From:	Linda Stedjee
To:	Harris, Ken@Waterboards
Cc:	Howard, Tom; Packard, Harvey@Waterboards
Subject:	Response to April 11, 2014 letter found among attachments to May 22 meeting agenda
Date:	Thursday, May 08, 2014 10:05:42 AM

Mr. Harris,

In looking through the attachments to the agenda for the May 22 RWQCB meeting, I found an April 11, 2014 letter from Dean Thomas to Harvey Packard. The letter presents arguments related to my November 1, 2013 letter to you.

Unfortunately, your staff evidently chose not to provide me with their responses to my concerns. Now that I have found them, however, I would like to address them in advance of the May 22 meeting. I have a number of concerns with the April 11 letter. You will note that, in the interest of more open communications, I have included Mr. Packard on the distribution for this email.

1. Inconsistencies in RWQCB staff comments and supporting data

While Mr. Thomas presents some interesting hypotheses, he unfortunately does not appear to have tested them sufficiently. It also appears that some of his arguments contradict others, and the data used to support some arguments contradicts other arguments. In other words, this latest analysis does not appear to look at things from a "big picture" perspective.

Example 1a: On page 1 of his letter, Mr. Thomas addresses my statement that the City's consultant has identified no change in farming activities that could account for the "radical spikes in nitrate levels whenever City wells are used." Mr. Thomas said,

> "*This is not true because Cleath's Report (Report) shows evidence for significant nitrate loading increases in the lower Morro Valley due to the switch to row crops and three-crops per year rotations, before the concentrations in the City's wells began to increase. The Report also shows that nitrate concentrations in lower Morro Valley groundwater increased nearly four-fold after the switch to higher nitrate loading*."

So, Mr. Thomas appears to be saying that the "significant nitrate loading increases" caused the spikes. However, On page 3 of his letter to Mr. Packard, Mr. Thomas said,

> "*Staff does not believe that timing of groundwater sample collection is very significant because of the slow and variable rate of movement of water through the unsaturated zone (estimated to be an average of two-year travel time),* ***and it is very improbable that specific loading events in Morro Valley can be correlated to a spike in concentrations in the City's wells*** *because of factors discussed above. If the soils were sandy, it might be possible, but during a site visit, staff observed that the soils are clay-rich in the lower Morro Valley*." (emphasis added)

Thus, in his statements on page 8, Mr. Thomas appears to be contradicting his statements on page 1.

Example 1b: Perhaps Mr. Thomas intended to say that increased fertilizer use has been reflected the overall level of nitrates in the wells. However, if that is the case, there is another problem – this time with data that contradicts the hypothesis. On page 1, Mr. Thomas says ,

"*It should be noted that any excessive nitrate loading that occurs in in lower Morro Valley fields would take several years to reach the City's wells because of the travel times through the vadose zone … Therefore,* ***a nitrate molecule discharged to a field in lower Morro Valley today may not turn up in the City's wells for six years. This is an average travel time estimate.*** *Processes of hydrodynamic dispersion result in some arriving more quickly, while others more slowly. Therefore, it would be impossible to correlate ones season's nitrate loading event to concentration increases in the City's wells*." (emphasis added)

On page 2, Mr. Thomas further states:

"The fact that the average concentration from the 2007 sampling round is a factor four times higher, and three times the MCL, is significant. Adding the fact that nitrate loading increased by an estimated factor of 2.5 between 1985 and 2007 makes a very compelling argument for downstream increases in nitrate concentrations."

Let us assume, for the sake of argument, that Mr. Thomas is correct, and that a change in the amount of fertilizer used in the Morro Valley will result in a change in nitrate levels in City wells after a period of about six years.

According to the City's consultant, there was a significant increase in fertilizer use in 1995, so, if Mr. Thomas is correct, we would expect to see that increase reflected in the nitrate levels in the City wells in approximately 2001. The wells were not used in 2001, but were used in 2002. Sure enough, there was a large spike in November, 2002 when the wells were used.

However, there is a problem when we attempt to apply the theory over the long term. I ask that you review the following table from the consultant's report:

Table 2
Harvested Acreage Adjustments 1977-2007
Morro/Little Morro Creek Valleys

Crop Type	Harvested Acreage (adjusted for multiple crops)					
	1977	1984	1992	1995	2001	2007
Truck (except legumes)	81	110	345	384	362	505
Legumes (peas/beans)	22	178	456	742	386	--
Field	70	69	--	--	--	6
Pasture	61	57	10	18	9	5
Orchard	59	187	258	361	562	798
Total	293	601	1069	1505	1319	1314

Note: Harvested acreage adjustments are for fertilizer use estimates only, not for water use.

Please note the total harvested acreage, adjusted for multiple crops, in the last line. You will see that, although there was a significant increase in 1995, by 2001, the acreage and fertilizer use had gone down from the 1995 level. The decrease in fertilizer use is confirmed by the following material from the report:

Using the above values as guidelines, estimates of the relative nitrogen applications for each crop survey year based on harvested acreage have been developed. Truck crops (except legumes) average 190 pounds N per acre, legumes average 100 pounds/acre, field crops average 200 pounds per acre (three harvests per year), and avocado averages 36 pounds N per acre for young trees and 100 pounds per acre for mature trees. The resulting nitrogen fertilizer applications are as follows:

1977: 37,000 pounds N
1985: 67,000 pounds N
1992: 135,000 pounds N
1995: 180,000 pounds N
2001: 157,000 pounds N
2007: 169,000 pounds N

Please note that although there was an increase in fertilizer use in 1995, by 2001, the use had dropped significantly, and in 2007, was higher than it had been in 2001, but still lower than it had been in 1995.

Based on Mr. Thomas' apparent premise that well nitrate levels reflect changes in fertilizer use, and his premise that it takes about six years for a nitrogen molecule to make it from the fields to the wells, in 2007, we should have seen a significant decrease in nitrate levels in the wells. In about 2013, we should have seen well nitrate levels somewhat higher than those for 2007, but not so high as in 2002.

That is not what happened. Nitrate data obtained from the CDPH shows that the highest nitrate level reported for well 03 in November, 2002, was 71. In 2007, it was 100. For well 04, the November, 2002 reading was 56, and the November, 2007 reading was 75. Well nitrate levels have continued to increase in recent years. In June of 2013, the nitrate level in well 03 was 105. In fact, on page 4 of his letter, Mr. Thomas states:

> *"Whether you believe that pumping is stable or declining, nitrate is increasing in all four of the City's wells overall."*

To summarize, while Mr. Thomas' hypothesis initially looked promising, the correspondence between fertilizer use levels and well nitrate levels is just not there in the long term.

2. Questionable and incomplete arguments

I find that some of Mr. Thomas' arguments do not appear to cover all of the points necessary to provide a complete and logical analysis of some of the issues.

Example 2a: On page 2 of his letter, in discussing our concerns regarding inadequate isotope testing, Mr. Thomas states:

> *"Because the end-member components do not have a unique signature and can have significant overlap in signature, results can be very qualitative and not conclusive in of themselves, particularly when mixing of two or more components are possible; hence, we agreed with Cleath that the results were inconclusive as to sources for the nitrate in the City's wells. A thorough analysis of the nitrate isotopes of local potential sources for nitrate would be a significant research study in of itself."*

First, I must ask why, if the isotope testing is not reliable, was any such testing done at all – and

furthermore, if the test results were inconclusive, why was more testing not done?

Second, I would like to again point out something very significant that was initially reported by Sadowski and Bruton in 2008. This is in regard to study done in New Mexico by Dennis McQuillan.

Mr. McQuillan found that nitrate signatures in sewage in local septic systems ranged from 7.6 to 12.1. He found that in the local sewage treatment plant, the signatures ranged from 7.2 to 12.1.

In the Morro Bay wells, the signatures ranged from 7.1 to 10.0. The standard range for commercial fertilizer is - 4 to + 4. If, indeed, the primary source of nitrates in the wells were fertilizer, we would expect to see lower numbers. Again, I believe that isotope testing and analysis was insufficient and incomplete.

Example 2b: On page 2 of his letter, in discussing tests for other components of wastewater, Mr. Thomas said:

> *"The Letter makes the case that concentrations of nitrate in the City's wells were not at highest levels when samples were collected; however, they were generally above the MCL at between 34 and 72 mg/L (as nitrate) and would be expected to show some component of wastewater signature because they are about three times the baseline concentrations (pre-1990s concentrations in the City's wells). As a side note, nitrate concentrations in MB-3 have reached 160 mg/L, which is higher than the estimated concentration at the WWTP of 125 mg/L, assuming all of the nitrogen is converted to nitrate."*

I believe that it will be helpful here to look at one of the diagrams in the consultant's report. As you know, Piper diagrams show the relative concentrations of ions in solutions. Presumably, the consultant was looking for similar and/or overlapping plottings of data from groundwater and wastewater samples.

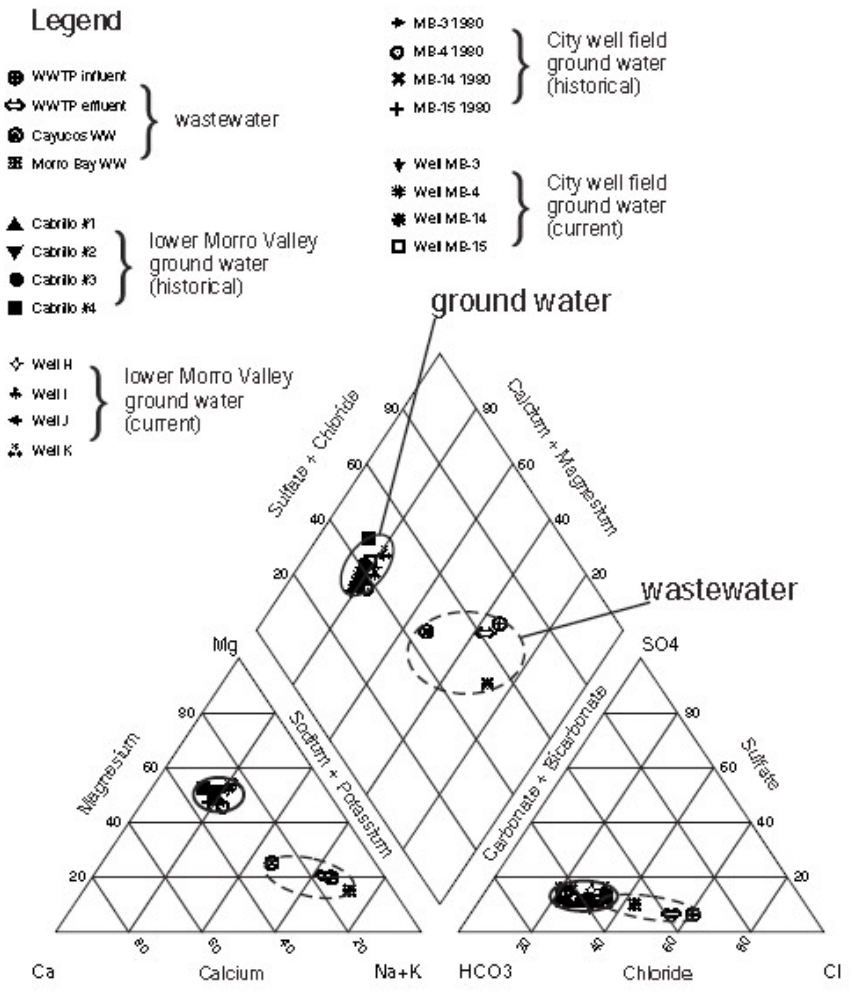

Figure 8
Piper Diagram
Morro Basin Nitrate Study
City of Morro Bay

Cleath & Associates

I submit that, whether or not nitrates in City wells were above the mcl when the samples were collected, they were NOT at their highest. If sewage is the cause of the high nitrates, then the data in a sample collected when the nitrate levels were at their highest levels for the year would not plot the same as data from samples taken when nitrates were at lower levels. In other words, I believe your staff's argument is simply not relevant to the basic issue. The samples were not drawn at the right time to give useful and relevant results - which would have been an accurate plotting of the data when nitrates in the wells were at their highest.

Example 2c: On page 3, Mr. Thomas argues that there is no significant hydraulic connection between the MTBE remediation site and the wells. Mr. Thomas cites a "geologic cross section", which he uses as evidence that there Is a the "lack of interconnected sand/gravel units between the wells and the former

Shell Station." Mr. Thomas said,

> *"Consistent with the conceptual model of a stream channel environment, the cross section shows lense-shaped buried sand/gravel units that are isolated by thick layers of silt and clay in the north-south directions. In this conceptual model, which is common for a coastal alluvial setting, groundwater flows preferentially within these units westward towards the ocean, under natural gradient. Despite the City's wells being the most powerful groundwater pumping wells in the area, the MTBE plume core has not been deflected towards the south by the City's wells, consistent with the lack of interconnected sand/gravel units between the wells and the former Shell Station. Staff believes that the hypothetical "finger plume" of low ppb concentrations of MTBE emanating from submerged sewer line does not constitute "hydraulic connection" in the context of the high ppm nitrate tainted volumes of water produced by the supply wells. Therefore, hypothetical movement of nitrate in the shallow units would need to pass vertically through clay and silt layers to reach the production intervals of the wells. This is remotely possible but the flux would be very low (e.g., hydraulically disconnected)."*

While it may have been true at one time that the, "*lense-shaped buried sand/gravel units*" were "*isolated by thick layers of silt and clay in the north-south directions*", we believe that changed as a result of the MTBE remediation project, with its major excavations and the drilling of the 63 monitoring and extraction wells. This concern has been clearly stated. It was first noted by Sadowski and Bruton, in 2008. Since then, they have restated the concern, and it has been repeated by others. However, Mr. Thomas does not address this critical issue in his arguments.

Example 2d: On pages 4 and 5 of his letter, Mr. Thomas argued for his hypotheses that the differences in nitrate levels in the Morro Bay municipal wells are a result of dilution by surface creek water. He said,

> *"During summer onset, the wells produce a higher proportion of their water from groundwater stored in the aquifer (that is high in nitrate); therefore, concentrations begin to climb at the onset of the dry season and peak around the following wet season. Higher flows in Morro Creek, which are captured by the pumping depression in groundwater created by the City's wells, act to dilute nitrate in the aquifer, which results in declining nitrate concentrations in City wells until the next dry season (thus completing the cycle). The recent drought period appears to exacerbate the problem and the over-all trend is dependent on pumping rates relative to creek inflows"*

and,

> *"The groundwater depression (lowering of the water table) caused by pumping induces a higher rate of stream recharge to the aquifer because downward hydraulic gradients are intensified. In fact, during periods of drought and high pumping rates, Cleath reports. that saltwater is drawn towards the wells from the ocean because the water table is lowered below sea level."*

First, it has often been stated that one of Morro Bay's water supply problems stems from the fact that groundwater is not "stored in the aquifer" – because the water in the aquifer consists of constantly-moving underground streams. Cleath has stated, "*During non-pumping periods, ground water flow below the narrows is toward the coast at a nominal hydraulic gradient of 0.0005 ft/ft*." However, this is not a significant issue when compared to the real "kicker" related to Mr. Thomas' hypothesis.

Mr. Thomas appears to be describing what he believes to be a standard, consistent and repetitive physical process in regard to stream recharge and nitrate levels – something that would be expected to remain constant year after year. It is not.

Please note the bold text in the following quote from the City-funded nitrate study:

> "*Beginning in 2002, nitrate concentrations in MB-3 have exceeded the drinking water standard on a seasonal basis (Figure 4). the pattern of fluctuations, however, appears linked to well field production. Nitrate concentration peaks between 2002 and 2006 coincide with full scale production at the well field, which occurs annually around November during the State Water Project shut downs.* ***Historically, nitrate concentrations in November were in decline, rather than peaking****."*

Here, we have another case of a hypothesis that initially sounded very promising, and was well-worth exploring. However, the data shows that it does not hold up over time. There was a major change in 2002.

Also contradicting the hypothesis is nitrate data from the Morro Bay Mutual Water wells located on the power plant property. One of the two wells, MBMW well 02, is close to the creek. However, MBMW 03 is approximately the same distance from the creek as Morro Bay municipal wells 03 and 04. We know that both MBMW wells have been consistently used over time in order to supply the needs of the power plant.

The MBMW wells are not part of a large public water system, and hence are not regulated by the CDPH. Rather, they are regulated by the County. Testing is far less frequent, but there is enough data to be significant. I obtained MBMW well nitrate data from the County. The data covered the years 2002 through 2012. I chose and documented the highest nitrate reading for each month for which data was available. The data shows that while nitrate levels in the municipal wells were extremely high, MBMW well nitrate levels remained low.

For example, in November, 2002, the highest nitrate level recorded for municipal well 03 was 71. The level reported for the MBMW wells was 10. In December, 2006, while the highest nitrate level for municipal well 03 was 81, the highest for MBMW wells was 10. In May of 2007, the highest level reported for municipal well 03 was 55. For the MBMW wells, the number was 7**.**9. In May, 2010, the highest nitrate level for municipal well 03 was 62. The highest number reported for MBMW wells was 2.6

From 2002 through 2011, the highest nitrate level ever reported for MBMW was 10, reported in 2002 and 2006 – which is obviously WAY less than the highest number for municipal well 03 – which was 100 (reported in 2007 and again in 2009). For your information, I provide below a map showing the approximate locations of the municipal and MBMW wells. The location of the creek is pretty easy to determine – it runs just to the south of the baseball fields at Lila Kaiser park.

Note the distance of MBMW well 03 from the creek. It is about the same distance away as municipal wells 03 and 04. Yet, the nitrate levels differ radically and consistently over time. Were Mr. Thomas' theory correct, one would expect to see the same nitrate levels in wells that are the same distance from the creek. Clearly, we do not.

In 2010, MBMW did attempt to gain permission to install and use a new, replacement well 03 closer to the creek, but the Coastal Commission denied the project, and MBMW was told that any such use would be illegal. City of Morro Bay records indicate that there was no further attempt to obtain a valid permit for the well. I must therefore assume that although it was installed, this well was abandoned and never used.

Conclusions

In conclusion, Mr. Harris, I would like to say that while I believe your staff did a great job identifying a number of interesting and potentially-valid hypotheses regarding the source of the nitrates in the municipal wells, I also believe that the evidence clearly demonstrates that they just didn't carry their analysis far enough.

Thus, the group of concerned residents of which I am a part stands by our original conclusion – that the primary source of the nitrates in City wells is exfiltrating sewage. We believe that the dilapidated trunk line suspected to be the primary source (the line shared by MorroBay and Cayucos) needs to be repaired as soon as possible, and that the condition of the Cayucos line should also be investigated.

Linda Stedjee