NEWTON GEO-HYDROLOGY CONSULTING SERVICES
420 E CARRILLO STREET
SANTA BARBARA, CALIFORNIA
93101

TECHNICAL MEMORANDUM

TO: Michael LeBrun, General Manager NCSD
FROM: Brad Newton, Ph.D., P.G.
RE: Technical Memorandum #28 - Fall 2013 Ground Water Index
DATE: December 04, 2013

INTRODUCTION

Groundwater surface elevations (GSE) underlying the Nipomo Mesa are regularly measured at many places (wells) across the mesa. The Fall 2013 Ground Water Index (GWI) has been computed and presented herein along with historical GWI from 1975 to present based on these groundwater surface elevation measurements collected during spring and fall across the Nipomo Mesa. Limited measurements of GSE were available for the years 1982, 1983, 1984, 1994 and 1997, thus precluding a reliable calculation of GWI for those years.

The Nipomo Mesa Management Area (NMMA) Technical Group (TG) has not reviewed this technical memorandum, its findings, or any presentation of this evaluation.

RESULTS

Fall 2013 GWI is 42,000 acre-feet (AF), a 23,000 AF (25 percent) decline from the Fall 2012 GWI (Table 1, Figure 1). Moreover, Spring groundwater elevations had declined from 89,000 acre-feet in 2012 to a Spring 2013 GWI of 67,000 acre-feet (a decline of 22,000 acre-feet or 25 percent less than that of Spring 2012), as presented to your Board on June 12, 2013 (NCSD 2013a). The Spring 2013 Key Well Index (KWI) has also significantly declined since 2012 and generally follows the same historical trends as the GWI (Figure 1). With last the water year's rainfall being slightly under average and this water year's rainfall being less than 50 percent of average and along with ongoing groundwater pumping, there is great cause for concern given that spring and fall groundwater elevations have declined significantly and are now below sea level across much of the central portion of the Nipomo Mesa.

While the development of and semiannual calculation of the relative change in the GWI has informed the Board of the current water supply conditions and the future reliability of water supplies to District customers; the unit (Acre-Feet) of the GWI has caused a challenging controversy. To resolve this controversy, the District authorized the modification of the GWI to transform the unit of Acre-Feet (AF) to a unitless value by scaling the spring and fall GWI values to between the historic low and historic high that occurred from the years of 1975 to 2008. The transformation of the GWI from Acre-Feet to a unitless value successfully retains the relative characteristics of the GWI over time and between the spring and fall values (see Tables 1a and 1b and Figures 1a and 1b). Applying the method to historic maps of ground water

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surface elevations was not successful at creating meaningful presentation data. Technical Memorandum #27 - Ground Water Index Update presents the details of this work product (NCSD 2013b). Alternatively, presenting maps of contours of ground water surface elevations would be a direct method to present the change in ground water surface across the Nipomo Mesa area and would be consistent with other materials presented to the public, such as annual reports prepared by the Nipomo Mesa Management Area Technical Group.

METHODOLOGY

The calculation of spring and fall GWI are based on GSE measurements regularly made by San Luis Obispo County Department of Public Works (SLO DPW), NCSD, USGS, and Woodlands. The integration of GSE data is accomplished by using computer software to interpolate between measurements and calculate GWI within the principal production aquifer assuming an unconfined aquifer and a specific yield of 11.7 percent. Limited measurements of GSE were available for the years 1982, 1983, 1984, 1994 and 1997, precluding a reliable calculation of GWI for those years.

Groundwater Surface Elevation Measurements

Groundwater surface elevation data were obtained from SLO DPW, NCSD, USGS, and Woodlands. SLO DPW measures GSE in monitoring wells during the spring (April) and the fall (October) of each year. Woodlands and NCSD measures GSE in their monitoring wells monthly. For the years 1975 to 1999, available representative GSE data were used to compute GWI. For the years 2000 to 2011, only GSE data from the same 45 wells were used to compute GWI.

The GSE data was reviewed in combination with well completion reports and historical hydrographic records in order to exclude measurements that do not accurately represent static water levels within the principal production aquifer. Wells that do not access the principal production aquifer or were otherwise determined to not accurately represent static water levels within the aquifer were not included in analysis.

Groundwater Surface Interpolation

The individual GSE measurements from each year were used to produce a GSE field by interpolation using the inverse distance weighting (IDW) method.

Ground Water Index

The GWI is defined as the saturated volume above sea level and bedrock multiplied by the specific yield of 11.7 percent. The GWI is comprised from approximately 45 ground water elevation measurements made by the County of San Luis Obispo each April and October. The value of the Ground Water Index was computed for an area approximately similar to the NMMA Boundary. The base of the saturated volume is mean sea level surface (elevation equals

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zero) or the bedrock above sea level, whichever is higher. The bedrock surface elevation is based on Figure 11: Base of Potential Water-Bearing Sediments, presented in the report, Water Resources of the Arroyo Grande – Nipomo Mesa Area (DWR 2002). The bedrock surface elevation was preliminarily verified by reviewing driller reports obtained from DWR (Figure 2). The specific yield is based on the average weighted specific yield measurement made at wells within the Nipomo Mesa Hydrologic Sub-Area (DWR 2002, pg. 86). The GWI is similar to the Key Well Index presented in the Nipomo Mesa Management Area Technical Group annual report to the Court, but is not directly comparable.

Key Well Index

The Key Well Index (KWI) was developed by the NMMA Technical Group from eight inland wells representing the whole of the groundwater basin within the NMMA. The Key Well Index was defined for each year from 1975 to present as the average of the normalized spring groundwater data from each well. The lowest value of the Key Well Index could be considered the "historical low" within the NMMA.

REFERENCES

Department of Water Resources (DWR). 2002. Water Resources of the Arroyo Grande – Nipomo Mesa Area, Southern District Report. 2002.

Nipomo Community Services District (NCSD). 2013a. Technical Memorandum #26 - Spring 2013 Ground Water Index. Prepared by Newton Geo-Hydrology Consulting Services, LLC. June 6, 2013.

NCSD. 2013b. Technical Memorandum #27 - Ground Water Index Update. Prepared by Newton Geo-Hydrology Consulting Services, LLC. December 04, 2013.

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Spring and Fall
Groundwater Index
(GWI, Acre-Feet)

Year	Rainfall (inches)	Spring GWI (Acre-Feet)	Number of Wells	Fall GWI (Acre-Feet)	Number of Wells	Spring to Fall Difference (Acre-Feet)
1975	17.29	99,000	54	91,000	54	8,000
1976	13.45	82,000	45	76,000	65	6,000
1977	10.23	64,000	59	54,000	63	10,000
1978	30.66	84,000	62	---	35	---
1979	15.80	72,000	57	77,000	63	(5,000)
1980	16.57	88,000	55	89,000	46	(1,000)
1981	13.39	97,000	46	75,000	47	22,000
1982	18.58	123,000	42	---	31	---
1983	33.21	---	35	95,000	42	---
1984	11.22	---	14	76,000	37	---
1985	12.20	106,000	37	82,000	41	24,000
1986	16.85	98,000	51	67,000	51	31,000
1987	11.29	83,000	48	71,000	52	12,000
1988	12.66	80,000	51	66,000	49	14,000
1989	12.22	59,000	47	47,000	57	12,000
1990	7.12	62,000	55	49,000	53	13,000
1991	13.18	62,000	52	55,000	54	7,000
1992	15.66	61,000	52	35,000	48	26,000
1993	20.17	72,000	54	52,000	61	20,000
1994	12.15	60,000	54	---	36	---
1995	25.87	87,000	35	74,000	52	13,000
1996	16.54	76,000	45	62,000	57	14,000
1997	20.50	---	20	91,000	48	---
1998	33.67	105,000	41	93,000	44	12,000
1999	12.98	106,000	56	88,000	49	18,000
2000	17.07*	108,000	44	84,000	41	24,000
2001	18.52*	118,000	43	85,000	35	33,000
2002	8.87*	96,000	29	79,000	41	17,000
2003	11.39	94,000	37	66,000	42	28,000
2004	12.57	89,000	42	81,000	35	8,000
2005	22.23	98,000	38	79,000	39	19,000
2006	20.83	107,000	44	78,000	41	29,000
2007	7.11	93,000	44	66,000	42	27,000
2008	15.18	83,000	43	65,000	42	18,000
2009	10.31	76,000	44	65,000	43	11,000
2010	20.07	80,000	45	67,000	42	13,000
2011	34.05	87,000	43	81,000	43	6,000
2012	15.35*	89,000	45	65,000	44	24,000
2013	6.48*	67,000	45	42,000	43	25,000

---: Insufficient for evaluation
*: Preliminary value

Table 1a: GWI (Acre-Feet) computed from Spring 1975 to Fall 2013.

**Spring and Fall
Groundwater Index
(GWI, Unitless)**

Year	Rainfall (inches)	Spring GWI	Number of Wells	Fall GWI	Number of Wells	Spring to Fall Difference
1975	17.29	0.3252	54	0.2602	54	0.0650
1976	13.45	0.1870	45	0.1382	65	0.0488
1977	10.23	0.0407	59	(0.0407)	63	0.0813
1978	30.66	0.2033	62		35	--
1979	15.80	0.1057	57	0.1463	63	(0.0407)
1980	16.57	0.2358	55	0.2439	46	(0.0081)
1981	13.39	0.3089	46	0.1301	47	0.1789
1982	18.58	0.5203	42		31	--
1983	33.21		35	0.2927	42	--
1984	11.22		14	0.1382	37	--
1985	12.20	0.3821	37	0.1870	41	0.1951
1986	16.85	0.3171	51	0.0650	51	0.2520
1987	11.29	0.1951	48	0.0976	52	0.0976
1988	12.66	0.1707	51	0.0569	49	0.1138
1989	12.22	0.0000	47	(0.0976)	57	0.0976
1990	7.12	0.0244	55	(0.0813)	53	0.1057
1991	13.18	0.0244	52	(0.0325)	54	0.0569
1992	15.66	0.0163	52	(0.1951)	48	0.2114
1993	20.17	0.1057	54	(0.0569)	61	0.1626
1994	12.15	0.0081	54		36	--
1995	25.87	0.2276	35	0.1220	52	0.1057
1996	16.54	0.1382	45	0.0244	57	0.1138
1997	20.50		20	0.2602	48	--
1998	33.67	0.3740	41	0.2764	44	0.0976
1999	12.98	0.3821	56	0.2358	49	0.1463
2000	17.07*	0.3984	44	0.2033	41	0.1951
2001	18.52*	0.4797	43	0.2114	35	0.2683
2002	8.87*	0.3008	29	0.1626	41	0.1382
2003	11.39	0.2846	37	0.0569	42	0.2276
2004	12.57	0.2439	42	0.1789	35	0.0650
2005	22.23	0.3171	38	0.1626	39	0.1545
2006	20.83	0.3902	44	0.1545	41	0.2358
2007	7.11	0.2764	44	0.0569	42	0.2195
2008	15.18	0.1951	43	0.0488	42	0.1463
2009	10.31	0.1382	44	0.0488	43	0.0894
2010	20.07	0.1707	45	0.0650	42	0.1057
2011	34.05	0.2276	43	0.1789	43	0.0488
2012	15.35*	0.2439	45	0.0488	44	0.1951
2013	6.48*	0.0650	45	(0.1382)	43	0.2033

---: Insufficient for evaluation
*: Preliminary value

Table 1b: Unitless GWI computed from Spring 1975 to Fall 2013.

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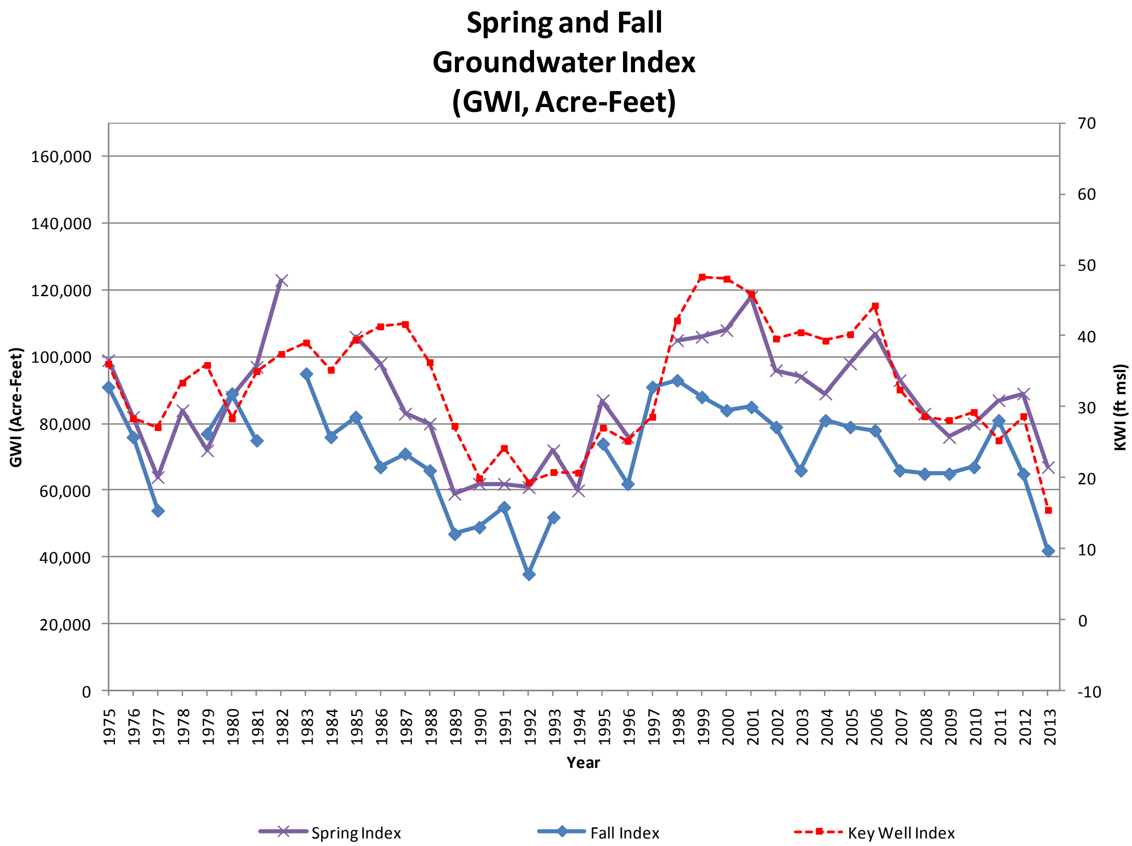

Figure 1a: GWI (Acre Feet) and KWI.

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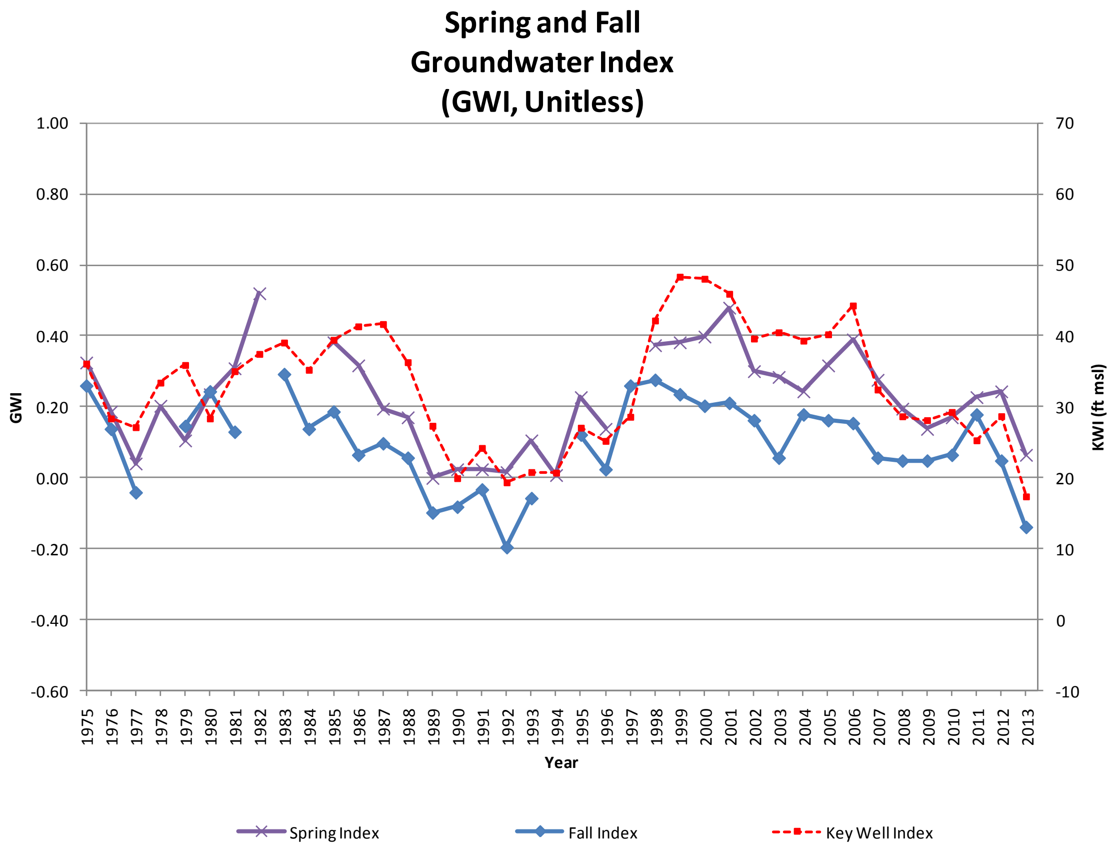

Figure 1b: Unitless GWI and KWI.

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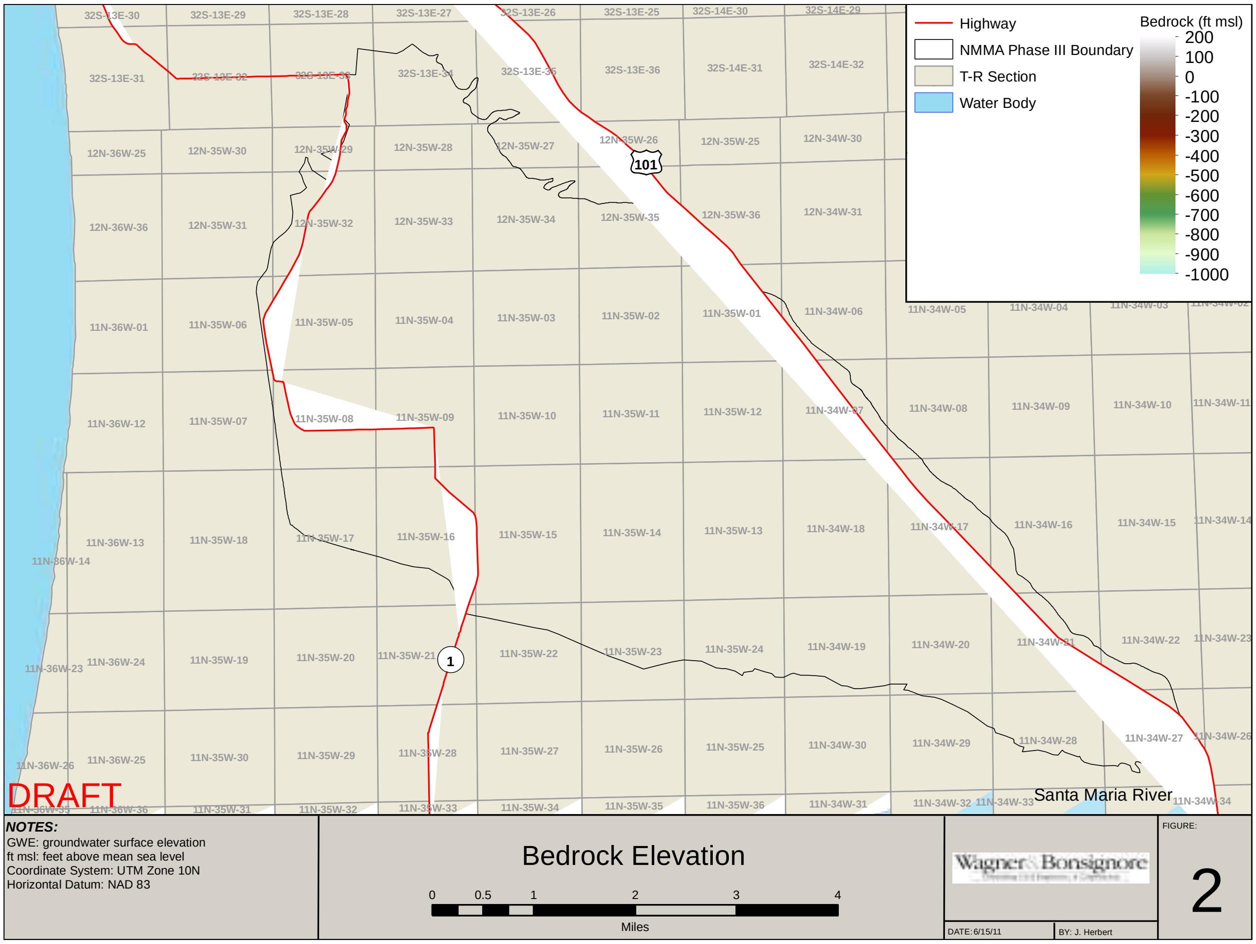

Figure 2: Elevation of bedrock underlying the NMMA.