TO: Harvey Packard

FROM: Dean Thomas
Engineering Geologist, Site Cleanup Program
CENTRAL COAST WATER BOARD

DATE: April 11, 2014

SUBJECT: RESPONSE TO LINDA STEDJEE'S NOVEMBER 1, 2013 LETTER OF CONCERN OVER LEAKY SEWER LINES AND NITRATE INCREASES IN SUPPLY WELLS

cc: John Robertson
Thea Tryon
Sheila Soderberg
Katie Disimone

Issues and Staff's Responses:

Background Section, Page 2, 4th from the last paragraph of Stedjee's 11/1/2013 letter (Letter) claims that Morro Bay's paid consultant has not shown why farmers might have suddenly started to cause "radical spikes in nitrate levels whenever City wells are used."

Staff's Response: 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. The Letter's claim indicates that the author lacks an understanding of groundwater and nitrate transport mechanisms. 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 (percolation and downward migration in the unsaturated zone), followed by lateral transport in the aquifer through the narrows. The travel times vary depending on seasonal rainfall totals and timing, irrigation efficiencies, local soil composition, and changes in groundwater gradient caused by seasons/weather cycles, pumping, etc. 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.

Issue No.1, Isotopic Analysis of Nitrogen. The Letter contends that the isotopic analysis in Cleath's report is incomplete because it did not include specific analysis of local potential sources for nitrogen.

Staff's Response: The Letter makes a good observation here. However, Cleath's report uses published literature values for isotopic signatures of both animal waste and fertilizers, the two possible end-member components. This is a typical approach used by researchers to describe nitrate signatures found in groundwater. 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.

Issue No. 2, Tests for Other Components of Wastewater. The Letter contends that the general mineral analysis using Piper diagrams is meaningless because the samples were collected when nitrate concentrations were low in the City's wells.

Staff's Response: 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.

Issue No. 3, Changes in Nitrate Concentrations in the Morro Valley and (City) Well Water. The Letter contends that Cleath's report cannot make the nexus between change in farming practice and increases in nitrate at the City's wells based on two rounds of sample collection (1980 and 2007) in Morro Valley wells. In addition, the timing of the sample collection relative to farming practice may bias the results.

Staff's Response: It is always nice to have more data. However, the 1980 snapshot, which represents the baseline period, is a significant data point because it is an average of samples collected from 6 wells. 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. More recent data from the Central Coast Water Board's Irrigated Lands Regulatory Program collected in 2011 indicates concentrations remain high in the lower Morro Valley (four wells sampled having concentrations of between 50

and 333 mg/L as nitrate), which bolsters the 2007 results even further. 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.

Issue No. 4, Reference to Amick and Burgess Study on Sewer Exfiltration. I did not comment on this originally.

Issue No. 5, "Pro-active" Maintenance. I did not comment on this originally.

Issue No. 6, Hydraulic Connection Between Area of Shell Station Site and Municipal Well Field. The Letter cites a May 1, 2006 document from the City's consultant, Cleath and Associates. The document argues against no further action for the MTBE plume case and recommends continued monitoring of MTBE attenuation. The document hypothesizes that MTBE may be migrating via permeable backfill along sewer lines, and emanating southward along a "finger plume" that is perpendicular to the east-west MTBE plume core centerline emanating from the former Shell station, as evidenced by detections of MTBE in the shallow monitoring well adjacent to MB-3.

Staff's Response: Cleath's hypothesis in their May 1, 2006 document is an interesting one; thank you for bringing it to our attention. It should be noted that Shell's consultant contended that the MTBE detections at MW-26 are from a local isolated source, which is plausible, given the low ppb detections in question and that many monitoring locations between MW-26 and the Shell site had non-detect MTBE. Staff should clarify that our current limited review of the Shell cleanup case consisted of looking at geologic cross sections, monitoring well locations, and the MTBE plume geometry based on a recent monitoring report. Geologic Cross Section A-A' (see attached) from a 2001 report by Miller Brooks cuts across the longitudinal axis of fabric of fluvial/alluvial (stream channel) geologic units emanating from the Morro Valley, particularly near City well MB-3 (see MW-12 location). 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

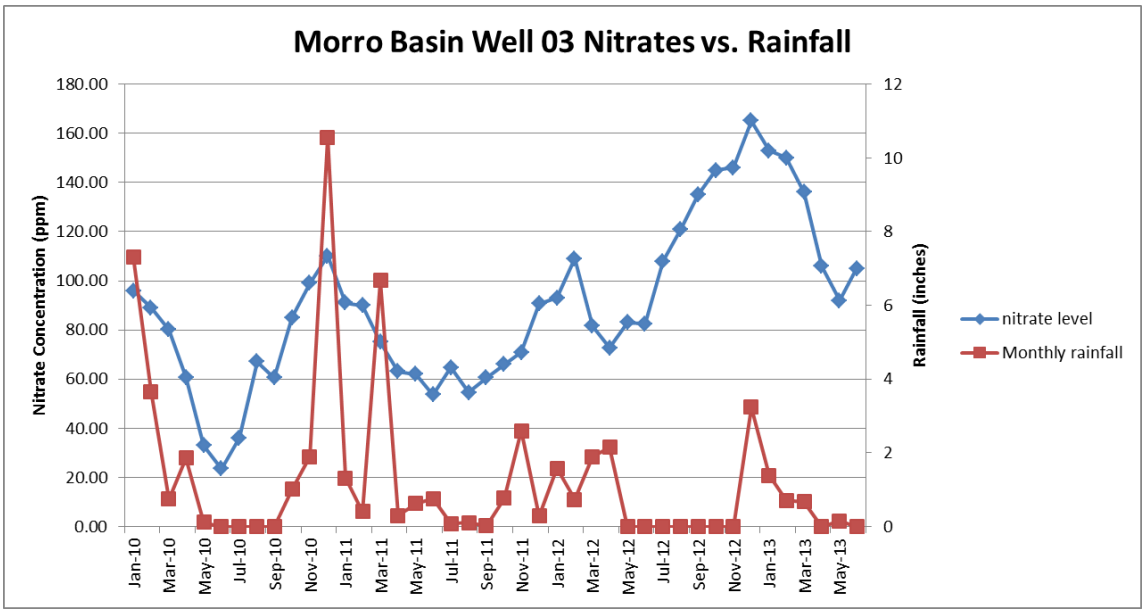
production intervals of the wells. This is remotely possible but the flux would be very low (e.g., hydraulically disconnected).

Issue No. 7, Declining Well Production from 2009 to Present. The Letter requests that staff clarify what well production data was used as it appears to be different than what the authors had provided.

Staff's Response: Staff used the same Excel spreadsheet the author provided but we converted discharge rates from acre ft. per month to gallons per minute. Regardless, if one uses the spreadsheet to do a linear regression analysis on the data, there is a downward trend from September 2009 to June of 2013 in the cumulative pumping rates for the City's wells. If you omit the 2010 data when Morro Bay did not have State Water supplied, then perhaps the pumping trend is stable at a median value of about 60 gallons per minute. Whether you believe that pumping is stable or declining, nitrate is increasing in all four of the City's wells overall.

Issue No. 8, Correlation Between Nitrate Concentrations and Creek Flows.

Staff's Response: To repeat, staff does not agree with the author's original contention that rainfall is not a significant factor in nitrate concentrations. The data indicates that before the onset of the wet season and significant flows in Morro Creek, nitrate concentrations begin to climb in summer and generally peak at the height of the wet season. What staff meant to say that there is an inverse correlation in that high rainfall causes declining nitrate concentrations, and that low or no rainfall results increasing nitrate concentrations (see graph modified to show scale below from data provided by Ms. Stedjee). Staff apologizes for the confusion in our previous explanation. 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.



Issue No. 9, Pattern of Comparative Nitrate Levels in the Morro Basin Wells. Please explain why water from the creek can dilute water in the wells when the creek is dry; explain why creek water could dilute nitrate levels in the water drawn by the wells; and provide data showing that nitrate in the stream is less concentrated.

Staff's Response: Please see explanation of rainfall/creek dynamics provided above. The concentration of nitrate in Morro Creek below the narrows is relatively low as evidenced by CCAMP data:

http://www.ccamp.info/_2010/view_data.php#top

with latest concentration of about 10 mg/L as nitrate found in 2009 below the narrows.

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.

Attachment 1. Geologic Cross Section