Santa Clara Valley Groundwater Basin, Niles Cone Subbasin

- Groundwater Basin Number: 2-9.01
- County: Alameda
- Surface Area: 65,800 acres (103 square miles)

Basin Boundaries and Hydrology

The Niles Cone Groundwater Basin was established in DWR Bulletin 118-80 as the southern portion of the east bay area bounded on the south by the Alameda-Santa Clara County boundary and on the north by the boundary of Alameda County Water District (ACWD), and southern portions of the City of Hayward.

The Niles Cone Groundwater Basin is bounded on the east by the Diablo Range and on the west by the San Francisco Bay. Alameda Creek, the principal stream in the basin, flows near the eastern and northern margins of the basin. Coyote Creek flows along the southern margin of the basin. Average precipitation within the basin is about 18 inches annually.

Hydrogeologic Information

DWR identifies Niles Cone as a subbasin of the larger structural feature of the Santa Clara Valley. It is also considered a subbasin because its northern and southern boundaries are defined by local district boundaries. However, the Niles Cone alluvial fan itself does have fairly distinct boundaries, which could lead it to be defined as a basin. For this reason, Niles Cone is referred to as a basin locally with two subbasins – the Above Hayward Fault and Below Hayward Fault. DWR has worked closely with ACWD in understanding our differences in nomenclature and has adopted the following description developed jointly with ACWD.

Water Bearing Formations

The Niles Cone Basin is comprised chiefly of the alluvial fan formed by Alameda Creek as it exits the Diablo Range and flows toward the San Francisco Bay. A few smaller alluvial fans and some foothill areas underlain by older sediments are also included in the basin. The shoreline of the bay has both transgressed and regressed in the past due to glacial and interglacial cycles thereby creating the large aquifers (regressive period) interbedded with aquitards (transgressive period). The majority of water-bearing materials are comprised of Quaternary alluvium, though the Santa Clara Formation underlies a portion of the groundwater basin along its eastern margin.

The Hayward Fault, which cuts across the apex of the Niles Cone alluvial fan, impedes the westward flow of groundwater and separates the basin into two subbasins, the Below Hayward Fault (BHF) and the Above Hayward Fault (AHF) subbasins. Large differences in water levels on either side of the fault demonstrate the relatively impermeable nature of the fault.

The Plio-Pleistocene-age Santa Clara Formation is exposed in the Mission Upland area, in the southeast corner of the groundwater basin. It dips to the west beneath the alluvium at 10 to 30 degrees. It consists of poorly sorted pebbly sandstone, siltstone and clay. However, exposures of the Santa Clara Formation in quarries in the Mission Upland show that the gravel lenses are well sorted and contain practically no fines. Well log data indicate that the unit fines from east to west. The thickness of the Santa Clara Formation in the Niles Cone Basin probably exceeds 500 feet. Well yields range between 35 and 400 gpm.

Pleistocene-to Recent-age alluvium is the most significant water-bearing unit in the Niles Cone Groundwater Basin. It consists of unconsolidated gravel, sand, silt, and clay. The AHF subbasin on the east side of the Hayward Fault is composed of relatively homogeneous sand and gravel (one aquifer). This aquifer is both unconfined and confined due to the presence of local low permeable layers.

The BHF subbasin on the west side of the fault is composed of a series of gently westward dipping aquifers separated by extensive clay aquitards. The aquifers are comprised of gravels and sands deposited from ancestral Alameda Creek and other small creeks as fluvial or alluvial deposits. The aquitards are comprised of silts and clays deposited from distal (low energy) portions of the alluvial fans and from the bay as marine, and estuarine deposits. The grain size and thickness of the aquifers decrease westward, while the intervening aquitards become thicker. The aquifers can be correlated between wells and have been delineated over a large area. In the forebay region, near the apex of the Niles Cone alluvial fan on the west side of the Hayward Fault, gravel constitutes nearly the total thickness of the alluvium and groundwater is unconfined. The first aquifer west of the fault, the Newark Aquifer, is confined except at the forebay area, where the overlying aquitard is absent. The deeper aquifers: Centerville, Fremont and Deep are all confined except possibly in the forebay area.

The Newark Aquifer is an extensive permeable gravel and sand layer between 40 and 140 feet below ground surface (bgs), except in the forebay area where it begins near the surface. The Newark Aquifer underlies most of the Niles Cone alluvial fan, extending westward under the bay. The thickness of the Newark Aquifer ranges from less than 20 feet at the western edge of the basin to more than 140 feet near the Hayward Fault (DWR 1968). The Newark Aquifer is overlain in most of the subbasin by a thick layer of silt and clay defined as the Newark Aquiclude by DWR (1967 and 1968), but ACWD considers this and other low permeable units to be aquitards. The Newark Aquiclude is absent immediately west of the Hayward Fault (the forebay area), allowing direct recharge to the Newark Aquifer from Alameda Creek and recharge ponds. Within the Newark Aquiclude, discontinuous layers of sand and silt comprise a non-regional hydrogeologic unit known commonly as the "shallow water-bearing zone."

The Centerville Aquifer first occurs between 180 and 200 feet below land surface, and ranges in thickness between 10 and 100 feet. It underlies most of the Niles Cone alluvial fan west of the Hayward Fault, and is composed of gravel and sand. Throughout most of the fan, the Centerville Aquifer is separated from the Newark Aquifer by a fairly impermeable aquitard, which protects it from the saline water in the overlying Newark Aquifer. However, the two aquifers merge in the vicinity of the Hayward Fault.

The Fremont Aquifer exists primarily east of the Coyote Hills, varying in depth from 300 to 390 feet below the land surface. It, too, merges with the overlying aquifers in the vicinity of the Hayward Fault. The Fremont Aquifer is not as well defined as the overlying aquifers, but like the Newark and Centerville Aquifers, the Fremont Aquifer is also composed of sand and gravel. The aquitard separating the Fremont and Centerville Aquifers is generally absent or thin near the inner portions of the alluvial fan and the aquifers are commonly referred to as the Centerville-Fremont Aquifer.

Finally, a series of deeper aquifers exists below the Fremont Aquifer. Historically they were sometimes referred to as the 400-foot Aquifer and 500-foot Aquifer, corresponding to the approximate depth at which they occur, but are currently referred to as the Deep Aquifer(s). Their lateral extent has not been well defined, but they are suspected to extend beyond the margins of the Nile Cone alluvial fan, and thus may be interconnected with adjacent basins to the north and west.

Groundwater Level Trends

The Below Hayward Fault subbasin was at record low water levels in the early 1960's due to overdraft of the basin. In 1962, ACWD began receiving a new source of water from the State Water Project that was used in recharging the basin. The effects of the artificial recharge are seen in all the wells as a steady rise in water levels. For the Newark Aquifer indicator wells, water levels rose from 68 feet below sea level in late 1961 to above sea level in the early 1970's (4S/1W-29A06 and 4S/1W-28D02). From the early 1970's, water levels in these indicator wells have generally ranged from sea level to approximately 20 feet above mean sea level.

Groundwater Storage

Groundwater Storage Capacity. Two values of groundwater storage capacity have been calculated. The estimated storage to a base corresponding to mean sea level is 47,000 af. The estimated storage to –400 ft below mean sea level is 1,361,000 af (DWR 1968). The former value is based from a recent groundwater model application developed by ACWD. The latter value is based on a groundwater model developed by DWR in the 1960's. Both of the models simulated complex hydrogeologic conditions, so no single value of specific yield was applied.

Groundwater in Storage. Estimated groundwater in storage in FY 1999-2000 was 38,000 AF. This calculation was made for the storage above mean sea level only. This value is based from the groundwater model application developed by ACWD.

Groundwater Budget (Type A)

The following groundwater budget was provided by ACWD. All input is from ACWD's FY 1999-2000 Survey Report on Groundwater Conditions (ACWD 2001b) that relies on ACWD's numerical model. Estimated groundwater inflows include natural recharge of 8,400 af, artificial recharge of 33,400 af, and applied water recharge of 3,100 af. No subsurface inflows are assumed. Groundwater budget outflows include annual urban extraction of 23,000 af, agricultural extraction of 300 af, extraction from ARP wells of 6,300 af (see groundwater quality impairments above). Subsurface outflow at the boundary of the groundwater basin in FY 1999-2000 is estimated to have been 7,400 AF. An additional estimated 10,900 AF of groundwater is suspected to have been discharged to surface water courses within the basin perimeter. When the piezometric head of the Newark Aquifer is less than 20 feet above mean sea level in an indicator well (4S/1W-29A06) within the forebay region of the Below Hayward Fault Subbasin, then subsurface outflow is typically less than 6,000 AF/yr.

Additional Basin Information

Artificial Recharge. Improved the recharge capability by constructing inflatable dams in Alameda Creek and increasing percolation capacity in the abandoned gravel quarries. About 33,000 acre-feet are recharged annually in normal to wet years.

Aquifer Reclamation Program (ARP). Installed nine wells to pump the entrapped saline water from the basin into San Francisco Bay to produce greater usable storage and prevent movement of salt water in the direction of ACWD's production wells. A desalination facility to treat some of this brackish water will be constructed and operational during 2003.

Groundwater Quality

Characterization. A sodium chloride groundwater type predominates along the western margin and center of the subbasin near San Francisco Bay, while a sodium bicarbonate groundwater type predominates along the eastern portion. TDS in the subbasin ranges from about 286 mg/L to 39,734 mg/L and averages 2,204 mg/L based on data from 113 wells (ACWD 2001a).

Impairments. Saline water intrusion of the Newark Aquifer was first noted in the 1920's. Overdraft of the basin for the next several decades led to the landward migration of saline water as far as the Hayward Fault by the 1950's. From here, saline water migrated into deeper aquifers through the natural connection at the forebay area and also in other areas of the fan where aquitards separating the aquifers are thin to absent. Also, saline water may have migrated downward from the Newark Aquifer to the deeper aquifers through abandoned, improperly sealed or multiple-aquifer-screened wells. Alameda County Water District has taken significant steps to control the movement of the saline groundwater and restore the quality of groundwater in the affected aquifers:

Water Quality in Public Supply Wells

Constituent Group[1]	Number of wells sampled[2]	Number of wells with a concentration above an MCL[3]
Inorganics – Primary	16	4
Radiological	14	1

Nitrates	16	1
Pesticides	16	0
VOCs and SVOCs	16	0
Inorganics – Secondary	16	7

[1] A description of each member in the constituent groups and a generalized discussion of the relevance of these groups are included in *California's Groundwater – Bulletin 118* by DWR (2003).
[2] Represents distinct number of wells sampled as required under DHS Title 22 program from 1994 through 2000.
[3] Each well reported with a concentration above an MCL was confirmed with a second detection above an MCL. This information is intended as an indicator of the types of activities that cause contamination in a given basin. It represents the water quality at the sample location. It does not indicate the water quality delivered to the consumer. More detailed drinking water quality information can be obtained from the local water purveyor and its annual Consumer Confidence Report.

Well Production characteristics

	Well yields (gal/min)	
Municipal/Irrigation	Range: Approx. 650 – Approx. 3,000	Average: About 2,000 (35 Wells)
	Total depths (ft)[1]	
Domestic	Range: 24 - 560	Average: 189 feet (138 Wells)
Municipal	Range: 45 - 650	Average: 267 feet (55 Wells)
Industrial	Range: 15 - 515	Average: 223 feet (29 Wells)
Agricultural	Range: 15 - 600	Average: 249 feet (102 Wells)

Footnote: [1] Well depth data is for active wells only

Active Monitoring Data

Agency	**Parameter**	**Number of wells /measurement frequency**
ACWD	Groundwater levels	350 wells annually/32 weekly
ACWD	Groundwater quality	120 wells annually
ACWD as required by DHS	Coliform/ Weekly Nitrates/ 3 times a year Minerals/ 3 times a year Organic chemicals/ Annually Radiological (complete set)/ Once every 4 years	9 to 12 wells as required in Title 22, Calif. Code of Regulations

Basin Management

Groundwater management:	ACWD manages groundwater under the County Water District Act (commences with Section 30000 of the Water Code). Additional powers were granted to ACWD for groundwater management under Chapter 1942 of the Statutes of 1961 called the Replenishment Assessment Act of Alameda County Water District. ACWD's Amended Groundwater Management Policy was adopted by the Board of Directors on March 22, 2001.
Water agencies	
Public	Alameda County Water District
Private	None

References Cited

Alameda County Water District. 2001a. Groundwater Monitoring Report, Fall 2000.

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Additional References

California Department of Water Resources. 1960. Bulletin 81, Intrusion of Salt Water into Groundwater Basins of Southern Alameda County, Bulletin 81.

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Clark, W.O. 1915. Ground-Water Resources of the Niles Cone and Adjacent Areas, California. U.S. Geological Survey Water-Supply Paper 345.

Errata

Updated groundwater management information and added hotlinks to applicable websites. (1/20/06)