January 14, 2013

Ms. Anne Holden
Lahontan Regional Water Quality Control Board
2501 Lake Tahoe Blvd.
South Lake Tahoe, CA 96150

Re: Hinkley Groundwater Project Independent Review Panel (IRP)
Manager's Comments on the Mn Issue.

(Specifically Regarding PG&E’s Report on the Assessment of In-Situ
Reactive Zone Treatment Byproducts¹ of December 17, 2012, and The
Water Board’s Mn Investigative Order (R6V-2012-0060) of December 21,
2012).

Dear Ms. Holden:

The Water Board hosted an IRZ and Manganese technical exchange meeting at
the Hinkley Elementary School on December 20, 2012². This pivotal meeting was
viewed by the CAC and Community as the initiation of an open transparent
technical evaluation “Process” to evaluate and respond to Community
manganese concerns generated by PG&E’s operations at the IRZ.

In kicking-off the “Process”, the IRP Manager provided a general overview of the
historical Mn data³, and PG&E walked the participants through a report (“the
Report”) the Company had just earlier submitted to the Water Board on the same
subject on December 17, 2012. At the conclusion of the December 20th meeting
the Water Board asked that any follow-up comments to the meeting should be
submitted to the Water Board. On the following day, December 21, 2012 the
Water Board issued a Manganese Investigative Order (IO)⁴ to PG&E. This letter
describes the Comments the Independent Review Panel (IRP) Manager is
submitting to the Water Board regarding PG&E’s “Report,” the Water Board’s
Order, and the Mn review “Process” we are all now engaged in.

In reminder, the function of the IRP Manager is to assist the CAC and
Community in their technical understanding of topics regarding PG&E’s programs
associated with the remediation of the Hinkley Cr6 groundwater plume. The IRP

¹ Assessment of In-Situ Reactive Zone Treatment Byproducts, PG&E Compressor Station, Hinkley California,
Submitted to California Regional Water Quality Control Board, Lahontan Region, by PG&E; Prepared by Arcadis, Roseville, CA, December 17, 2012.
² Participants included Water Board staff, CAC and Community members, PG&E and their consultants and the
IRP Manager and staff.
³ Slides used by the IRP Manager are provided in Attachment A. Data was received from PG&E, Water Board
and individual Community members.
⁴ Manganese Investigative Order, R6V-2012-0060, Byproduct Plume Monitoring in IRZ Areas, Lahontan
Regional Water Quality Control Board, December 21, 2012.
Manager also submits comments to PG&E and the Water Board on proposed programs, with the general goal of improving the quality, scope and practical implementability of any program.

These comments on the Assessment of Byproducts in the In-Situ Reactive Zone (IRZ) and the recent Mn IO are submitted in this spirit.

An issue of major Community concern that arose during the latter half of 2012 was the observation of “black water” at several domestic wells on the western boundary of the Cr6 plume; located essentially cross-gradient to the areas of operation of PG&E’s IRZ systems. Several Community members collected groundwater samples at domestic wells for analysis of arsenic and manganese. Mr. Nick Grill, a member of the CAC, was the lead Community member who took the initiative on sampling several domestic wells for arsenic and manganese levels. To further address the Hinkley Community’s concerns regarding the “black water,” the Water Board (with IRP Manager assistance) arranged a Technical Exchange Meeting (TEM) with the CAC, PG&E and their consultant, Arcadis. PG&E prepared for the meeting by documenting data findings and their opinions in a Report (see earlier ref. 1) which was issued in the days before the meeting.

The IRP Manager has further reviewed the Report and now provides comments and suggestions to the Water Board. The IRP Manager has five General Comments in the areas of (1) tracer studies, (2) Mn data gaps on the western boundary (also, related to the Process associated with the WB’s December 21st IO), (3) background Mn levels, (4) lithology on the western boundary and north of Hwy 58, and (5) the need for further details regarding the geochemistry in the reduction of Cr6.

General Comments are:

1. Further Discussion of Tracer Results from the IRZ Pilot Studies and a Proposed Focused Future Tracer Test

The PG&E Report discusses tracer results conducted during the IRZ pilot test in 2007. We recommend that more details’ regarding the prior tracer studies be incorporated into the Report (or an appendix). This would certainly assist CAC and Community understanding, and provide valuable background for the further tracer study demands contained in the December 21, 2012 IO.

The CAC and the IRP Manager agree that a new, but initially focused, IRZ tracer test is an appropriate way to confirm groundwater flow direction in the western

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5 Meeting was held on December 20, 2012 at the Hinkley Elementary School.
6 PG&E’s Mn report was issued on December 17, 2012.
7 Details which could be folded into the Report from prior tracer studies include: integrated map based summaries of the temporal monitoring of the tracer together with measured, then computed, groundwater elevations, and flow directions respectively.
part of the IRZ. A tracer test should be conducted to prove or disprove the groundwater flow direction. While there are three IRZ systems, it is the source of the Mn in the seemingly Mn impacted area to the immediate west of the Source Area IRZ system which most immediately interests the CAC. A focused tracer test conducted in this area, sanctioned by all key stakeholders would help definitively confirm the “disputed” groundwater flow direction at the western boundary, and measure the so called “containment integrity” of the IRZ “reactor box” for IRZ-generated manganese and arsenic.

2. Mn Data Gaps on the Western Boundary, and the WB’s December 21, 2012 Investigative Order (IO)

All stakeholders participating in the December 20th Mn technical exchange meeting were encouraged about entering into a technical exchange “Process” which, at its conclusion, will deliver more information on the manganese matter for remedial technical decision making. The accumulated information can also be used to guide interim technical decision-making\(^8\) regarding IRZ operations until final remedy decision time.

The Water Board’s new IO arrives on the scene of the Mn evaluation Process, just as the agreed-to technical Process is getting underway. While the IRP Manager agrees that a Mn Analysis and Interpretation Work Plan will be required eventually, as suggested by the recent IO, my opinion is that a final Work Plan will be of far improved quality, and receive more immediate CAC and Community endorsement, if the Work Plan results from the information derived and the technical discussions which occur as part of the aforementioned Process.

For example, at the December 20th meeting, which kicked off the Mn Process, considerable time was spent in a team-work fashion with CAC and Community Members identifying and then debating the significance of Mn monitoring data gaps. Figure 1 is direct evidence of the Process at work…excellent participation and attentive listening.

Also, to assist the Community’s understanding of the Mn situation, and further the CAC’s goals of outreach, data understanding and transparency, beyond just the use of “dots and colors on maps,” Project Navigator, Ltd. prepared a 3D model. This model, shown in Figure 1, was introduced into the Mn discussions via the Process. The model, and the ensuing brainstorming it generated in open forum, is helping all parties, but especially the CAC and Community work to move onto the same page regarding Mn data understanding.

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\(^8\) See IRP Manager’s letter to Water Board on November 5, 2012, entitled “Comments on the Draft Hinkley Groundwater Remediation EIR (dated August, 2012), wherein the CAC’s opinions about shutting down the IRZ until “more is understood” about the system are documented. In the same letter, however, the IRP Manager goes on record of noting that there are four other approaches which could be pursued to better understand and resolve the Mn issue, including (1) the installation of a select few new Mn monitoring wells, (2) process optimization of the IRZ (e.g. lower carbon dosings), (3) quantification of the masses of Mn and As being generated in the context of a health risk assessment computation, and (4) the immediate convening of focused Mn technical exchange meetings. With the current Process, the latter is underway.
The full CAC and the IRP Manager have discussed the parallel paths of (a) the requirements and timeline of the IO and (b) the open forum Mn review Process. While the CAC is appreciative of the Process and the opportunities it will provide for a technical dialog and improved understanding, the CAC also values the existence of the IO, and its schedule. The CAC feels the presence of the IO delivers a much needed focus on IRZ systems’ byproducts, and elevates the formality of PG&E’s reporting requirements on the topic (…such as quarterly Mn maps).

However, while the timeline of the new Mn IO kicks in⁹, the CAC and the IRP Manager also wish that the now commenced Process should also be allowed to play out¹⁰ in parallel. This approach will permit the CAC and the IRP Manager a transparent mechanism for learning and providing input.

As an example of how the Process could improve any future Mn investigative efforts, please consider the following from the IRP Manager’s initial review of IO R6V-2012-0060. Page 2 of the IO identifies five (5) gap areas which the WB believes have inadequate Mn monitoring. These locations are shown in Figure 2¹¹. The IO then provides very specific guidance for the spacing of the new Mn monitoring points. The expectation is that PG&E will submit a work plan by February 15, 2013¹² detailing these locations. But rather than have PG&E solely decide upon the locations of the monitoring points, and given the recent degree to which Mn issues have been raised at late 2012 monthly Community Meetings, the CAC is interested in actively participating in the Process which would lead to the specific siting of monitoring points via a very transparent approach.

3. Background Mn Levels

As evidenced by discussions at the technical exchange meeting, the topic of what is the range of true (baseline) background Mn concentrations in the IRZ area, prior to IRZ operations, continues to need to be evaluated. Presently, for mapping purposes PG&E has been using a background Mn concentration of 390 ppb. The CAC and Community saw this number being challenged by the Water Board during dialog.

(For the December 20th meeting the IRP Manager plotted available Mn data prior to December, 2004. This data, which we assume was collected before the initiation of any IRZ pilot studies, is shown in Slide 14 of Attachment A. With the admission of no data QA/QC on the part of Project Navigator, Ltd. the pre-IRZ

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⁹ Manganese monitoring Work Plan is due to WB by February 15, 2012 (per letter from Patty Kouyoumdjian (WB) to Sheryl Bilbrey (PG&E), dated January 3, 2013.

¹⁰ This does not need to be a long timeframe, but at least through mid March, 2013.

¹¹ As a cross check the locations are also evident on the "straw model," and thereby become evident to any interested Community member participating in the Process.

¹² February 15, 2013 is the amended submission date for the Mn monitoring work plan per IO R6V-2012-0060. February 15, 2013 date is described in letter from Water Board to Sheryl Bilbrey, PG&E, dated January 3, 2013.
Mn readings are remarkably high, and well in exceedance of PG&E’s 390ppb presumed background concentration).

4. Further Discussion Regarding on the Lithology on the Western and North of HWY 58

PG&E should include details about the lithology around the western boundary and the area north of Hwy 58. PG&E has already extensively discussed this information in their recent Western Investigation Report\(^3\). However, this lithological information needs to be “uploaded” to the current Mn report, and then integrated and verified with the claims made in the Mn report. Preferential lateral transport pathways have been recently conjectured, and we would like to hear PG&E’s opinions on the subject. For example, a discussion on sand channeling, and commentary on the possibility of cross gradient channels, especially north of Hwy 58 and the rail road tracks, by the western boundary, would be worthwhile.

5. Geochemistry of Cr\(_6\), Arsenic, Manganese Reactions and Other Constituents Involved in the Reduction of Cr\(_6\) to Cr\(_3\)

The IRP Manager agrees with the PG&E report’s description that the IRZ will be described by a “certain geochemical profile;” (as discussed on page 3, paragraph 3 of the Report). However, further details regarding the geochemistry of the IRZ should be provided and discussed.

Topics should include the following:

- Discuss the chemical affinity of chromium to arsenic, manganese and iron and other constituents
- Discuss the mass-generation of arsenic, manganese and iron as a result of the reduction of Cr\(_6\), and compare these amounts to what may exist in the general location of the IRZ in a natural background condition.
- Discuss the half lives of the reduction and oxidation of chromium along with key parameters that influence both reactions (e.g. pH, Redox Potential, Manganese, etc.)
- Provide further details regarding the chromium and manganese reactions and mechanisms in aquifer systems (as outlined in an EPA Chromium Report\(^4\))
- Generate maps depicting mole ratios of manganese, arsenic or chromium to define any pattern trends in the Hinkley Valley

\(^3\) Preliminary Reporting of Geology and Hydrogeology for Investigations in the Western Area, Pacific Gas and Electric Company’s Hinkley Compressor Station, Submitted to California Regional Water Quality Control Board, Lahontan Region, by PG&E; Prepared by Stantec, Lafayette, CA, November 19, 2012

\(^4\) In-Situ Treatment of Soil and Groundwater Contaminated with Chromium, Technical Resource Guide, EPA/625/R-00/005, October 2000
Include a section describing the estimated time for manganese to attenuate back into the soil matrix

Should you have any questions or comments, please feel free to contact either of the undersigned.

Very Truly Yours

Ian A. Webster, Sc.D.    Raudel Sanchez, Ph.D.
IRP Manager     Project Manager

cc:
CAC Members
Laurie Kemper, Lahontan Regional Water Control Board
Sheryl Bilbrey, PG&E
Kevin Sullivan, PG&E
Jason Keadjian, Keadjian Associates, LLC, for PG&E

Attachments

Figure 1: Manganese Technical Exchange Meeting (the "Process") at Hinkley School, December 20, 2012
Figure 2: Locations of the Manganese Data Gaps Identified in Water Board Investigative Order No. R6V-2012-0060 of December 21, 2012
Attachment A: Slides used by IRP Manager at December 20, 2012 Manganese Technical Exchange Meeting at Hinkley School
Meeting was facilitated by the Water Board and also included participants from CAC, Community-at-Large, USGS, PG&E, Arcadis and IRP Manager (Project Navigator, Ltd.). Meeting was an initial step in the Process to understand the generation and transport of IRZ-generated manganese. Tools such as a Mn 3D Tabletop Model were used to facilitate the Process.
FIGURE 2

North
In the 1000-ft gap between wells EX-21 and EX-22.

West
In the 1,300-ft gap between wells CA-MW-108 and SC-MW-13.

Southwest
In the 1,900-ft gap between wells SA-MW-16 and MW-78.

South
In the 1,100-ft gap between wells MW-78 and MW-39.

East
In the 1,000-ft gap between wells SA-MW-25 and SC-MW-01.

Note: All information shown on this Figure was derived from Google Earth topography. The data is provided by PG&E, Water Board, and Private samplers. (12/18/12)
ATTACHMENT A
Hinkley Groundwater Remediation Project

Manganese Data Review

December 20, 2012
Hinkley Elementary School

Prepared for
Stakeholders* Team Meeting

Prepared by
Dr. Ian A. Webster
Project Navigator, Ltd.

* CAC, PG&E, Water Board, USGS, and IRP Manager

Mn and “Black Water.”
How We Got Here.

<p>| | |</p>
<table>
<thead>
<tr>
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<tbody>
<tr>
<td>1</td>
<td>Residents to West of IRZ Voice Observations of “Black Water” (late summer)</td>
</tr>
<tr>
<td>2</td>
<td>Knowledge that the Reductive Nature of the IRZ Operations are Known to Liberate Mn (and As) from the Soil (literature and ca 2004, onwards, pilot testing)</td>
</tr>
<tr>
<td>3</td>
<td>Community Becomes Concerned about the ill-defined Migration of Mn (fall)... “Black Water Observations”</td>
</tr>
<tr>
<td>4</td>
<td>Community and Water Board Start Collecting Water Samples for Analysis (fall)</td>
</tr>
<tr>
<td>5</td>
<td>Debate Arises About Direction of GW Flow and Data Validity</td>
</tr>
<tr>
<td>6</td>
<td>All Parties Agree for the Need for Open Dialog, Leading to a Common Technical Understanding</td>
</tr>
</tbody>
</table>

...hence the Reason we are here today.
Information to Consider

- **Groundwater Flow Directions**
- **Processes Leading to the Presence of Mn in Groundwater**
  - Natural leaching Vs IRZ reductive mechanisms
- **Mn Measurements**
  - Sampling Methodology
    - Well type (domestic Vs monitoring well)
  - Mn as a function of (a) location & (b) time*
  - Geochemical profile (for IRZ, elevated Mn, occurs with low Cr6)
  - Historical baseline Vs today’s observations*

* These two issues are highlighted in the figures in this slide deck.
Manganese Data and Ownership

<table>
<thead>
<tr>
<th>Data “Owner”</th>
<th>Number of Samples</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Community</td>
<td>33</td>
<td>Collected 2012, Q3 and Q4</td>
</tr>
<tr>
<td>Water Board</td>
<td>20</td>
<td>Collected 2012, Q3 and Q4</td>
</tr>
<tr>
<td>Mojave Water Agency</td>
<td>53 (33 Near Hinkley)</td>
<td>Collected Historical Data</td>
</tr>
<tr>
<td>PG&amp;E</td>
<td>304</td>
<td>Collected 2012, Q3</td>
</tr>
</tbody>
</table>
Manganese Data Sources and Interpretation Process

- Community (33 samples)
- Water Board (20 Samples)
- Mojave Water Agency (53 Samples)
- PG&E (304 Samples)

Combined Database (410)

Data Collection and Database Creation

ArcGIS & EVS Maps and Analysis

Stakeholders Review & Discussion

3D Interpretations

PG&E

Community

Water Board

Mojave Water Agency
Map Legend

- **Community**
- **Water Board**
- **Mojave Water Agency**
- **PG&E**

**Manganese Concentration Intervals (ppb):**
- ND
- ND – 50
- 50 – 500
- 500 – 5,000
- > 5,000
Manganese, PG&E, 3rd Q 2012

Note: All information shown on this Figure was derived from Google Earth topography. The data is provided by PG&E, Water Board, an Private samplers. (12/18/12)
Manganese, Community, 3rd & 4th Q 2012

Manganese Concentration Intervals (ppb)
- ND
- ND – 50
- 50 – 500
- 500 – 5,000
- > 5,000

Note: All information shown on this Figure was derived from Google Earth topography. The data is provided by PG&E, Water Board, and Private samplers. (12/18/12)
Manganese, Water Board, 3rd & 4th Q 2012

Note: All information shown on this Figure was derived from Google Earth topography. The data is provided by PG&E, Water Board, and Private samplers. (12/18/12)
Manganese, Mojave Water Agency (1950’s to Present-day)

Manganese Concentration Intervals (ppb)
- ND
- ND – 50
- 50 – 500
- 500 – 5,000
- > 5,000

Note: All information shown on this Figure was derived from Google Earth topography. The data is provided by PG&E, Water Board, and Private samplers. (12/18/12)
Note: All information shown on this Figure was derived from Google Earth topography. The data is provided by PG&E, Water Board, and Mojave Water Agency. (12/18/12)
Manganese: Community + Water Board (Zoomed to IRZ Area)

Manganese Concentration Intervals (ppb)
- ND
- ND – 50
- 50 – 500
- 500 – 5,000
- > 5,000

Note: All information shown on this Figure was derived from Google Earth topography. The data is provided by PG&E, Water Board, and Private samplers. (12/18/12)
Manganese Sampling Data from PG&E + Community + Water Board + Mojave Water Agency (Zoomed to IRZ Area)

Manganese Concentration Intervals (ppb)
- ND
- ND – 50
- 50 – 500
- 500 – 5,000
- > 5,000

Legend:
- PG&E Water Agency (West Val.)
- Manganese (g/L)
- Manganese + 50 µg/L
- Manganese + 10 µg/L
- Manganese + 2 µg/L
- Manganese + 0.5 µg/L
- Manganese + 0.1 µg/L
- Manganese + 0.05 µg/L
- Manganese + 0.01 µg/L
- Manganese + 0.001 µg/L
- Water Board (mL equiv. L)
- ND
- ND – 10
- 10 – 20
- 20 – 40
- 40 – 80
- 80 – 160
- 160 – 320
- 320 – 640
- > 640

Note: All information shown on this Figure was derived from Google Earth topography. The data is provided by PG&E, Water Board, an Private samplers. (12/18/12)
Manganese:
Before December 14, 2004 and 2012 3rd Quarter

Note: All information shown on this Figure was derived from Google Earth topography and groundwater sampling data supplied by PG&E to PNL in PNL’s role as IRP Manager.
Manganese Distribution in 3D
(Includes PG&E 2012 Q3, Water Board 2012 Q3 & Q4 + Community 2012 Q3 & Q4)

**Note:** All information shown on this Figure was derived from Google Earth topography. The data was provided by PG&E and Water Board et al.

- **140,000 ppb**
- **99,000 ppb**
- **7,600 ppb**
- **Max Mn Concentration in IRZ is approx 6,000 ppb**