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RECEIVED  
Dec 11, 2014  
RND



December 3, 2014

Mr. Bob Christiansen  
Chaffee County Administrator  
Chaffee County  
P.O. Box 699  
Salida, CO 81201

ARROWHEAD

DEER  
PARK

CALISTOGA

ICE  
MOUNTAIN

***Subject: Nestlé Waters North America Inc. ("NWNA") Application for Permit Revision to 1041 Permit ("Permit") and Special Land Use Permit ("SLUP") Regarding Surface-Water and Groundwater Monitoring and Reporting Reduction***

Dear Mr. Christiansen:

Ozarka

Poland  
Spring

Zephyrhills

Aberfoyle

perrier

PANNA

S. PELLEGRINO

Since NWNA began monitoring its surface water and groundwater measuring network according to the Chaffee County approved Surface Water and Groundwater Monitoring and Mitigation Plan (SWGWMMP) (dated April 29, 2010), NWNA has recognized that some of the data collected is redundant for interpretation of aquifer conditions, that the variation in measured parameters is relatively consistent, and the required frequency of measurement or reporting may be excessive. In addition, difficulty maintaining the surface-flow measuring devices due to erosion, beaver and cattle activity, freezing, and runoff events has prompted NWNA to seek County approval to replace measurements from these structures with measurements from nearby monitoring wells whose water levels are less erratic but show good correlation with measured surface flows.

Therefore, NWNA is requesting a Technical Revision to its 1041 Permit and SLUP to adopt a revised SWGWMMP to include the following changes to the monitoring program. (In support of this request for Technical revision to its Permits, NWNA is providing attached to this request a proposed revised SWGWMMP – see Exhibit 1.)

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### **Proposed General SWGWMMP Revisions:**

- 1) Eliminate water-elevation measurements from up-gradient monitoring well BVMW-9.
- 2) Replace flow measurements from RMS weir with water-level measurements from nearby monitoring well BVMW-12.
- 3) Replace flow measurements from the RMS upper flume (Cogan Property) with water-level measurements from nearby well BVMW-12.
- 4) Replace flow measurements from the Bighorn Springs (BHS) flumes BHPF-1 and BHPF-3 with water-level measurements from nearby monitoring well BHBH-2.
- 5) Change the SWGWMMP reporting to Chaffee County from monthly to quarterly which will have a summary narrative and supporting charts and graphs, but no data tables. Monitoring frequency will not change, and a complete set of data tables will be submitted to the County with the annual 1041 report.

Additionally, NWNA through a verbal commitment to Chaffee County began with the 2011 Annual Report reporting water-level measurements from wells BVMW11, BVMW12, and BVMW13, installed after the approval of the SWGWMMP, in order to begin a record of correlation between surface water flows and water-table elevations in those wells. (The SWGWMMP was never updated to reflect that reporting.) Thus, NWNA also proposes changes to the established monitoring and reporting protocol as follows:

- 6) Eliminate water-elevation measurements from monitoring well BVMW-11. Rely on water-level measurements from RMBH-1, RMBH-2, and RMBH-3.
- 7) Eliminate water-elevation measurements from monitoring well BVMW-13. Rely on water-level measurements from BVMW-12.

Since the SLUP primarily addresses land-use matters, the enclosed supporting information will not specifically address any administrative revisions to the SLUP.

In the event that any provision of this request to modify NWNA's SWGWMMP is not granted, NWNA will continue to operate its Chaffee County Project according to the existing SWGWMMP.

In support of NWNA's request, I have enclosed the Technical Revision request and a proposed revised SWGWMMP. Please review the enclosed information, and contact me with any questions or if you require additional

information to process NWNA's request for permit revision in accordance with Sections 5.4-5.7 of the Permit and Section 3 of the SLUP. I appreciate your consideration of this request and look forward to hearing from you.

Sincerely,



David Feckley  
Natural Resource Manager  
Nestlé Waters North America  
[David.Feckley@waters.nestle.com](mailto:David.Feckley@waters.nestle.com)  
972.415.3074

**Attachments:**

- Exhibit 1 - Proposed Surface Water and Groundwater Monitoring and Mitigation Plan Ruby Mountain Springs and Bighorn Springs Site, Chaffee County, Colorado
- Exhibit 2 - Hydrographs for Monitoring Wells BVMW-8 and BVMW-9
- Exhibit 3 - Hydrographs for Ruby Mountain Springs Weir and Monitoring Wells BVMW-12 and BVMW-13
- Exhibit 4 - Hydrographs for Ruby Mountain Springs Upper Flume and Monitoring Wells BVMW-12 and BVMW-13
- Exhibit 5 - Hydrographs for Bighorn Upper and Lower Flumes and Monitoring Well BHBH-2

## **A. SUBMITTAL REQUIREMENTS**

According to NWNA's Permit Section 5.1, NWNA may seek and be granted by the County Technical Revisions to its Permits and permit conditions subject to certain conditions in Section 5. NWNA is submitting this request as a Technical Revision in accordance with Section 5.1 of its existing Permit which states:

*5.1 Technical Revision. A technical revision to the Permit will be allowed if the County Staff determines that:*

- a. Permittee and the Project are in compliance with all terms and conditions of the original Permit at the time the County Staff receives notice of the proposed technical revision; and*
- b. There will be no increase in the quantity of water or size of the area affected by the Project; and*
- c. There will be no increase in the nature or intensity of impacts caused by the Project from those contemplated by this Permit; and*
- d. Only minor changes to the terms or conditions of this Permit would be required to ensure that the Project will continue to comply with all applicable Chaffee County regulations and intergovernmental agreements as they exist at the time the County receives notice of the proposed technical revision.*

Regarding provision "a", NWNA has demonstrated its compliance with all Permit Conditions in its 2013 Annual Report which was approved by Chaffee County in the Staff Memo dated April 4, 2014, which report and memo are incorporated by reference into this request. NWNA has not modified its operations since the Annual Report was submitted and NWNA continues to operate in compliance with all Permit requirements.

Regarding provision "b", the requested Permit revision does not increase the quantity of water to be used by NWNA, nor does it change in any way the area affected by the Project.

Regarding provision "c", there will be no change in the nature or intensity of impacts caused by the Project since the requested change only pertains to minor changes to NWNA's Surface Water and Ground Water Monitoring and Mitigation Plan (SWGWMMP). NWNA operations in Chaffee County will not change as a result of this administrative permit revision.

Regarding provision "d", as will be discussed in detail herein, the requested change in water monitoring and reporting will result in only minor changes to the terms and conditions of the existing Permit and NWNA's operations will continue to comply with all applicable regulations. It will be demonstrated herein that the requested modifications to the SWGWMMP will provide to NWNA and the County information essentially equivalent to that currently provided under the existing SWGWMMP, but from monitoring structures which are less difficult to maintain and provide less erratic data. In

addition, the proposed modification to required reporting protocol will reduce submittal of redundant information to the County. NWNA submits that monitoring under the terms of the proposed SWGWMMP will be at least as effective in monitoring aquifer conditions and the influences potentially attributable to NWNA's water withdrawals as under the terms of the existing SWGWMMP.

NWNA provides the following information in support of this request for permit revision as required by Section 5 of the Permit.

## **B. DOCUMENTATION OF THE CURRENT PERMIT APPROVALS.**

Pursuant to Section 5.2 NWNA may seek and be granted by the County modifications of its Permits if provisions within Section 5 are met. NWNA applied for and received approval for ten (10) Technical Revisions to its original Permit and two (2) Permit Amendments subsequent to initial issuance of NWNA's Permits granted by Resolutions 2009-42 and 2009-43.

To date, NWNA has received the following Technical Revisions:

### **TR#1: Truck Loading Facility (TLF) – Office Space and Parking Space**

NWNA applied for modification of the floor-plan of the TLF to provide an office space for a locally-based NWNA employee and associated on-site parking.

The County approved this Technical Revision on November 3, 2009. The TLF was constructed in accordance with this revision.

### **TR#2: Pipeline Size Reduction and Pipeline Realignment**

NWNA applied for reduction of its water transmission pipeline from 8" (O.D.) to 6" (O.D.) based on final engineering calculations. NWNA also requested minor realignments of the pipeline along some segments between the Ruby Mountain Springs Parcel and the TLF because: (1) the Project no longer included pumping at the Bighorn Springs; and (2) the pipeline would be afforded more protection within easements on private property as opposed to within County Road Right of Way (ROW) and within the Union Pacific Railroad ROW.

The County approved this Technical Revision on February 23, 2010. The pipeline was constructed in accordance with this revision.

### **TR#3: Pipeline Realignment on Gunsmoke Property**

NWNA applied for a minor realignment of its pipeline on the Gunsmoke property to accommodate the realignment of NWNA's pipeline due to the alternate river crossing alignment, the addition of the Town of Buena Vista's water main at the

river crossing, and to minimize impact to the private owner's commercial utility of the Gunsmoke property.

The County approved this Technical Revision on March 10, 2010. The pipeline was constructed in accordance with this revision.

**TR#4: Construction of a Water Discharge Pipeline to Bray Ditch**

NWNA applied to the County to construct a spring-water discharge pipeline that would transmit spring water from the TLF back across the Arkansas River through NWNA's crossing sleeve to discharge to the Bray Irrigation Ditch. This discharge pipeline was sought by NWNA in order to keep NWNA's pipeline from the Ruby Mountain Springs to the TLF operational even when NWNA was not transporting water to its Denver Bottling plant in order to maintain sanitary conditions of the pipeline and associated infrastructure.

The County approved this Technical Revision April 5, 2010. NWNA did not ultimately pursue this Technical Revision, because a final agreement between NWNA and the owner of the Bray Ditch was never finalized.

**TR#5: Installation of Pipeline Sleeve under County Road 301**

NWNA applied to construct a 12" diameter sleeve at NWNA's pipeline crossing at County Road 301 in order to expedite construction of the County road crossing and to minimize any lane closures of CR 301 during installation of the pipeline.

The County approved this Technical Revision on April 23, 2010. The pipeline was constructed in accordance with this revision.

**TR#6: Water Discharge Pipeline to Arkansas River Outfall**

NWNA applied to the County to construct a spring-water discharge pipeline that would transmit spring water from the TLF back across the Arkansas River through NWNA's crossing sleeve to discharge to a protected outfall on the east bank of the Arkansas River. This discharge pipeline was sought by NWNA in order to keep NWNA's pipeline from the Ruby Mountain Springs to the TLF operational even when NWNA was not transporting water to its Denver Bottling plant in order to maintain sanitary conditions of the pipeline and associated infrastructure.

The County approved this Technical Revision on June 14, 2010. The discharge pipeline was constructed in accordance with this revision and has been in operation through 2012.

**TR#7: Alternative Truck and Tanker Size**

In order to increase efficiency and to reduce total number of truck trips between Chaffee County and Denver, NWNA applied to the County to allow for use of an

alternative tractor and tanker size. The proposed change potentially allows for 2,600 fewer truck trips annually. The proposed alternative configuration utilizes a 500 horsepower tractor and an 8,200 gallon tanker, versus the previously-approved 450 hp tractor with a 6,500 gallon tanker.

The County approved this Technical Revision on June 23, 2010. Since beginning operations in 2010, NWNA has employed both allowed tractor-tanker configurations in its water transport to the Denver plant.

**TR#8: Modifications to Production Well (RMBH3) Configuration**

NWNA requested certain modifications of the configuration for the new production well RMBH3. The requested modifications included: a larger casing diameter to allow for installation of water quality sampling instrumentation, a shorter screen interval to allow for a deeper pump placement to provide better pump cooling. NWNA did not request changes to County-imposed water-level pumping constraints.

Additionally, NWNA applied for a minor increase in the size of the RMBH3 well house to accommodate water quality sampling and process equipment for pipeline sanitation.

The County approved this Technical Revision on August 18, 2010. NWNA has since constructed RMBH3 and associated well house in accordance with this permit revision. RMBH3 was used as the primary production well in 2012.

**TR#9: Tanker and Driver Parking at Truck Loading Facility**

In order to facilitate the hiring of local truck drivers by making access to the NWNA tankers and the Truck Loading Facility convenient, NWNA applied to modify its site plan to allow for the parking of four (4) tankers and six (6) truck driver automobiles on private property south of and adjacent to NWNA's property. This re-configuration requires modification of the south fence and driveway apron in order for drivers to have access to the off-property parking spaces. This request was presented as an alternative to the permitted site plan and is to be implemented by NWNA when tanker parking on-site was no longer feasible due to increased activity.

The County approved this Technical Revision on September 13, 2010. However, NWNA did not implement the reconfiguration of its site allowed by this permit revision in 2012.

**TR#10: Tanker and Driver Parking at Truck Loading Facility**

In order to meet growing plant demand and to facilitate the hiring of local truck drivers by making access to the NWNA tankers and the Truck Loading Facility

convenient, NWNA applied to the County on April 12, 2012 to modify its site plan to allow for the parking of additional tankers and truck driver automobiles on site.

The County approved this Technical Revision on April 19 2012, and NWNA modified its parking facility according to the plan in 2012.

To date, NWNA has received the following amendment of its Permits:

**Permit Amendment #1: Alternative River Crossing**

At the request of the Town of Buena Vista in order to provide a major water transmission line across the Arkansas River to meet the Town's projected need for water resources, NWNA applied to change its previously-approved directional drilling approach to cross the river to an open trenching method. This modification allowed for concurrent installation of NWNA's and the Town's water lines at no cost to the Town. In addition, the alternative crossing method required a minor realignment of the pipeline.

The U.S. Army Corps of Engineers (USACE) granted NWNA a General Permit 12 on March 2, 2010 for the river crossing. The County approved this 1041 Permit Amendment on February 22, 2010 by Resolution 2010-20 and approved a revised Special Land Use Permit (SLUP) by Resolution 2010-21. The pipeline was constructed in accordance with this Permit Amendment and USACE Permit.

**Permit Amendment #2: Alternative Water Augmentation Source**

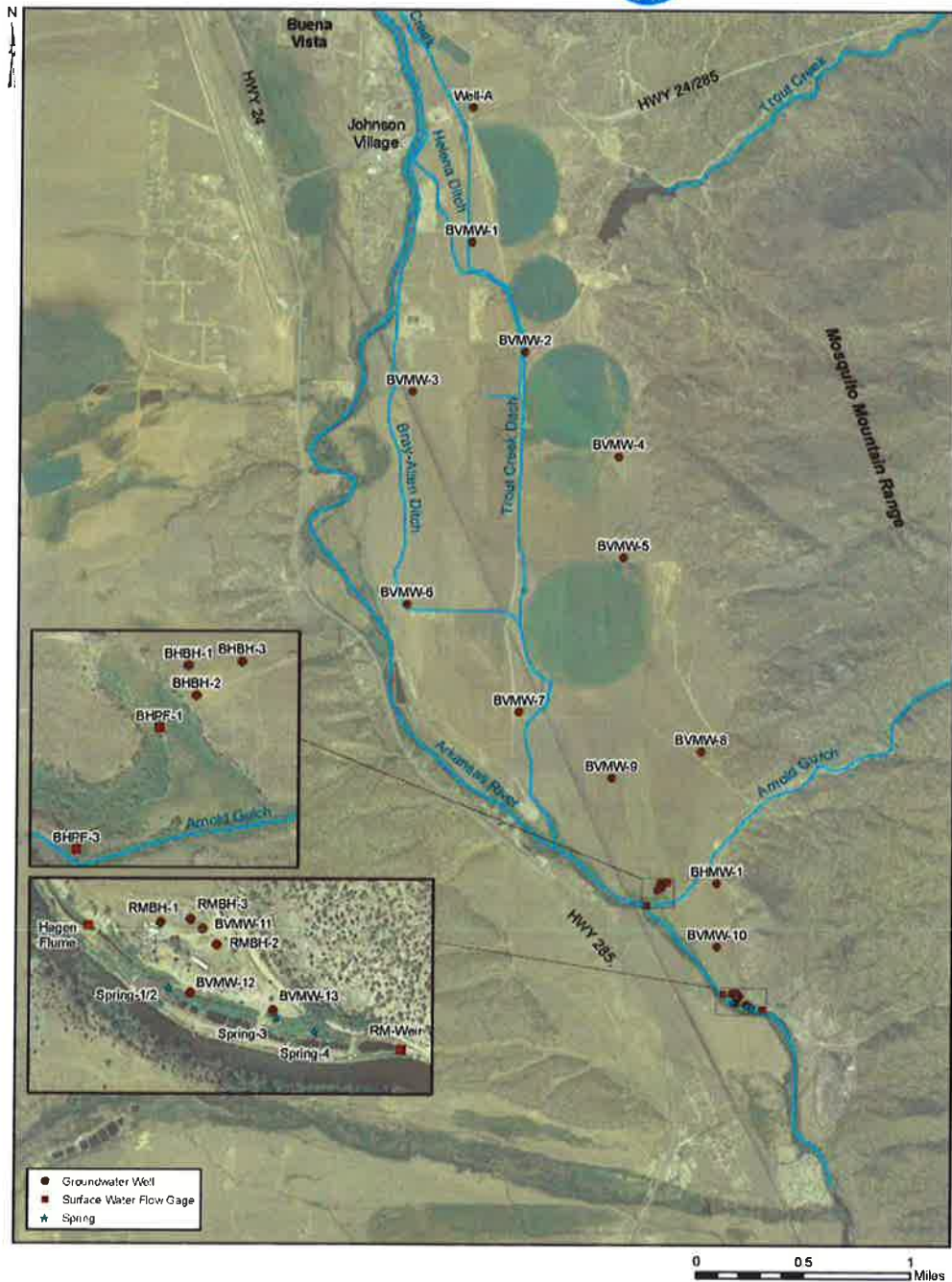
In 2013, the Upper Arkansas Water Conservancy District (UAWCD) requested that NWNA consider using the UAWCD Augmentation Plan to supply replacement water for the depletions from the NWNA's production wells. After negotiating an agreement with UAWCD, NWNA filed a request with Chaffee County to revise its 1041 Permit to allow NWNA to use the UAWCD Augmentation Plan as an alternative to using augmentation water from the City of Aurora. Chaffee County approved a Permit Amendment by Resolution 2013-35 on October 8, 2013.

This Permit Amendment requires that NWNA receive the UAWCD augmentation water and NWNA operate its wells under the same restrictions previously specified in NWNA's 1041 Permit which allowed for use of City of Aurora augmentation water. NWNA did not use the UAWCD source for its augmentation water in 2013 nor has NWNA relied on it to date in 2014. NWNA will transition to augmentation with UAWCD in 2015.

**C. DRAWINGS AND PLANS OF PROPOSED CHANGES TO THE PROJECT.**

NWNA provides the following map showing locations of all previously installed wells and monitoring structures for reference only.





**Figure 1** Location map for Pinedale Aquifer (including Bighorn and Ruby Mountain Springs)

The only change in drawings or plans for this Technical Revision is a revised map showing the updated water monitoring structures in the proposed SWGWMMP (Exhibit 1).

#### **D. DESCRIPTION OF CHANGED CIRCUMSTANCES.**

The rationale for each of proposed surface-water and groundwater monitoring revisions is described subsequently.

##### **1) Cease Monitoring of Well BVMW-9**

The monitoring well BVMW-9 is located on Colorado Department of Corrections (CDOC) land north of NWNA's Bighorn Springs (BHS) Parcel and is located in the western half of the surficial aquifer that feeds the Ruby Mountain Springs. All of the other monitoring wells that are in the SWGWMMP are along the eastern margin of the aquifer. Through historical monitoring measurements collected to date, NWNA has determined that the wells along the eastern portion of the aquifer along the front of the crystalline rocks of the Mosquito Range tend to have water chemistries more similar to that observed in the Ruby Mountain Springs water. The water chemistry from wells in the central to western portion of the aquifer appears to be more significantly influenced by irrigation than wells along the eastern margin of the aquifer. Additionally, BVMW-8 and BVMW-9 are at approximately equal positions on the north-to-south hydraulic gradient, so the groundwater levels measured in these well are almost equivalent (see hydrograph in Figure 1 in Exhibit 2). Water-level measurements from BVMW-9 appear to be largely redundant to measurements from BVMW-8.

Therefore, NWNA requests that the County approve the cessation of monitoring and reporting from well BVMW-9. NWNA does not intend on abandoning this well at this time, but will provide to the County a copy of the Colorado Division of Water Resources (CDWR) Well Abandonment Report when it is abandoned.

##### **2) Replace Monitoring of RMS Weir with Well BVMW-12**

The RMS weir has historically been the structure by which the flows emanating from the Ruby Mountain Springs through the pond/channel system have been measured (with the recognition that some spring water may be lost directly below the ponds and channels to the Arkansas River. This weir has been the primary structure required by the County for measuring spring flows seasonally and long-term.

The measurements from the weir have been relatively useful in evaluating spring water flows from season to season and also to observe how maximum and minimum water levels change from year to year. Additionally, measurements of flows through this weir have been able to show the very small, but perceptible changes in flows when NWNA either operates its production wells RMBH-2 and RMBH-3 or shuts these wells off. However, the effectiveness of this structure is highly dependent upon the physical

conditions of the pond immediately upstream and immediately downstream of it. That is to say when these areas above and below are free from aquatic plant growth or debris, the weir measurements are relatively accurate measurements of spring flows.

However, during the summer and early fall when vegetative growth in the pond/channel system is abundant and when beaver activity in the area increased due to migratory patterns up-river, the weir is often subject to blockages which results in measurements of flows which are much higher than actually reflective of spring discharge. These readings show up as spikes in flow rates that are more than 2 cfs above actual flows which are typically 2-3 cfs during that time period (see Figures 1 and 3). Additionally, when beaver blockages occur upstream of the lower pond, breaches of the pond/channel berm result in water loss directly to the river which result in negative flow rate dips in the hydrograph data. (NWNA through its hydrology consultants have provided the County with interpolated hydrographs in an attempt to more accurately reflect actual spring flows from season to season and from year to year.) Further, NWNA expends significant effort every year maintaining all of its surface-water measuring devices to keep them measuring properly, but even with this diligent effort, significant amounts of erratic data have been unavoidable.

With the goal of providing another strategy for more accurately determining spring flows, NWNA installed shallow monitoring wells BVMW-12 and BVMW-13, which are located immediately to the north and up-gradient of the pond/channel system and in the region where natural spring emanations have been observed historically. NWNA believed that water-level measurements from these wells could be correlated over a period of time with sufficient precision and accuracy that flow measurements from the weir could be replaced by calculating a flow rate based on water-levels measured in either or both of these wells.

Even though these wells were installed in 2010, water-level data collected from them prior to completion of the RMS Habitat Reclamation Project could not be used in this correlation because the hydrology in the pond/channel system and near these wells changed due to construction. NWNA now has compiled flow data from the weir and these two monitoring wells post-reclamation during the period June 2012 through July 2014 and presents that data summarized in hydrographs in Figures 1-3 in Exhibit 3. From these hydrographs, one can see that there is a significant degree of correlation between weir flows and water-level measurements from these wells, though there is a time lag (a slight delay) in response in the weir relative to the wells. (This lag is likely due to the fact that the wells are slightly up-gradient of the pond/channel system and the changing hydraulic gradient over time as the immediate aquifer zone is naturally charged or discharged.)

Figure 4 of Exhibit 3 shows the superimposition of these hydrographs with a calculated weir flow based on water-level measurements from each of these wells. (The calculated flow curves were obtained through a statistical correlation, with obvious flow outliers removed, and resultant equations [shown on figure] relating flows with water-levels.) It can be seen that the water-level data quite accurately reflect measured

surface flows. However the “predicted” surface flows also are subject to the lag seen in the hydrographs.

Figure 5 of Exhibit 3 shows “predicted” weir flows based on water-level measurements from BVMW-12 and BVMW-13 in relation to actual weir flows based on a correction for lag in flows based on a gradient calculation. It can be seen that calculated weir flows based on water-level data from BVMW-12 more accurately reflect actual weir flows. NWNA submits, from this correlation analysis, that calculated spring flows through the pond/channel system based on water-level measurements from BVMW-12 are sufficiently accurate relative to the magnitude of normal fluctuations in flows from season to season and from year to year that direct measurements of flows from the weir are unnecessary.

Therefore, NWNA requests that the County approve the cessation of monitoring and reporting from the RMS weir and replace those measurements with calculated spring flows through the pond/channel system based on water-level measurements from BVMW-12.

### **3) Replace Monitoring of RMS Flume (Cogan Property) with Well BVMW-12**

The RMS Upper Flume was installed by NWNA to measure flows coming onto the NWNA Ruby Mountain Springs property and into the pond/channel system from an adjacent and up-gradient parcel (Cogan). These flows originated from the construction of a ditch by the previous owner of the RMS property in an attempt to capture additional spring flows emanating on the adjacent property to enhance flows through the old fish hatchery. NWNA needed to understand how much water was flowing through the RMS pond/channel system from this up-gradient source in order to design the RMS Habitat Reclamation Project to accommodate existing flows as well as possible reduced flows if the Cogan's were to abandon the upper ditch.

Figure 1 of Exhibit 4 presents measured flows from the Upper Flume post-reclamation for the period June 2012 through July 2014. It can be seen that the upper ditch does not flow for a significant portion of the year typically between May through June and sometimes into July. When the upper ditch does flow, measured flows through the flume are erratic being subject to blockages from aquatic weed growth and beaver activity; surface runoff events from precipitation, and losses due to freezing and overflow of the upper ditch.

On August 3, 2014 a heavy rainfall event caused erosion of the banks northeast of the upper ditch and left debris in the ditch in certain locations including below the flume where ditch flows enter a rock-filled infiltration bed feeding the buried perforated pipe which transmits water to the waterfall aeration structure above the stream/pond system. This debris completely plugged the infiltration bed so that flows no longer enter the pipe and now run overland from the ditch directly to the lower channel system.

Though flows from the upper ditch still run through the stream/pond system onto the RMS property, these flows are no longer being aerated through the waterfall for the aquatic habitat. NWNA does not believe that this will have any significant impact on the health of the aquatic biota since flows emanating from springs on the RMS property alone are sufficient at all times of the year to provide ample aeration. (Of note, when the upper ditch does not flow due to the seasonally low water-table elevation, the pond/channel system has only been fed by on-site flows and the aquatic biota has flourished historically.)

NWNA has done a correlation analysis for Upper Flume flows in relation to water-level measurements from the shallow monitoring wells BVMW-12 and BVMW-13 similar to that performed for the RMS weir. Figure 2 in Exhibit 4 shows the relation of flume flows to water-levels in the two monitoring wells. Figure 3 in Exhibit 4 shows calculated flow rates as based on the water-levels in the monitoring wells. It can be seen that there is reasonable agreement between calculated flow rates and actual flume measurement for most of the period measured with the following observations: (1) there is a lag of 4 to 6 days in well water levels relative to flume flows likely due to the spring sources in the upper ditch being up-gradient relative to the monitoring wells, (2) all water-levels below a certain threshold correspond to the no-flow condition of the flume, and (3) reduced (and erratic) flume flows during the winter season 2013-2014.

NWNA submits that the flume flows predicted by water-levels in BVMW-12 are sufficiently representative of measured flume flows relative to the magnitude of normal fluctuations in flows from season to season and from year to year that measurements of flows from the flume are unnecessary.

Therefore, NWNA requests that the County approve the cessation of monitoring and reporting from the RMS Upper Flume and replace those measurements with calculated flows through the upper ditch based on water-level measurements from BVMW-12. NWNA intends to monitor and report these calculated flows for as long as NWNA operates its Ruby Mountain Springs project and as long as the upper ditch is maintained and allowed to operate by its owner. Upon abandonment of the upper ditch by its owner, NWNA will cease reporting calculated flows for the Upper Flume.

#### **4) Replace Monitoring of BHS Parshall Flumes with Well BHBH-2**

NWNA installed the Parshall flumes BHPF-1 (upper) and BHPF-3 (lower) to monitor spring flows emanating from the NWNA's Bighorn Springs Property. As with the other surface flow measuring structures on the RMS property, these flumes have been subject to maintenance issues including blockages from aquatic plant growth and beaver activity as well as erosion around and under the flumes allow for significant leakage. Figure 1 in Exhibit 5 is a hydrograph showing the highly erratic flow measurements from these flumes during the period September 2009 through June 2014. It can be seen that measurements from these structures, especially in the last two years have not been accurately reflective of actual flow conditions, exemplified by the period June 2013 to June 2014 when higher flows were recorded from the upper flume

(BHPF-1) than for the lower flume (BHPF-3) which presumably measures all flow recorded by the upper flume plus the significant spring outflows downstream of the upper flume.

NWNA has performed a correlation analysis for the BHS flume flows in relation to water-level measurements from the monitoring wells BHBH-2 similar to that performed for the RMS weir. Figure 2 in Exhibit 5 shows the relation of flume flows to water-levels in the monitoring well. Figure 3 in Exhibit 5 shows calculated flow rates as based on the water-levels in the monitoring well. It can be seen that there is reasonable agreement between calculated flow rates and actual flume measurements when obviously erratic data are omitted for the period measured. In fact, for the period June 2013 to June 2014, the calculated flows for these flumes actually shows the correct relationship between the two flumes in that the lower flumes shows higher flows than the upper flume.

Therefore, NWNA requests that the County approve the cessation of monitoring and reporting from the BHS Parshall flumes BHPF-1 and BHPF-3 and replace those measurements with calculated flows based on water-level measurements from BHBH-2.

#### **5) Change SWGWMMP Reporting Frequency and Detail**

Currently, NWNA provides to the County monthly, quarterly, and annual reports of its surface-water and groundwater monitoring including detailed tables of measurements. Based on input from the County, some of this information is redundant and not necessary. Therefore, NWNA requests approval from the County to continue its surface-water and groundwater monitoring according to Table 1 in the SWGWMMP approved by the County at that time, but to change its reporting to the County by eliminating monthly reporting, providing quarterly reports which will include a narrative summary with supporting maps, diagrams, and graphs but which will not provide detailed data tables, and an annual report in the traditional form and content which includes all of the data tables.

#### **6) Cease Monitoring of Well BVMW-11**

Given the close proximity to the production wells, water-level measurements from BVMW-11 are of little value since the well is significantly influenced by pumping. Drawdown levels due to pumping are better measured directly in the production wells. Additionally, this well cannot measure the cone of depression away from the production wells because it is in between them. RMBH-1 serves as the closest monitoring well on the RMS property to the production wells and has provided reliable water-level data which show the minor influence of pumping in the localized cone of depression.

NWNA submits that there is no justification to continue monitoring and reporting water levels in this well.

Therefore, NWNA requests that the County approve the cessation of monitoring and reporting from well BVMW-11. NWNA does not intend on abandoning this well at this time, but will provide to the County a copy of the Colorado Division of Water Resources (CDWR) Well Abandonment Report when it is abandoned.

#### **7) Cease Monitoring of Well BVMW-13**

BVMW-13 was drilled at the same time that BVMW-12 was installed for the intended purpose of providing shallow groundwater level measurements to be correlated with surface flow measurements from the RMS weir and Upper Flume. It has been shown in prior sections 2 and 3 of this request that water-level measurements from BVMW-12 more accurately "predict" surface flows from these structures than do measurements from BVMW-13. This may be due to the proximity of BVMW-13 to the outfalls of the buried infiltration pipes into the waterfall structure. Additionally, water-level data from BVMW-13 is largely redundant to that from BVMW-12.

Therefore, NWNA requests that the County approve the cessation of monitoring and reporting from well BVMW-13. NWNA does not intend on abandoning this well at this time, but will provide to the County a copy of the Colorado Division of Water Resources (CDWR) Well Abandonment Report when it is abandoned.

#### **E. DESCRIPTION OF ADDITIONAL OR CHANGED MITIGATION PLANS.**

NWNA is providing a proposed revised SWGWMMP as Exhibit 1 in support of this request for Technical Revision.

#### **F. ANY ADDITIONAL INFORMATION THAT THE COUNTY STAFF REQUIRES.**

No additional information for this Technical Revision was requested by Chaffee County's Development Coordinator. NWNA will submit any other information that County Staff requests after reviewing this request.

#### **G. ALLOWED TECHNICAL REVISIONS**

In accordance with Section 5.1 of the 1041 Permit and Section 3(a) of the SLUP, the County will allow a technical revision if staff determines the following:

***Permittee and the Project are in compliance with all terms and conditions of the original Permit at the time the County Staff receives notice of the proposed technical revision.***

NWNA has demonstrated its compliance with all 1041 Permit Conditions in its 2012 Annual Report which was approved by Chaffee County in the Staff Memo dated April 13, 2013, which are incorporated by reference into this request.

Since submittal of its 2012 Annual Report and in accordance with Permit requirements, NWNA has submitted its monthly reports on City of Aurora Supply and Demands (augmentation reports), NWNA pumping and surface flows to Chaffee County on the following dates:

	<u>Aurora &amp; Augmentation</u>	<u>Pumping &amp; Flows</u>
January Reporting:	3/11/2014	2/10/2014
February Reporting:	4/10/2014	3/7/2014
March Reporting:	5/8/2014	4/9/2014
April Reporting:	6/12/2014	5/7/2014
May Reporting:	7/9/2014	6/10/2014
June Reporting:	8/14/2014	7/9/2014
July Reporting:	9/9/2014	8/11/2014
August Reporting:	10/10/2014	9/9/2014
September Reporting:	11/11/2014	10/8/2014
October Reporting:	Not due	11/5/2014

NWNA submitted its 2014 1<sup>st</sup> Quarter Monitoring Report to the County on May 15, 2014. NWNA submitted its 2014 2<sup>nd</sup> Quarter Monitoring Report to the County on August 12, 2014. NWNA submitted its 2014 3<sup>rd</sup> Quarter Monitoring Report to the County on November 14, 2014.

Finally, since the submittal of the 2013 Annual Report, NWNA received approval from the Colorado Division of Water Resources of its 2014-2015 Substitute Water Supply plan covering the period March 22, 2014 through March 21, 2015.

At the time of this request, NWNA continues to operate in compliance with all 1041 Permit requirements.

***There will be no increase in the quantity of water or size of the area affected by the Project***

The requested permit revision does not increase the quantity of water to be used by NWNA, nor does it change in any way the area affected by the Project.

***There will be no increase in the nature or intensity of impacts caused by the Project from those contemplated by this Permit.***

There will be no change in the nature or intensity of impacts caused by the Project since the requested change only pertains to minor changes to NWNA's Surface Water and Ground Water Monitoring and Mitigation Plan (SWGWMMP). NWNA operations in Chaffee County will not change as a result of this administrative permit revision.

***Only minor changes to the terms or conditions of this Permit would be required to ensure that the Project will continue to comply with all applicable Chaffee***



***County regulations and intergovernmental agreements as they exist at the time the County receives notice of the proposed technical revision.***

The requested change in water monitoring and reporting will result in only minor changes to the terms and conditions of the existing Permit and NWNA's operations will continue to comply with all applicable regulations. It has been demonstrated herein that the requested modifications to the SWGWMMP will provide to NWNA and the County information essentially equivalent to that currently provided under the existing SWGWMMP, but from monitoring structures which are less difficult to maintain and provide less erratic data. In addition, the proposed modification to required reporting protocol will reduce submittal of redundant information to the County. NWNA submits that monitoring under the terms of the proposed SWGWMMP will be at least as effective in monitoring aquifer conditions and the influences potentially attributable to NWNA's water withdrawals as under the terms of the existing SWGWMMP.

# **EXHIBIT 1**

## **Proposed Surface Water and Groundwater Monitoring and Mitigation Plan Ruby Mountain Springs and Bighorn Springs Sites Chaffee County, Colorado**



## **PROPOSED**

# **Surface Water and Groundwater Monitoring and Mitigation Plan Ruby Mountain Springs and Bighorn Springs Sites Chaffee County, Colorado**

**December 1, 2014**

### **Introduction**

Subject to the limitations in its permit, Nestlé Waters North America Inc. (NWNA) may divert up to 200 acre-feet of spring water per year from the Ruby Mountain Springs site via RMBH-2 and/or RMBH-3. Based upon extensive hydrologic monitoring since NWNA began diversions from its production wells in 2010, NWNA has shown that the effects of the Ruby Mountain Springs diversions have been minor and localized with no detrimental effects to surface water, groundwater, or other users of water.

The objective of this updated Surface-Water and Groundwater Monitoring and Mitigation Plan (SWGWMMP) is to provide for continued monitoring and evaluation of any effects on surface water and ground water resulting from the NWNA withdrawals, provide definition of the indicators used to determine possible adverse impacts, and identify any necessary mitigation steps.

To provide a baseline characterization of hydrogeologic conditions, NWNA began hydrologic monitoring of the Ruby Mountain and Bighorn Springs sites and the associated Pinedale Outwash Aquifer at limited locations in January 2007 which were expanded throughout 2007 and 2008 to include additional monitoring stations (wells, staff gauges, flumes, and weirs).

Since beginning operations in 2010, NWNA has provided to Chaffee County and the Colorado Division of Water Resources (CDWR) surface water and groundwater monitoring data report as required by the previously-approved

SWGWMMP. These reports document the annual seasonal patterns of high-flow (high-water table) and low-flow (low-water table) conditions in the monitored aquifer, as well as year to year fluctuations governed primarily by recharge from precipitation (snowmelt) in the Mosquito Range and irrigation patterns on the aquifer surface. During future operations, long-term monitoring and reporting will continue under this SWGWMMP.

## **Background**

NWNA began monitoring surface flows at Ruby Mountain Springs in January 2007. Monitoring of water levels in RMBH-2 and BHBH-2 also began in January, 2007. NWNA installed its broader monitoring well network in 2008, and began collecting data from these wells in April 2008. In 2010 NWNA installed its second production well RMBH-3, monitoring well BVMW-11, and two shallow monitoring wells (BVMW-12 and BVMW-13) at the Ruby Mountain Springs in advance of the habitat reclamation project (removal of old fish hatchery). **Figure 1** shows the aquifer area and the locations of NWNA's surface and groundwater measuring structures. NWNA has continued to monitor surface flows and groundwater elevations since production began in 2010.

**Figure 2** is a hydrograph presenting January 2007 through December 2009 water-level data collected from RMBH-2, BHBH-2, and the SGWMMP monitoring wells in the up-gradient recharge area. The hydrograph shows that under ambient (non-pumping) conditions, the aquifer has relatively large (several feet) changes in water level throughout the hydrologic year.

**Figure 3** is an updated hydrograph presenting water level data measured from selected wells in NWNA's extended monitoring network during the period from May 2008 through June 2014. Depending on location in the aquifer, high water levels have generally occurred in June through December; and annual low water levels are observed in January through April. It can also be seen that wells in the northern part of the aquifer and located near irrigation ditches have water levels that increase earlier and more rapidly than down-gradient wells which are less influenced by irrigation. Water-level increases in down-gradient wells show up to a month lag time. In the northern portions of the study area, the water-table elevations have been observed to vary by as much as 17 to 18 feet. In the vicinity of the Bighorn Springs site, annual water-level fluctuations have been on the order of 7 to 9 feet (e.g., BHBH-2, BHMW-1, and BVMW-10). At the Ruby Mountain Springs site, in the southern portion of the study area, the annual ambient water-table elevation variations have been in excess of 6 feet (e.g. RMBH-2). Water-table fluctuations in a given monitoring well vary to greater or lesser extent depending on recharge conditions in any given year.

The magnitude of natural annual variations in water-table elevations that have been documented since project inception are significantly greater than the drawdown

induced in observation wells during the operation of RMBH-3 and RMBH-2 to date. Maximum pumping-induced drawdown at RMBH-1 and RMBH-2 during operation of RMBH-3 is approximately 0.5 feet. In comparison, seasonal variations in water levels for wells RMBH-1 and RMBH-2 is approximately 6-8.5 feet, and variation in year-to-year maximum or minimum water levels have been approximately 0.5-2.5 feet. As noteworthy is that no pumping-induced drawdown has been observed at any off-site monitoring well locations.

### **Proposed Monitoring Program**

There are three (3) areas that are subject to monitoring: the Ruby Mountain Springs site; the Bighorn Springs site; and a significant portion of the aquifer up-gradient of the two sites. The monitoring network consists of 11 wells, including the production wells RMBH-2 and RMBH-3 (see **Figure 4**). The nature and frequency of automated measurements from these wells are provided in **Table 1**. (Manual water-level measurements are also taken periodically to ensure proper function of automated devices.)

Water-level measurements from BHBH-2 are used to calculate and report surface flows through the former surface-flow measuring flumes BHPF-1 (upper) and BHPF-3 (lower) using a correlation analysis performed in 2014 and contained in the Technical Revision #11. Water-level measurements from BVMW-12 are used to calculate and report surface flows through the former surface-flow measuring structures Upper (Hagen) Flume and Lower Weir using a correlation analysis performed in 2014 and contained in the Technical Revision #11.

### **Ruby Mountain Springs Site**

The general layout of the Ruby Mountain Springs site is shown in **Figure 1**. Ground-water monitoring at Ruby Mountain Springs consists of automated measurements made in the spring-water production wells (RMBH-2 and RMBH-3), and the monitoring wells RMBH-1 and BVMW-12 (**Table 1**). Additionally, automated measurements will be made in monitoring well BVMW-10 located between the Ruby Mountain Springs site and the Bighorn Springs. Inorganic and organic constituents will be measured and reported annually from the production boreholes and BVMW-10.

The production wells at Ruby Mountain Springs are instrumented with automatic recording devices (digital flow meter) to measure the rate and total quantity of water withdrawal. Withdrawals are reported as daily, monthly, and annual totals. In addition, turbidity, pH and Total Dissolved Solids are measured in water withdrawn from the wells either in the well house or Truck Loading Facility and recorded on a daily basis.

Surface-water flows at the Ruby Mountain Springs site were formerly measured at the Upper Flume and Lower Weir. The Upper Flume, located on the Cogan Parcel to the northwest of the RMS property and for which NWNA has temporary access permission, was formerly used to measure flows from the Hagen Ditch onto NWNA's property. The Lower Weir, located at the outfall of the Ruby Mountain Springs restored pond/channel system into the Arkansas River, formerly measured the combined discharge from the springs emanating on the property as well as flows coming from the Upper Ditch. Due to erratic flow measurements caused by maintenance issues with these structures NWNA sought to establish another mechanism for more accurately determining surface flows.

Thus, NWNA performed a correlation analysis for Upper Flume and Lower Weir flows in relation to water-level measurements from well BVMW-12. In Technical Revision #11, it was shown there was reasonable agreement between calculated surface-flow rates based on water-level measurements in BVMW-12 and actual flow measurements from these structures. Hereafter, surface flows at the Ruby Mountain Springs site will be reported as calculated flows based on water-level measurements from well BVMW-12.

### **Bighorn Springs Site**

The site layout at Bighorn Springs is shown in **Figure 1**. Two flumes were initially installed at the BHS property to measure surface flows for springs emanating on the property. These structures were BHPF-1 (upper) and BHPF-3 (lower). BHBH-2 is a test borehole located in close proximity to the Bighorn Springs and associated wetlands which was installed to perform pumping tests and monitoring of aquifer conditions near the springs. During the hydrogeologic testing of Bighorn Springs, pumping from BHBH-2 showed a direct hydraulic connection to the Bighorn Springs. In other words, BHBH-2 is completed within the spring-water aquifer feeding the natural springs. Therefore, it was anticipated that any water level changes affecting the springs (and wetlands) would be reflected in the water-level record from BHBH-2.

Since the beginning of production pumping at the Ruby Mountain Springs, monitoring of BHBH-2 has shown no effect on the water-levels in this well due to pumping. BHBH-2 remains the primary monitoring well for the Bighorn Springs, but groundwater monitoring on the property is supplemented by well BHMW-1 located to the east (see **Table 1; Figure 4**).

In 2014, NWNA performed a correlation analysis for the BHS flume flows in relation to water-level measurements from well BHBH-2. In Technical Revision #11, it was shown that there was reasonable agreement between calculated surface flow rates based on water-level measurements in BHBH-2 and actual

flume measurements. Therefore, surface flows at the Bighorn Springs will be reported in the future as calculated flows based on water-level measurements from well BHBH-2.

### **Up-Gradient Monitoring Wells**

NWNA will continue to monitor a series of wells (Well A, BVMW-2, BVMW-5, and BVMW-8) installed in portions of the surficial aquifer located up-gradient of Bighorn Springs and the Ruby Mountain Springs sites to characterize background conditions within the springs-source aquifer (see **Figure 4**). These monitoring wells will be measured automatically (**Table 1**).

### **Other Monitoring**

NWNA will collect precipitation data from a heated, tipping-bucket, rain gauge installed at the Ruby Mountain Springs site. NWNA will also report the precipitation data collected by the National Weather Service at the Central Colorado Regional Airport in Buena Vista (approximately 4.5 miles northwest of RMBH-2).

NWNA will report daily and long-term average Arkansas River flow data collected from two gaging stations (the seasonal station near Nathrop operated by the USGS, and the year-round station in Salida operated by the Colorado Division of Water Resources).

NWNA will report annual diversion and water-use information compiled by the Colorado Division of Water Resources for the Trout Creek Reservoir, Helena Ditch, Bray Ditch, Trout Creek Ditch, and Trout Creek lateral of the Cottonwood Ditch. The Colorado Division of Water Resources reports this information after the irrigation season and the diversion records are typically completed by the beginning on the next irrigation season. If diversion records are not available at the time of submittal of the annual monitoring report, these records will be provided to the County as a supplement to the Annual Report once they become available.

### **Wetlands Condition Documentation**

NWNA will on an annual basis document the condition of the previously-delineated wetlands on the Bighorn Springs Parcel, as well as reclaimed habitat on the Ruby Mountain Springs Parcel. Documentation of wetlands condition will include a descriptive narrative as well as photographs. This annual wetlands documentation, will be provided to the County as part of NWNA's Annual Report. In addition, copies of the wetlands documentation will be provided to Colorado Parks and Wildlife and Natural Resources Conservation Service for their review

and representatives from each organization will be permitted on NWNA's properties to periodically assess wetland and upland habitat conditions.

### **Data Reporting**

Data from the monitoring program described above will be distributed to Chaffee County on a quarterly basis as approved in Technical Revision #11. NWNA will assemble the data into an Annual Report that it will submit to Chaffee County. The period covered under the annual monitoring reports will be by water year (e.g. November 1 through October 31). Submittal of the annual monitoring report will occur on or before March 1 following the water year just concluded.

### **Evaluation of Potential Up-Gradient Propagation of Pumping Influence**

The monitoring program and impact avoidance and mitigation plan described herein will provide the data needed to assess the potential for up-gradient propagation of the zone of influence over time. The water-level record from monitoring wells will be examined within the context of the prevailing hydrogeological conditions (weather patterns, irrigation ditch diversion records, surface water monitoring and the water-level response in the more distant, northern parts of the aquifer) to assess any effects that could be attributable to the onset of commercial spring-water withdrawals from the Ruby Mountain Springs site.

Importantly, it is expected any water-level change in the aquifer at Bighorn Springs would be reflected in monitoring well BHBH-2 water levels. BHBH-2 has been demonstrated to have a direct connection to the springs that flow through the wetlands at the Bighorn Springs site. Similar to other wells and boreholes throughout the studied aquifer area (**Figure 1**), water levels in BHBH-2 have been observed to fluctuate significantly on a seasonal and annual basis in response to the timing and volume of the various contributory recharge mechanisms.

The primary indicator of potential negative effects at Bighorn Springs due to pumping at the Ruby Mountain Springs site would be a sustained downward trend in water-level pattern at BHBH-2 that is consistently lower than anticipated when interpreted within the context of irrigation ditch diversions, surface water monitoring and the behavior of more distant monitoring locations and the prevailing hydrogeological conditions. It is expected such a trend would be first observed in monitoring well BVMW-10, roughly midway between Bighorn Springs and the Ruby Mountain Springs site. Monitoring well BHMW-1 would serve as a cross-gradient data point on the Bighorn Springs property.

Another indicator of potential negative effects to the Bighorn Springs would be an observed correlation between change in water levels and change in the pumping



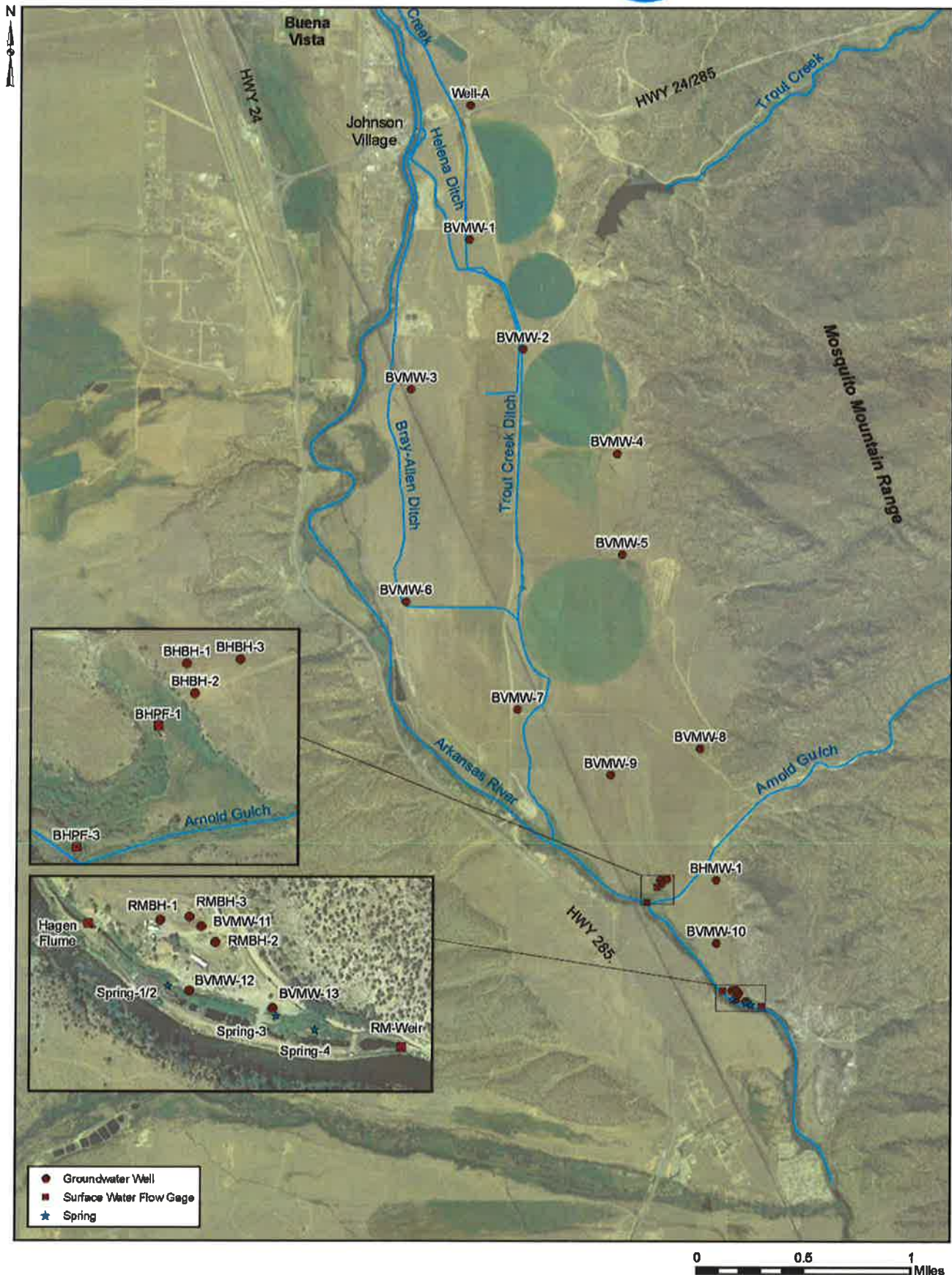
rates from RMBH-2 and RMBH-3. The magnitude of any such effects will be evaluated through a thorough hydrologic analysis.

As NWNA compiles data over the long-term and as seasonal variations of the aquifer are better understood, modifications to this plan may be made to change the location or number of wells or surface devices monitored, their prescribed measurement frequency, or the schedule for reporting. Such modifications to the monitoring plan will only be made with the approval of the County.

### **Mitigation Measures**

If, at any time, NWNA or the County infers from the monitoring data that the withdrawals from the Ruby Mountain production wells have detrimentally affected the Bighorn Springs, any surface or groundwater, or up-gradient users of water, the parties shall take the following actions:

1. Within 14 days, the County will request a meeting between NWNA (and its representatives and consultants) and the County's hydrogeological consultant to jointly review the available scientific information.
2. If NWNA and the County agree that no significant negative effect has occurred, no further action should be taken.
3. If NWNA and the County do not agree that no significant negative effect has occurred, the dispute should be resolved using the provisions of the 1041 Permit Condition 4.3.
4. If NWNA and the County agree that a significant negative effect has occurred, NWNA shall reduce or suspend withdrawals pending agreed upon mitigation measures for the significant negative effect.



**Figure 1** Location map for Pinedale Aquifer (including Bighorn and Ruby Mountain Springs)

Figure 2. Buena Vista Monitoring Wells  
 Water-level change relative to April 24, 2008  
 Extending through February 23, 2010

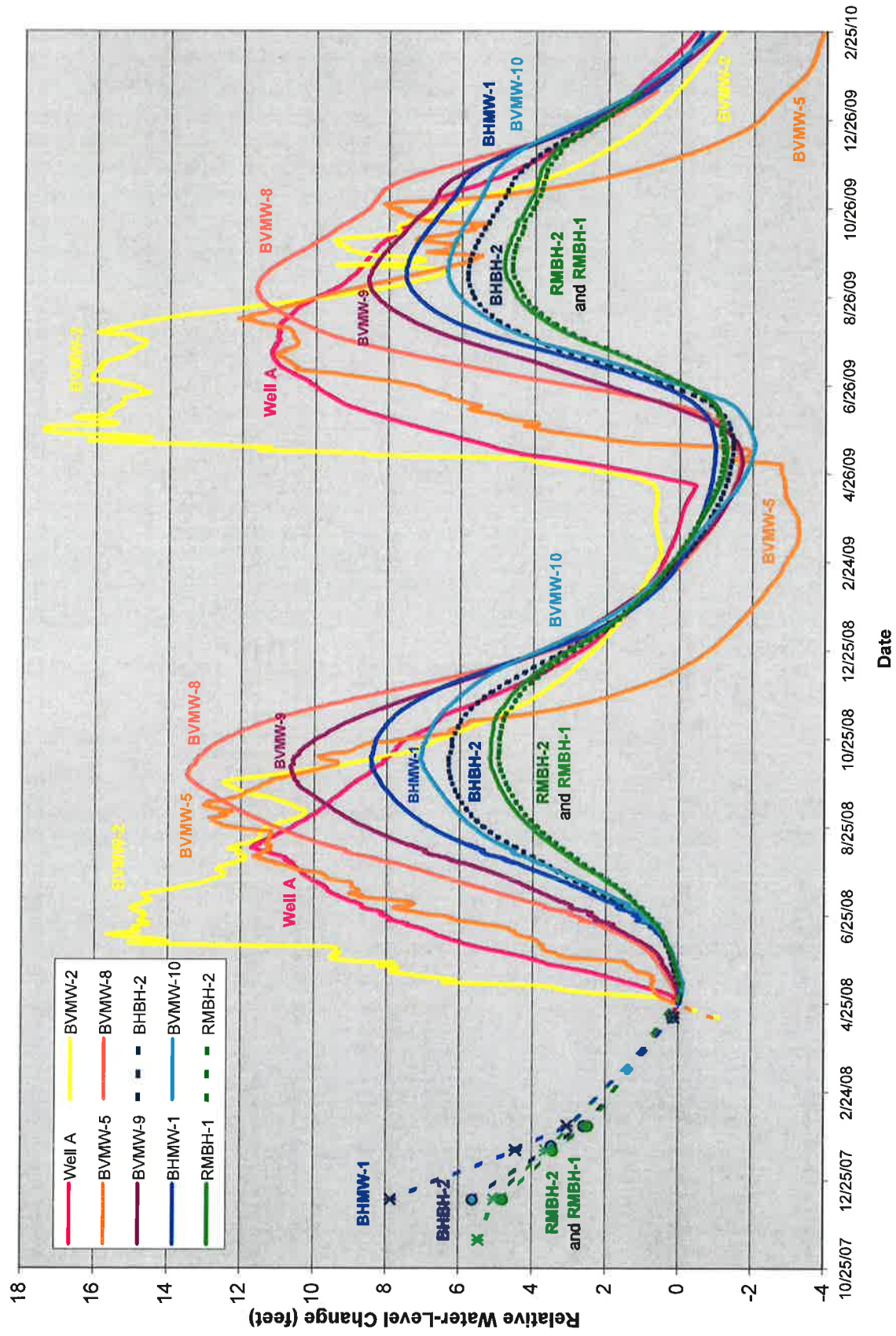
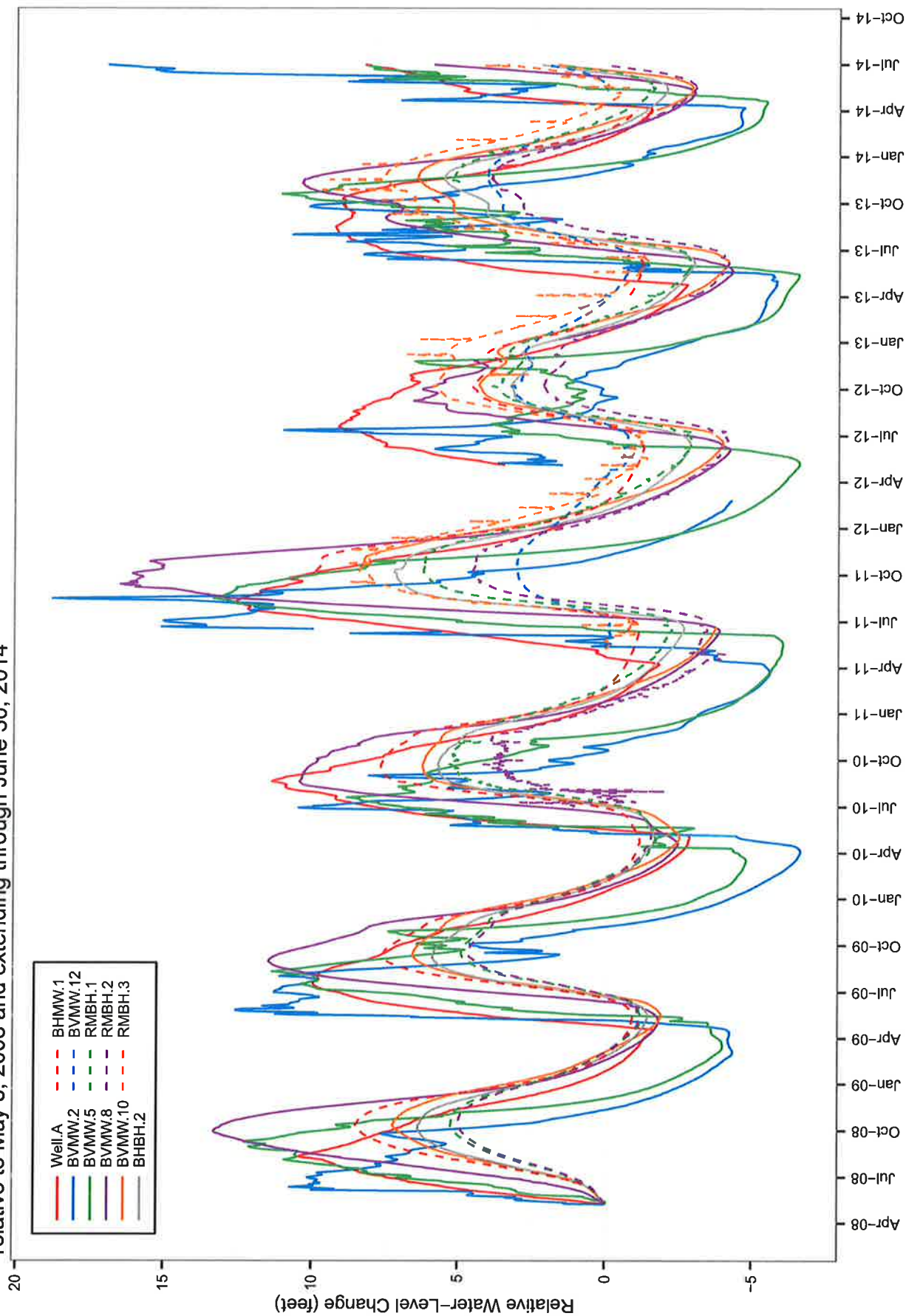
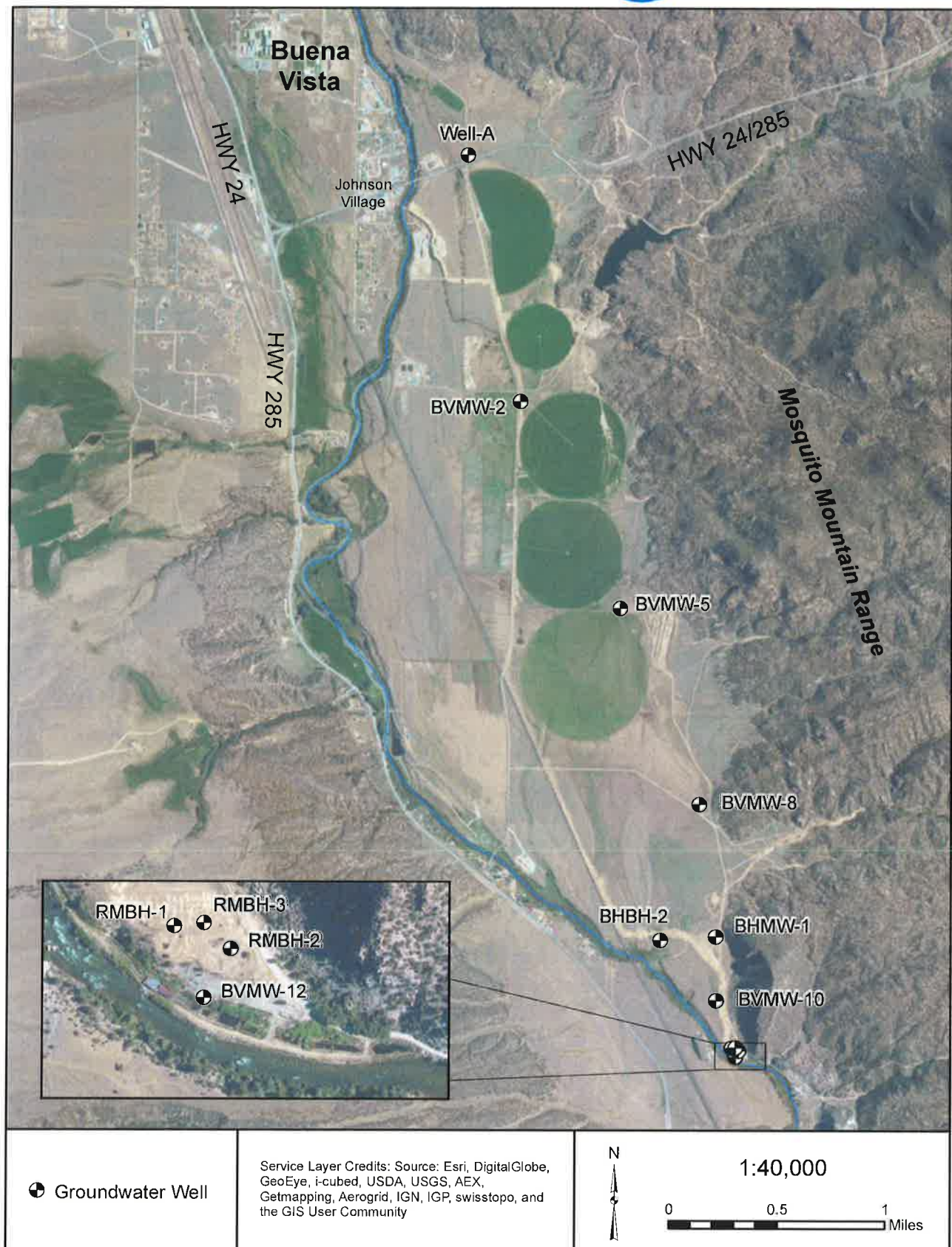




Figure 3. Buena Vista Monitoring Wells water-level change relative to May 8, 2008 and extending through June 30, 2014



\*For wells RMBH-3 and BVMW-12, water level change relative to May 8, 2011.



**Figure 4**  
**Monitoring Stations in the Surface- and Ground-Water Monitoring and Mitigation Plan**  
Ruby Mountain Springs, Chaffee County, Colorado

**Table 1**  
**Monitoring Network of the Surface- and Ground-Water Monitoring and Mitigation Plan**

Location	Station Type	Monitoring Parameters	Minimum Monitoring Frequency <sup>1</sup>
<b>Ruby Mountain Springs Monitoring Stations</b>			
RMBH-3	Production Borehole 3	Water Level, Conductance	4 Readings/Day
RMBH-2	Production Borehole 2	Water Level, Conductance	4 Readings/Day
RMBH-1	Monitoring Well	Water Level	4 Readings/Day
BVMW-10	Monitoring Well	Water Level, Conductance	4 Readings/Day
BVMW-12	Monitoring Well	Water Level	4 Readings/Day
<b>Bighorn Springs Monitoring Stations</b>			
BHBH-2	Monitoring Well	Water Level, Conductance	4 Readings/Day
BHMW-1	Monitoring Well	Water Level, Conductance	4 Readings/Day
<b>Up-gradient Monitoring Stations</b>			
Well-A	Monitoring Well	Water Level	4 Readings/Day
BVMW-2	Monitoring Well	Water Level	4 Readings/Day
BVMW-5	Monitoring Well	Water Level	4 Readings/Day
BVMW-8	Monitoring Well	Water Level	4 Readings/Day

<sup>1</sup> Data loggers will be programmed to record measurements at the indicated frequency or a greater frequency (up to hourly). Reported data will be the daily average of the measurements.

## **EXHIBIT 2**

**Hydrographs for Monitoring Wells BVMW-8 and BVMW-9**



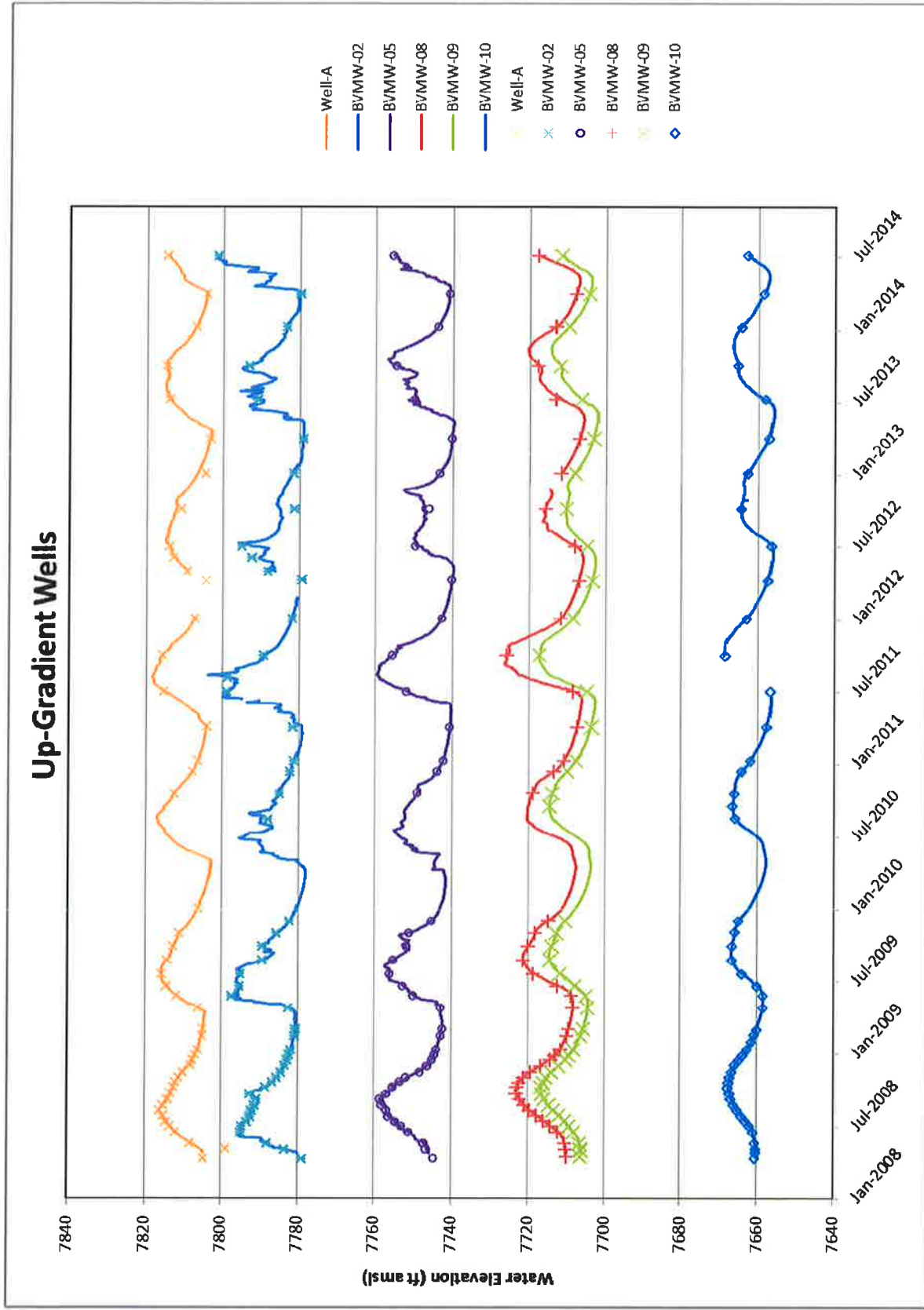


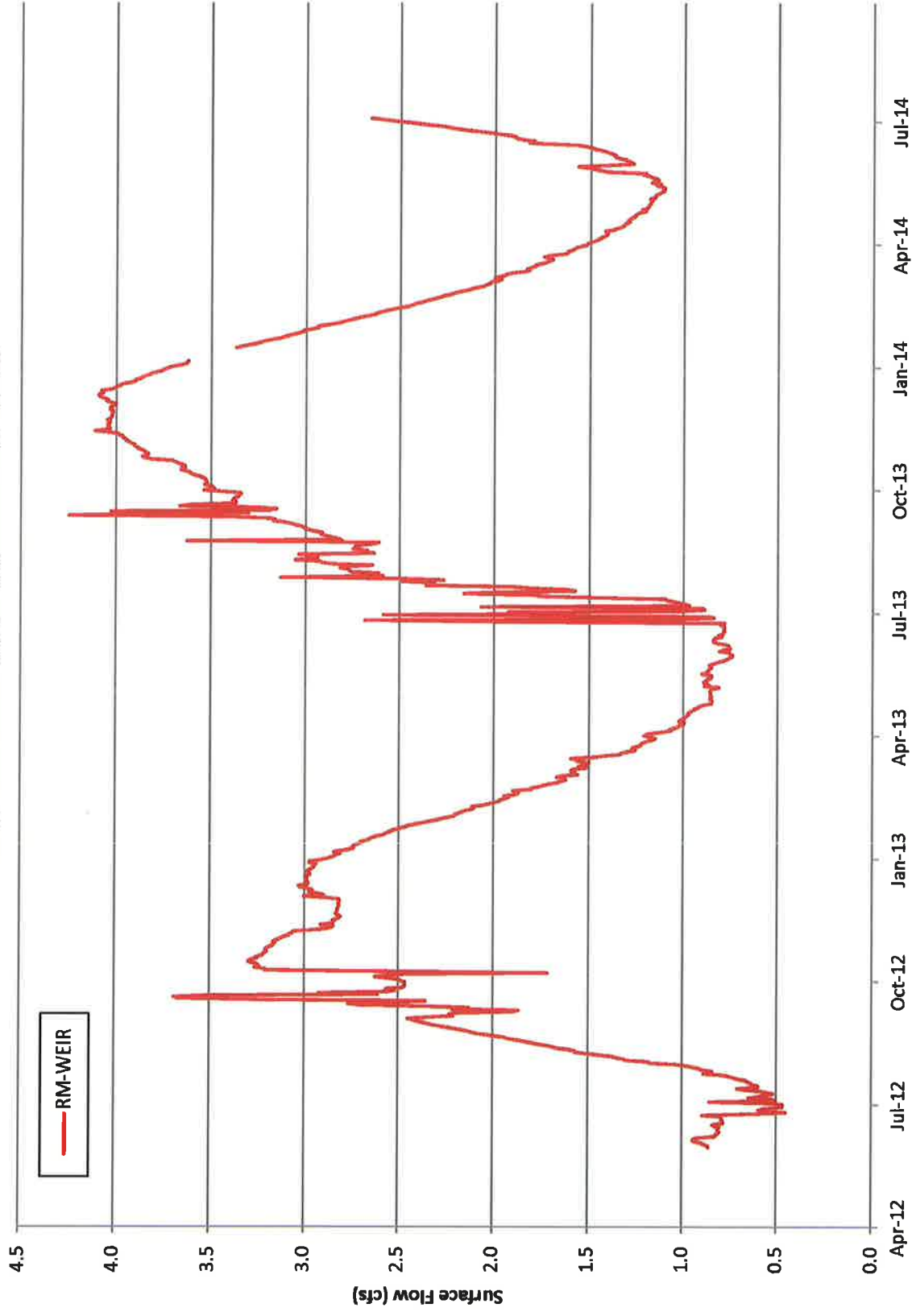
Figure 1. Hydrograph of up-gradient monitoring wells.



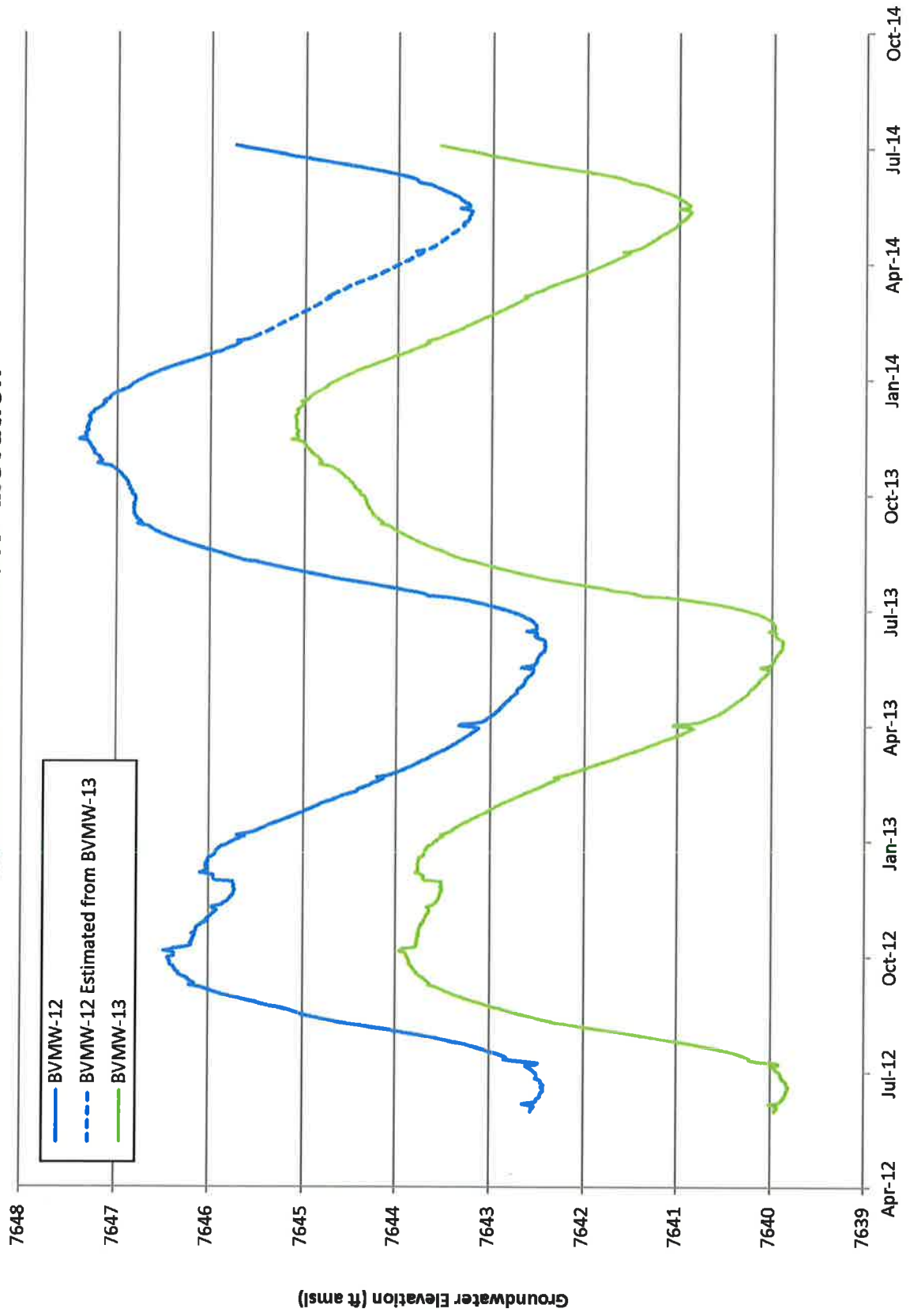
## **EXHIBIT 3**

**Hydrographs for Ruby Mountain Springs Weir and  
Monitoring Wells BVMW-12 and BVMW-13**

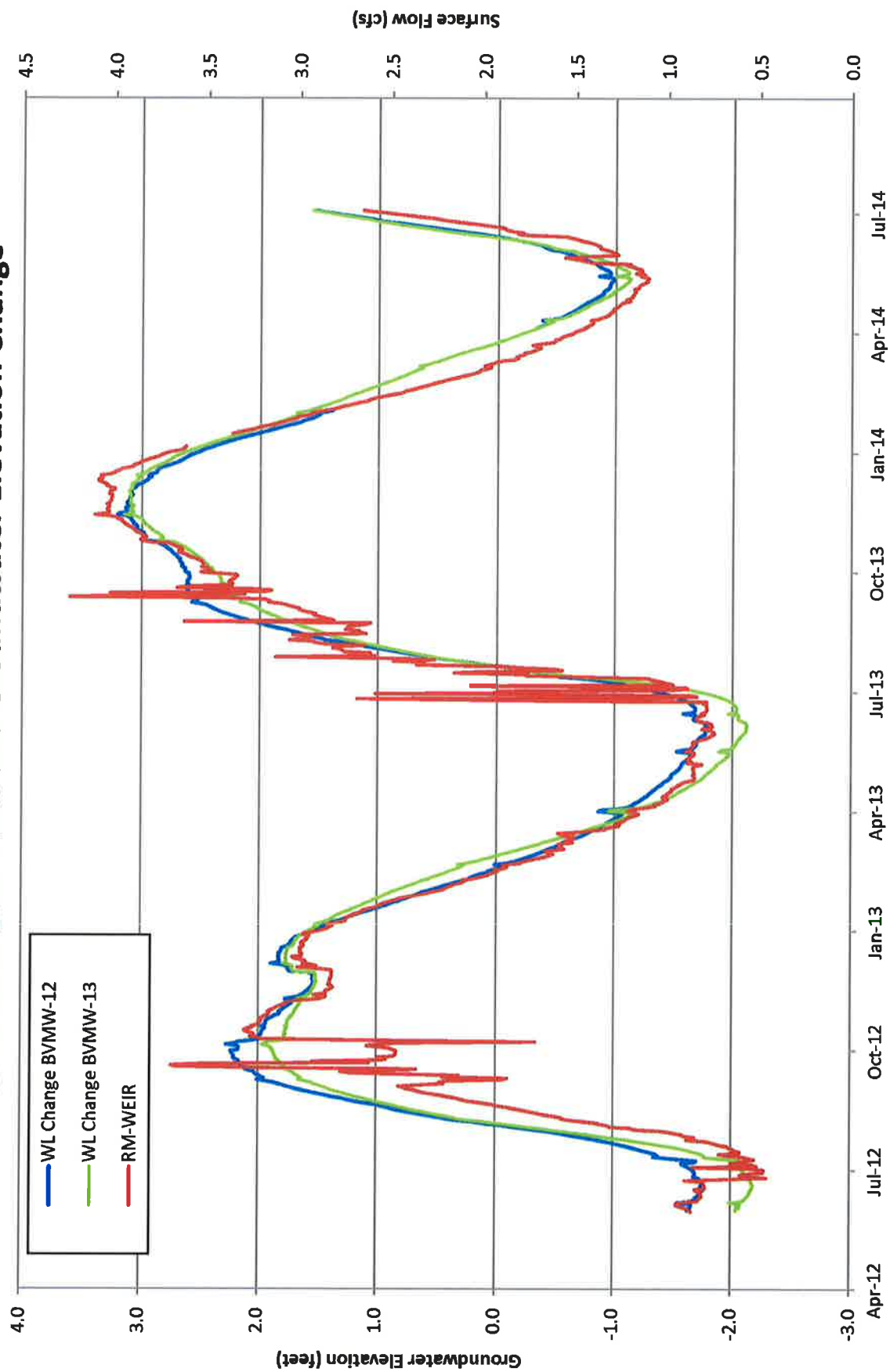
Figure 1  
Ruby Mountain Springs  
Downstream Weir Measured Flow



**Figure 2**  
**Ruby Mountain Springs**  
**Measured Groundwater Elevation**



**Figure 3**  
**Ruby Mountain Springs**  
**Downstream Weir Flow and Groundwater Elevation Change**



# Figure 4

## Ruby Mountain Springs

### Downstream Weir Estimated Flow from Groundwater Elevation

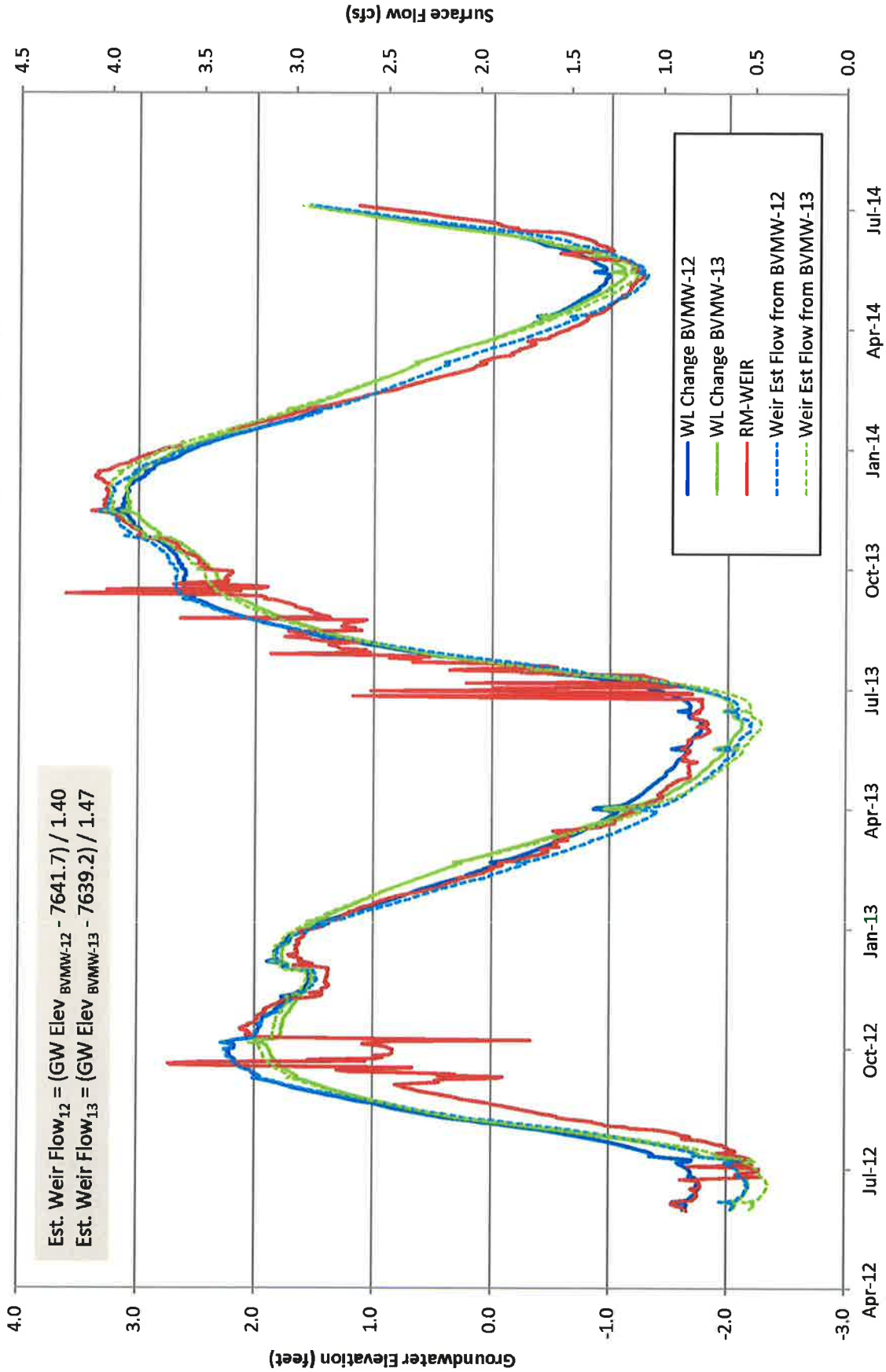
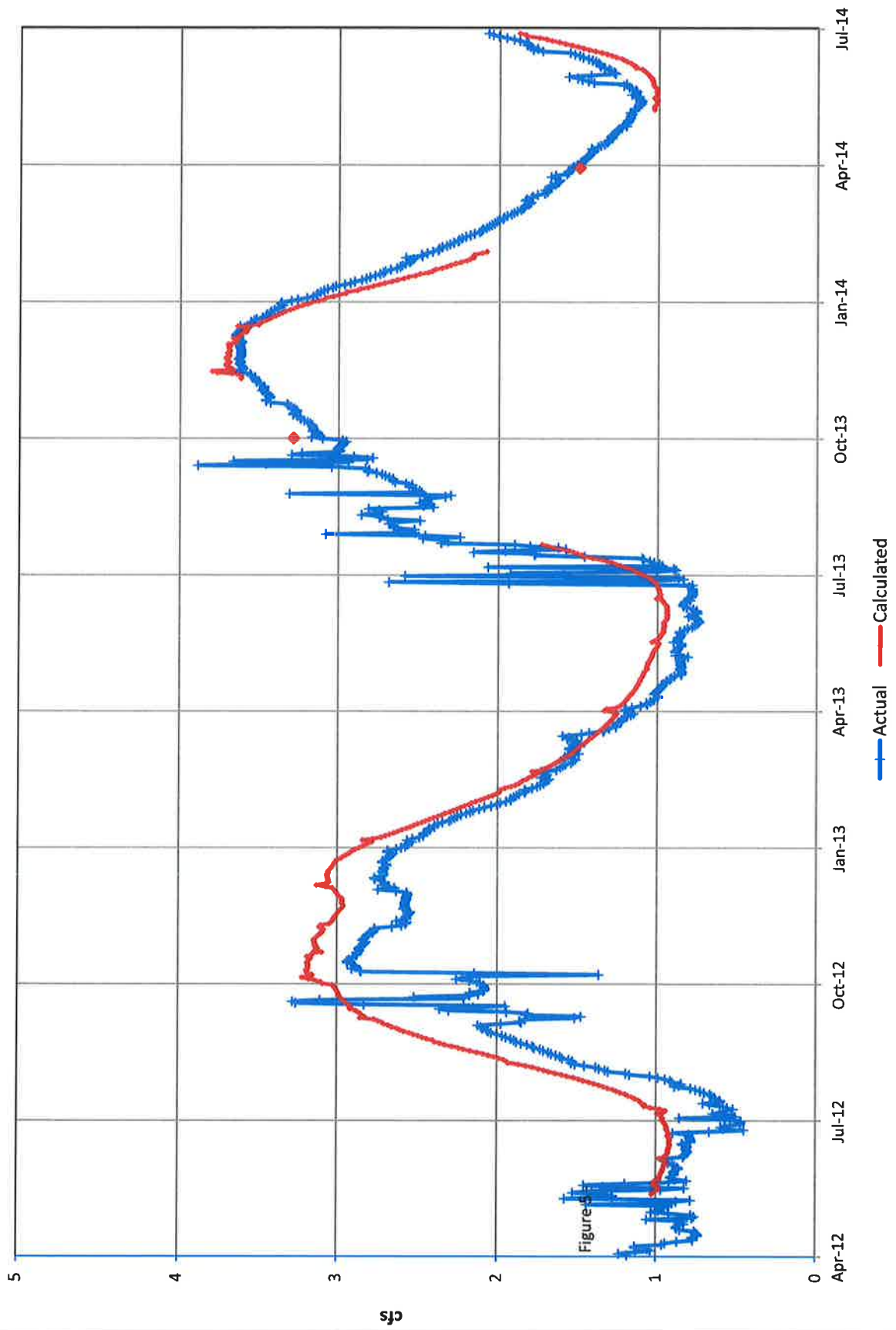


Figure 5 - Ruby Mtn Calculated Spring Flow  
(based on RMBH1 - BVMW-12 gradient for post-reclamation, 2012 data)



## **EXHIBIT 4**

**Hydrographs for Ruby Mountain Springs Upper Flume and  
Monitoring Wells BVMW-12 and BVMW-13**

Figure 1  
Ruby Mountain Springs  
Upper Hagen Flume Measured Flow

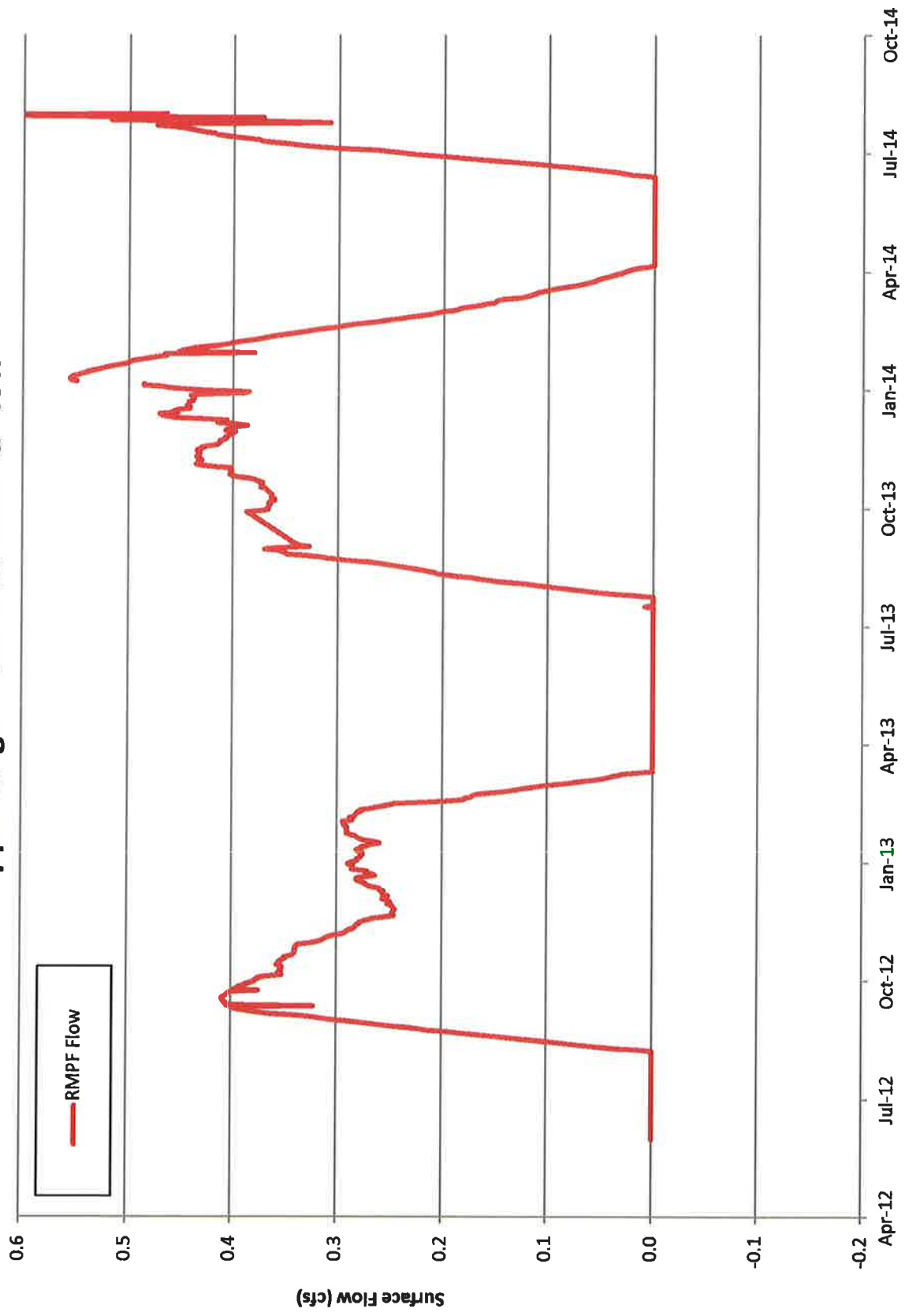




Figure 2  
 Ruby Mountain Springs  
 Upper Hagen Flume Flow and Groundwater Elevation Change

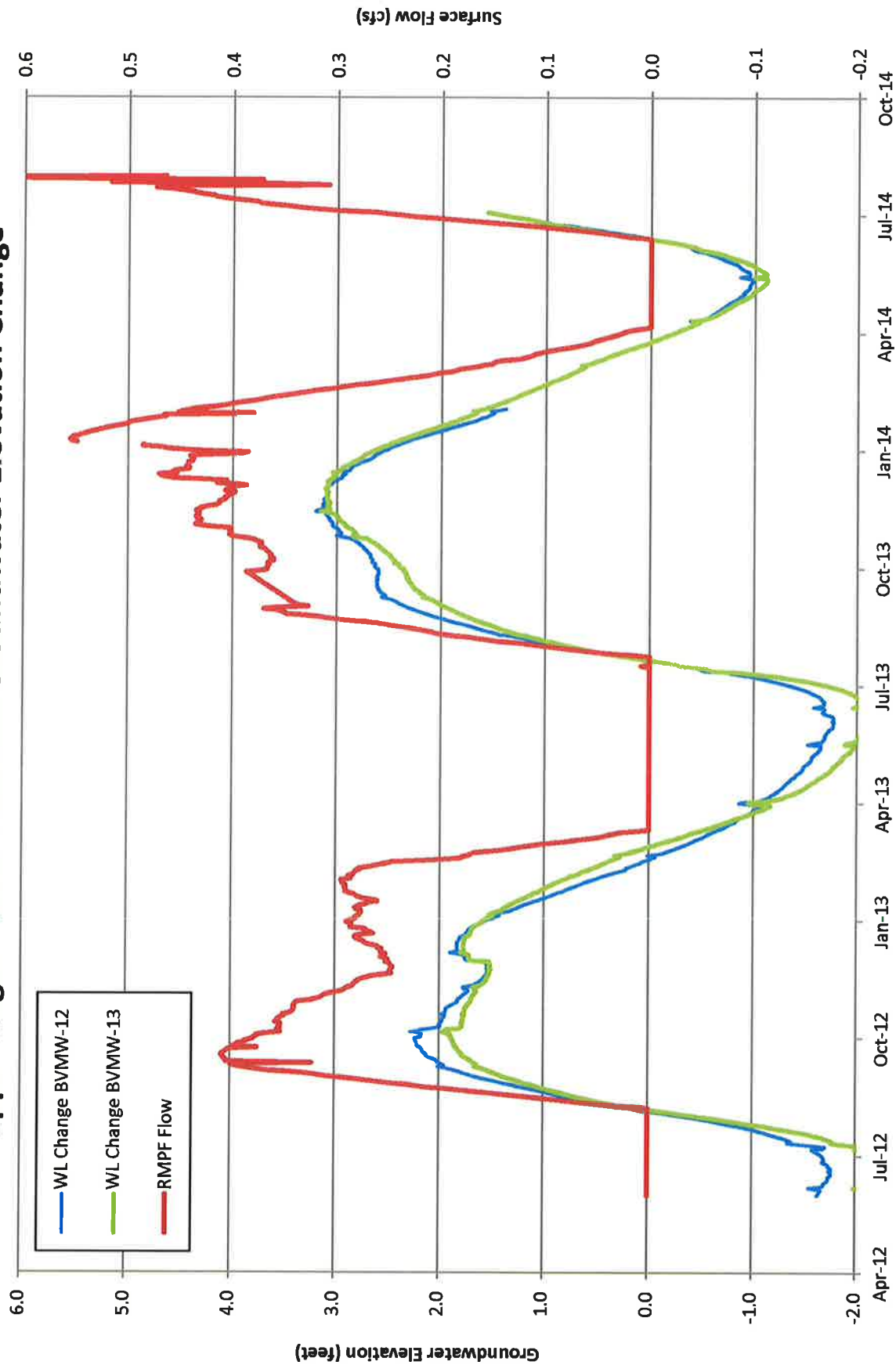
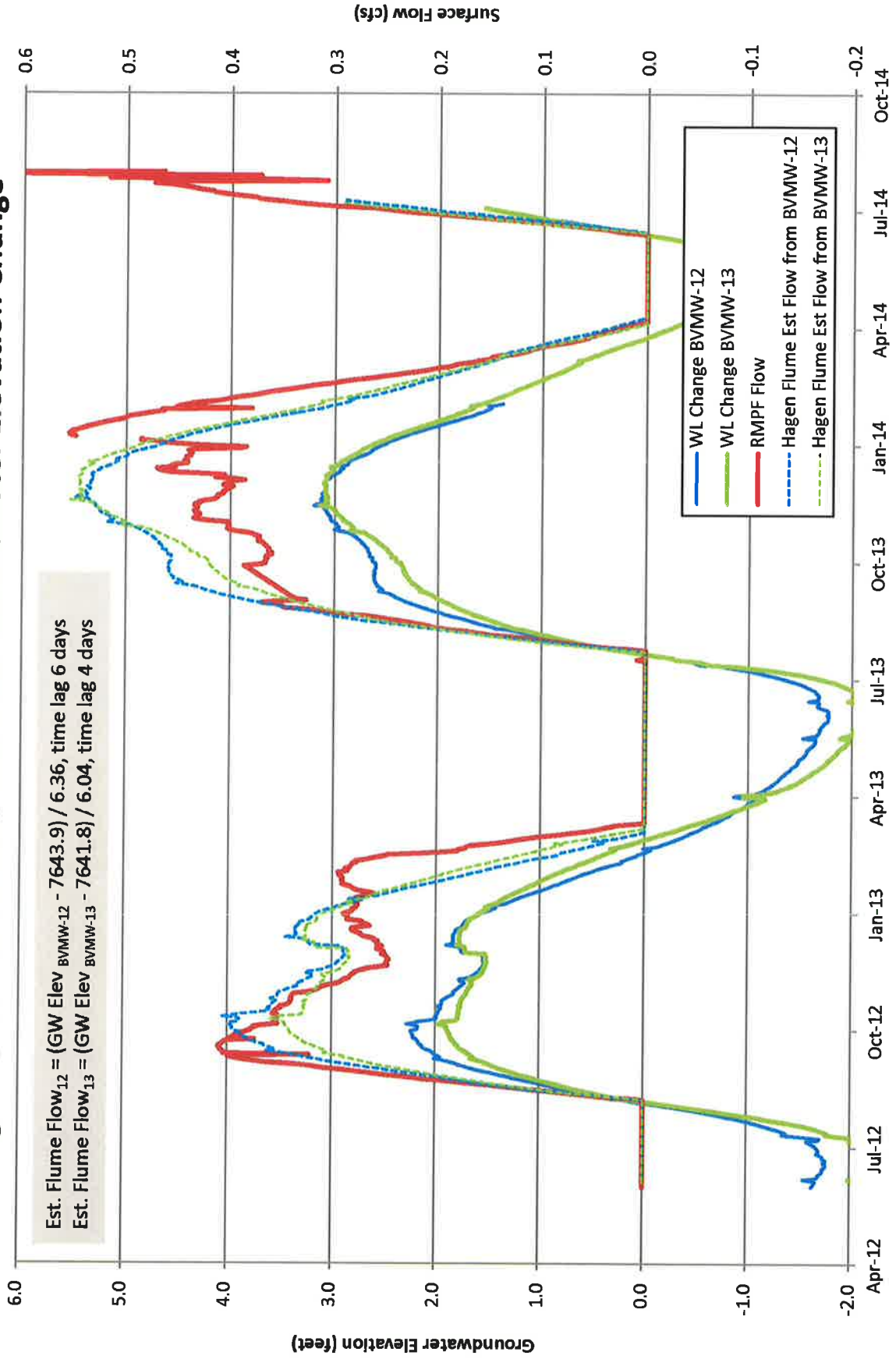


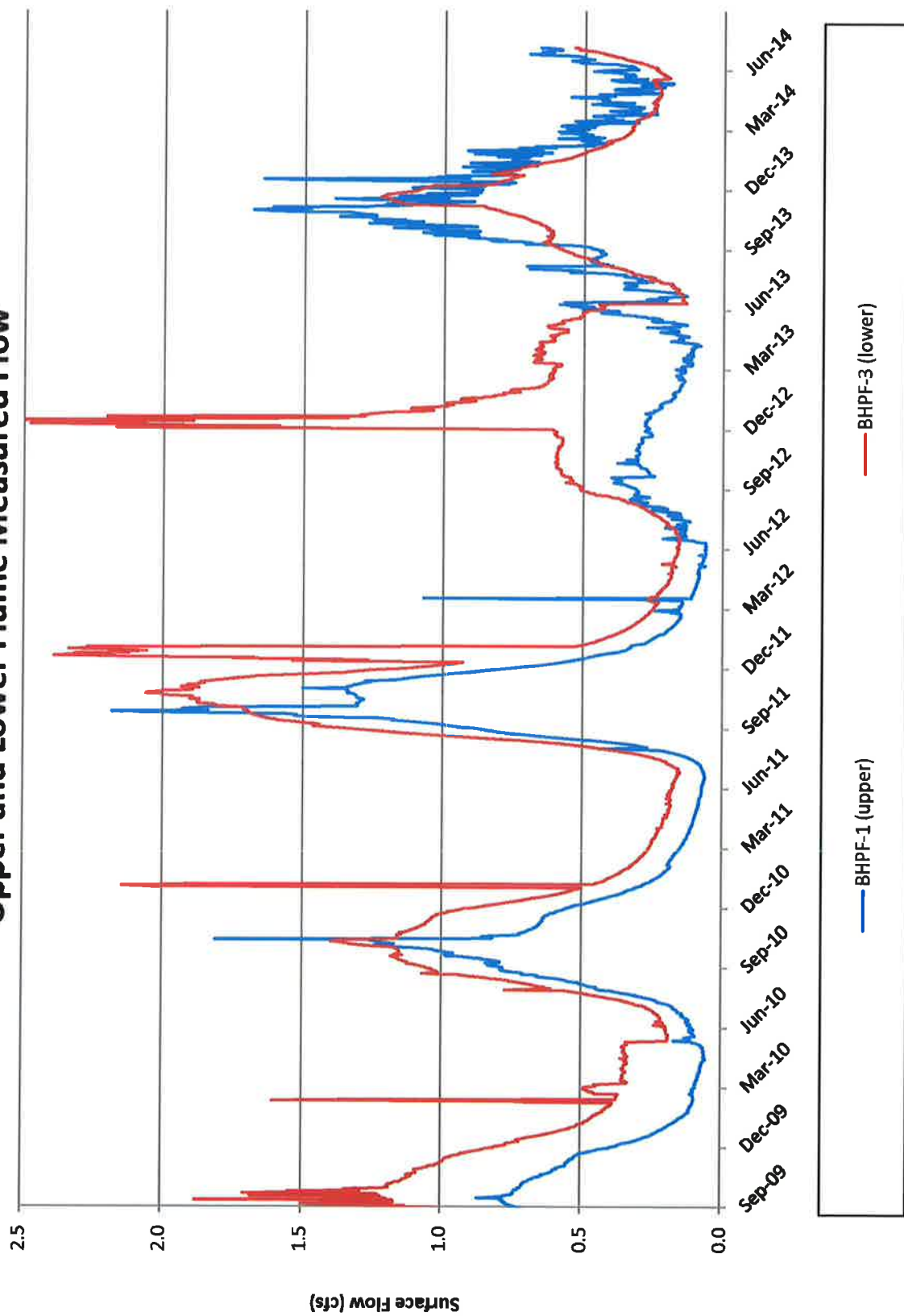
Figure 3  
 Ruby Mountain Springs  
 Hagen Flume Estimated Flows from Groundwater Elevation Change



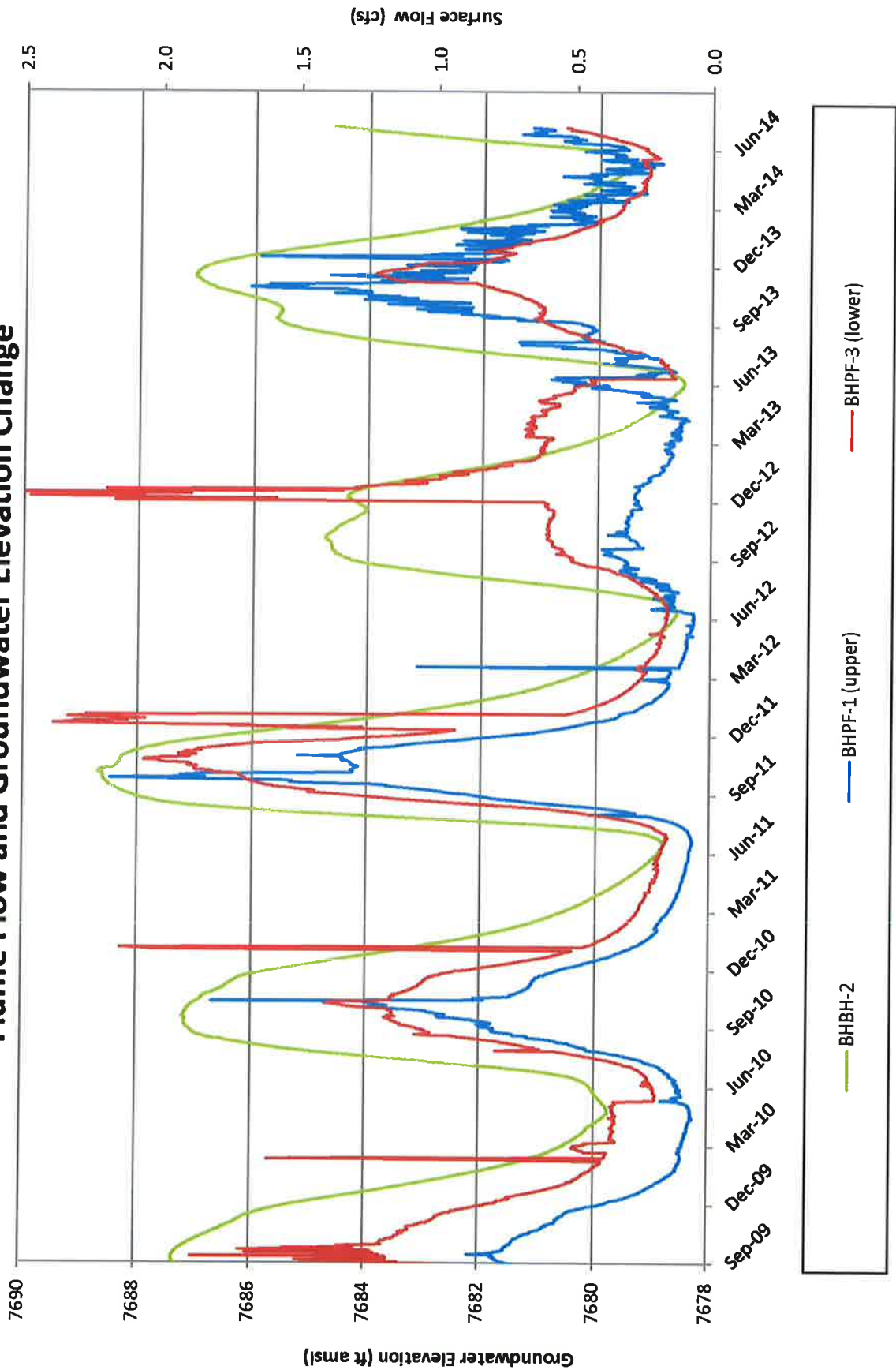
## **EXHIBIT 5**

**Hydrographs for Bighorn Upper and Lower Flumes and  
Monitoring Well BHBH-2**

**Figure 1**  
**Bighorn Springs**  
**Upper and Lower Flume Measured Flow**



**Figure 2**  
**Bighorn Springs**  
**Flume Flow and Groundwater Elevation Change**



**Figure 3**  
**Bighorn Springs**  
**Flume Estimated Flows from Groundwater Elevation Change**

