provide a Site Map

Map shall include an approximate scale of north arrow. Upon completion of well activities, a site map with each well location identified must be filed with each Geotechnical Hole Report (OR 690-240-035).

Thank You for your information and assistance on compliance with Oregon Administrative Rules

<u>SITE MAP</u>



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JUL 25 2005
WATER RESOURCES DEPT
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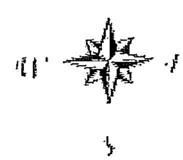
WATER RESOURCES DE
SALEM, OREGON



Site Address 1200 NE Frontage Rd
Client Kleinfelder
Cascade Drilling Project No P05-135-119

HOOD 50735

HOOD 50735

STATE OF OREGON
WATER SUPPLY WELL REPORT
(as required by ORS 537.765)
Instructions for completing this report are on the last page of this form.

Certificate No. 41302
WELL I.D. # L ~~67396~~ 16767
START CARD # W 205106

(1) LAND OWNER Well Number
Name City of Cascade Locks C/O Pacific Groundwater Group
Address 2377 Eastlake Ave. E
City Seattle State WA Zip 98102

(2) TYPE OF WORK
☒ New Well ☐ Deepening ☐ Alteration (repair/recondition) ☐ Abandonment

(3) DRILL METHOD:
☒ Rotary Air ☐ Rotary Mud ☐ Cable ☐ Auger
☐ Other

(4) PROPOSED USE:
☐ Domestic ☐ Community ☐ Industrial ☐ Irrigation
☐ Thermal ☐ Injection ☐ Livestock ☒ Other Test

(5) BORE HOLE CONSTRUCTION:
Special Construction approval ☐ Yes ☒ No Depth of Completed Well 97 ft.
Explosives used ☐ Yes ☒ No Type Amount

HOLE Diameter	From	To	SEAL Material	From	To	Sacks or pounds
12"	0	19	Bentonite chips	0	19	16 sks.

How was seal placed: Method ☐ A ☐ B ☐ C ☐ D ☐ E
☒ Other poured
Backfill placed from ft. to ft. Material
Gravel placed from ft. to ft. Size of gravel

(6) CASING/LINER:

	Diameter	From	To	Gauge	Steel	Plastic	Welded	Threaded
Casing:	8"	+2'	84'6"	.250	☐	☐	☒	☐
riser	5"	80'6"	84'2"		☒	☐	☐	☐
tail	5"	89'2"	97		☒	☐	☐	☐
					☐	☐	☐	☐
Liner:					☐	☐	☐	☐
					☐	☐	☐	☐

Drive Shoe used ☐ Inside ☒ Outside ☐ None
Final location of shoe(s) 84'6" B.G.

(7) PERFORATIONS/SCREENS:
☐ Perforations Method
☒ Screens Type Telescopic Material Stainless steel

From	To	Slot size	Number	Diameter	Tele/pipe size	Casing	Liner
84'2"	89'2"	.025	1	5"		☐	☐
						☐	☐
6 x 5" Neoprene packer w/						☐	☐
6 x 5" concentric reducer to 5" riser pipe						☐	☐

(8) WELL TESTS: Minimum testing time is 1 hour
☐ Pump ☐ Bailer ☒ Air ☐ Flowing Artesian

Yield gal/min	Drawdown	Drill stem at	Time
100 GPM		84' B.G.	1 hr.

Temperature of water Depth Artesian Flow Found
Was a water analysis done? ☐ Yes By whom
Did any strata contain water not suitable for intended use? ☐ Too little
☐ Salty ☐ Muddy ☐ Odor ☐ Colored ☐ Other
Depth of strata:

(9) LOCATION OF WELL by legal description:
County Hood River Latitude Longitude
Township 2N N or S Range 8E E or W. WM.
Section 6 NE 1/4 SE 1/4
Tax Lot 510 Lot Block Subdivision
Street Address of Well (or nearest address) 90 Herman Creek Lane Cascade Locks, OR

(10) STATIC WATER LEVEL:
57 ft. below land surface Date 1/10/10
Artesian pressure lb. per square inch Date

(11) WATER BEARING ZONES:

Depth at which water was first found

From	To	Estimated Flow Rate	SWL
58'	98'	100 GPM	57'

(12) WELL LOG:
Ground Elevation

Material	From	To	SWL
Top soil	0	1	
Cobbles, boulders, silt	1	17	
Sand, gravel, little clay	17	22	
Sand & gravel, loose layers	22	97	57'
Brown sand	97	98	57'

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JAN 15 2010
WATER RESOURCES DEPT
SALEM, OREGON

Date started 1-4-10 Completed 1-6-10

(unbonded) Water Well Constructor Certification:
I certify that the work I performed on the construction, alteration, or abandonment of this well is in compliance with Oregon water supply well construction standards. Materials used and information reported above are true to the best of my knowledge and belief.
Timothy D. Jones WWC Number 1446
Signed Date 1-12-10

(bonded) Water Well Constructor Certification
I accept responsibility for the construction, alteration, or abandonment work performed on this well during the construction dates reported above. All work performed during this time is in compliance with Oregon water supply well construction standards. This report is true to the best of my knowledge and belief.
Ronald C. Aspaas WWC Number 1445
Signed Date 1-12-10

ORIGINAL – WATER RESOURCES DEPARTMENT FIRST COPY – CONSTRUCTOR SECOND COPY – CUSTOMER

P 206.329.0141 | F 206.329.6968

2377 Eastlake Avenue East | Seattle, WA 98102

P 360.570.8244 | F 360.570.0064

1627 Linwood Avenue SW | Tumwater, WA 98512

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