CHAPTER 4
GROUNDWATER

This chapter describes the Niles Cone Groundwater Basin, the District's reliance on it as a source of water supply and the District's policy and activities for managing it.

4.1 BACKGROUND

As described in Chapter 3 (Sources of Supply), the Niles Cone Groundwater Basin provides a significant source of water supply for the ACWD service area. ACWD manages the basin both in conjunctive use mode (most recharge of surface water occurs in the wet season, with most groundwater extraction occurring during the dry season) as well as in a groundwater banking mode (excess water is stored in the basin during wet years for recovery during dry years when local and imported supplies may be significantly cut back). Because of its importance as a local supply, the protection of this valuable local resource has long been a high priority for ACWD.

Niles Cone Groundwater Basin Hydrogeology

The Niles Cone Groundwater Basin, as delineated by the Department of Water Resources (DWR), exists almost exclusively within the District's boundaries. The groundwater basin is an alluvial aquifer system consisting of unconsolidated gravel, and, silt, and clay. The groundwater basin is divided by the Hayward Fault which is an active fault with low permeability that impedes the lateral flow of groundwater. Large differences in water levels on either side of the fault demonstrate the relatively impermeable nature of the fault. ACWD manages both the Above Hayward Fault (AHF) and the Below Hayward Fault (BHF) sub-basins. The AHF sub-basin on the east side of the Hayward Fault is composed of highly permeable sediments referred to as the AHF Aquifer. The BHF sub-basin is composed of a series of relatively flat lying aquifers separated by extensive clay aquitards. The location of the Hayward Fault is shown in Figure 4-1. Figure 4-2 provides a cross-section based on a DWR conceptual figure (DWR, 1968).

Figure 4-1
ACWD Groundwater Management Facilities

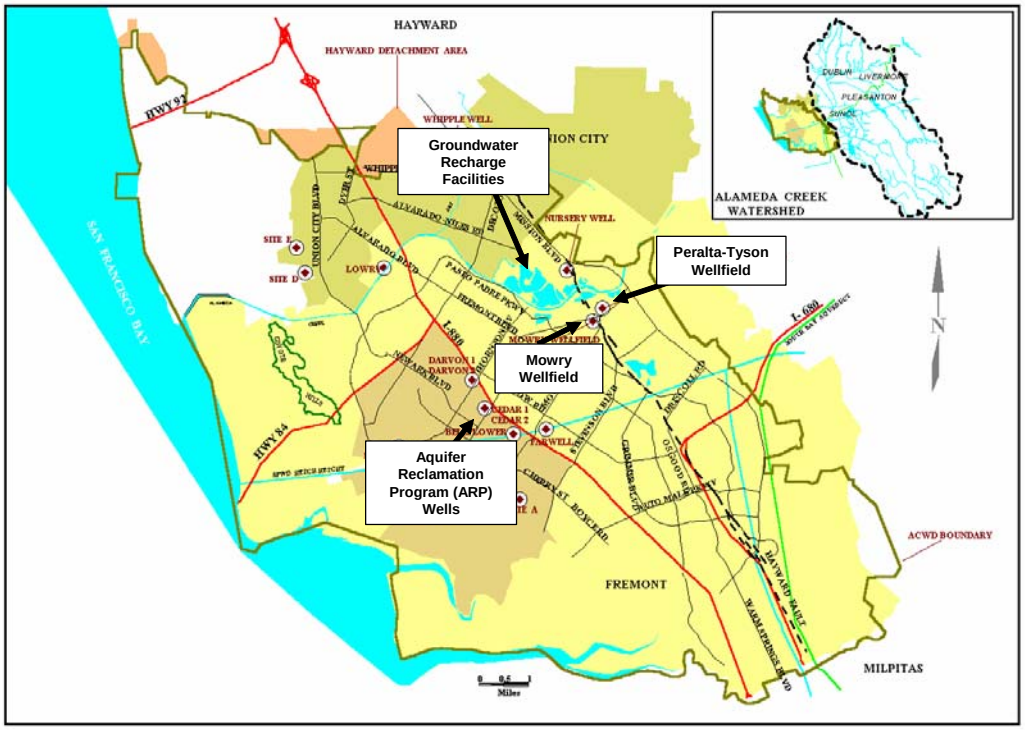
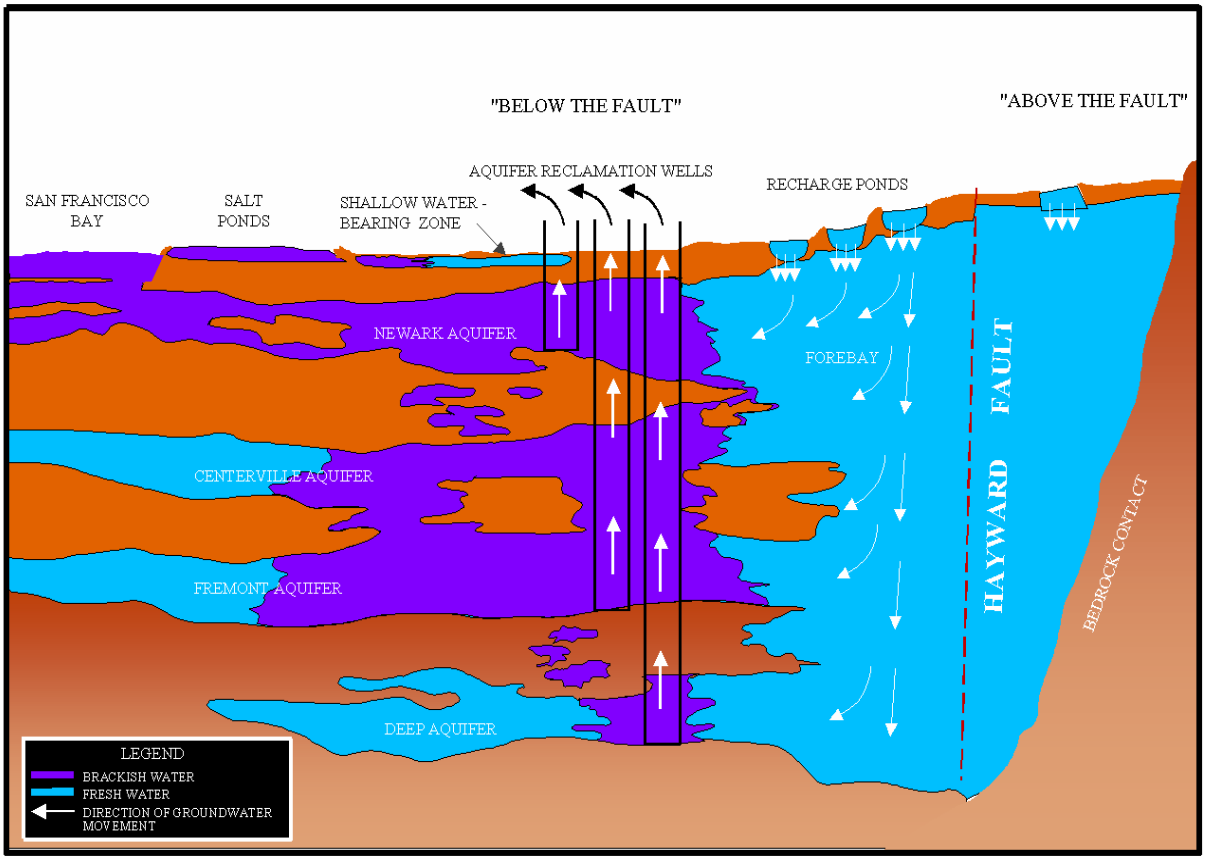


Figure 4-2
Niles Cone Groundwater Basin Schematic



The shallowest regional aquifer in the BHF sub-basin, the Newark Aquifer, is an extensive permeable gravel and sand layer between 40 and 140 feet below ground surface (bgs), except in the forebay (inland) area where it begins at the surface. The thickness of the Newark Aquifer ranges from less than 20 feet at the western edge of the basin to more than 140 feet at the Hayward Fault (DWR, 1968). The Newark Aquifer is overlain in most of the sub-basin by a thick layer of silt and clay called the Newark Aquiclude (DWR, 1968). The Newark Aquiclude is absent in the forebay area, allowing direct recharge to the Newark Aquifer from Alameda Creek and the 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.

An extensive thick clay aquitard separates the Newark Aquifer from the Centerville Aquifer. The Centerville Aquifer, the top of which lies at an average depth of 180 to 200 feet bgs, overlies a thick clay aquitard, which in turn overlies the Fremont Aquifer which exists in the interval of 300 to 390 feet bgs. The Centerville and Fremont Aquifers are considered as one combined aquifer (Centerville-Fremont Aquifer) in some parts of the basin based on lithology and water level data that indicate that they are in good hydrogeologic connection. However, water level and water chemistry results from recently installed wells indicate that, in some areas of the basin, these two aquifers are isolated from each other.

The deepest water-bearing units, referred to collectively as the Deep Aquifers, are present at approximately 400 and 500 feet bgs (and possibly deeper) and are separated from the overlying Fremont Aquifer by a competent regional aquitard. Also, based on ACWD's lithologic data and DWR (1967), these deep aquifers are both hydraulically separated and connected by the presence or absence of intervening clays dependent on the location in the basin, and extend beyond the limits of the Niles Cone Groundwater Basin to act as conductive layers for the migration of groundwater out of the basin.

Groundwater Quality

Groundwater quality in the AHF Aquifer is acceptable for potable use; however, groundwater quality in certain areas of the BHF aquifers has been degraded by salt water intrusion. The salt water intrusion was first noticed in the 1920's and occurred due to historical pumping from the basin that was in excess of recharge (i.e. overdraft). Many years of this chronic overdraft caused the groundwater levels in the Newark Aquifer to drop below sea level. This relative elevation difference between the groundwater in the basin and the saline water from San Francisco Bay caused a landward direction of groundwater flow through the Newark Aquifer and intrusion of salt water into the groundwater basin. Several decades of salt water intrusion occurred and saline water migrated as far as the forebay area. The piezometric heads in the deeper aquifers are generally lower than that of the Newark Aquifer, and the aquitards separating the aquifers are thin to absent in the Forebay area. As a result, saline water in the forebay area migrated downward from the Newark Aquifer and into the lower aquifers. Also, saline water may have migrated downward from the Newark Aquifer to the deeper aquifers through abandoned and improperly sealed water wells.

Since 1962, ACWD has purchased State Water Project water supplies to supplement local recharge and raise groundwater levels. This has resulted in bringing the water table above sea level and returning the hydraulic gradient to its natural bayward direction in the Newark Aquifer. Although there has been substantial improvement in the basin, a considerable volume of saline water still remains in the aquifers. As described below, ACWD has also implemented an Aquifer Reclamation Program (ARP) to pump out brackish groundwater from the impacted areas of the aquifer system. Historically, this brackish water has been discharged back to San Francisco Bay through local flood control channels. However, a portion of it is now treated at the Newark Desalination Facility for potable use.

In order to protect the Basin from further seawater intrusion the District's operational goals are to maintain groundwater levels above sea-level in the Newark Aquifer system. During critically dry periods the District may temporarily reduce groundwater levels slightly below sea-level (no lower than -5 feet mean sea-level), in the Newark Aquifer in the Forebay area. Groundwater modeling analysis has indicated that temporarily drawing the aquifer down in this inland area can provide additional supply in critically dry years without impacting the integrity of the Basin.

Groundwater Facilities

ACWD's groundwater management activities include groundwater recharge as well as production. As shown on Figure 4-1, ACWD groundwater facilities include production wellfields and groundwater recharge facilities. Currently, 16 wells are available for production in the Forebay area. Eight of the wells are located in the Peralta-Tyson Wellfield in the AHF sub-basin. The remaining eight wells are located in the Mowry Wellfield in the BHF sub-basin.

The Niles Cone Groundwater Basin is recharged through (1) deep percolation of rainfall and applied water, and (2) percolation of water in Alameda Creek received at ACWD's groundwater recharge facilities. Most of the water for this artificial recharge program is from Alameda Creek Watershed runoff and the remainder is imported supplies released to tributaries of Alameda Creek. Water percolates into the groundwater basin through the stream channel bed and through the District's off-stream recharge ponds. The District utilizes inflatable rubber dams in the channel to divert water from the creek into the ponds.

As described below, ACWD's Aquifer Reclamation Program, which is designed to remove and control the movement of intruded saline water, has been in operation since 1974. The program facilities consist of nine wells. These wells also provide the source water for the Newark Desalination Facility. This facility removes salts and other impurities from the brackish groundwater and provides the treated water as a source for the District's distribution system.

Aquifer Reclamation

High volume pumping in the 1920's through the early 1960's without adequate recharge for replenishment of the basin led to lower water levels in the Newark Aquifer and salt water intrusion. The District, concerned with this salt water intrusion, began importing water from the SWP to artificially recharge the groundwater basin. The District's aggressive artificial recharge program and its use of imported water in lieu of groundwater have caused water levels to slowly rise above sea-level. Thus, further seawater intrusion has been prevented and saline water in the Newark Aquifer is now flushed towards San Francisco Bay. However, because the Centerville-Fremont and Deep Aquifers are not in direct hydraulic connection with San Francisco Bay, saline water in those deep aquifers cannot be easily flushed back by simply raising groundwater levels. Consequently, there are trapped pockets of saline water in these deeper aquifers.

In 1974, the District initiated its Aquifer Reclamation Program (ARP) to restore water quality in the groundwater basin by removing the saline water trapped in the aquifer system. Nine wells are utilized for reclamation pumping: three in the Newark Aquifer, five in the Centerville-Fremont Aquifer, and one in the Deep Aquifer. This brackish groundwater is the source water for ACWD's Newark Desalination Facility, with any excess pumped brackish groundwater discharged to San Francisco Bay through flood control channels. The quality of groundwater in the basin is improved as recharge water replaces the pumped brackish groundwater. ARP pumping also prevents the plume of brackish water in the Centerville-Fremont and Deep Aquifers from further migrating toward ACWD's Mowry Wellfield.

Groundwater Elevations

ACWD actively manages the Niles Cone Groundwater Basin to prevent groundwater overdraft conditions that could lead to future seawater intrusion and groundwater overdraft. In order to monitor the groundwater basin conditions, since 1961 ACWD has conducted the Spring/Fall Groundwater Monitoring Program to visit wells, obtain water level measurements and collect water samples. The data collected is summarized in an annual groundwater monitoring report prepared by ACWD.

The groundwater elevations throughout the basin fluctuate seasonally due to seasonal changes in groundwater pumping and recharge. In general, the groundwater elevations are the highest in the late winter and early spring (in response to high recharge and lower groundwater pumping) and are the lowest in the fall months (in response to peak groundwater pumping during the warmer summer and fall months). However, throughout the year groundwater elevations in the Newark Aquifer are maintained above sea-level with a positive groundwater gradient from the inland area (at the recharge ponds) towards San Francisco Bay. The groundwater elevations in the Centerville/Fremont and Deep Aquifers are generally lower than that of the Newark Aquifer, thereby allowing percolation from the Newark Aquifer to these deeper aquifers. Because ACWD operates the groundwater basin in a balanced "put and take" mode, groundwater elevations over the past thirty years have remained fairly consistent (within a typical operating range), and there have been no long-term trends that suggest the basin is in overdraft condition.

4.2 GROUNDWATER MANAGEMENT AND PROTECTION POLICY

In 1989 ACWD adopted a Groundwater Management Policy to protect and manage the Niles Cone Groundwater Basin. This Groundwater Management Policy was last updated in 2001, and effectively serves as ACWD's groundwater management plan for the Niles Cone Groundwater Basin. This Groundwater Management Policy is based on the statutory authority granted to ACWD under the County Water District Law (commencing with Section 30000 of the Water Code); the Replenishment Assessment Act of the Alameda County Water District (Chapter 1942 of the Statutes of 1961, as amended in 1970 and 1973), which grants additional powers to ACWD to prevent pollution, contamination, or diminution in quality of the groundwater supply; local well ordinances (Fremont No. 950, as amended; Newark No. 136; and Union City No. 109-73); agreements with other agencies; and local hazardous materials ordinances.

A copy of ACWD's Groundwater Management Policy is provided in Appendix A.

Groundwater Management Policy Statement

ACWD's groundwater management policy statement is as follows:

"It is the policy of the Alameda County Water District to efficiently protect and manage the Niles Cone Groundwater Basin to ensure a reliable supply of high quality water that satisfies present and future municipal, industrial, recreational, and agricultural water needs in the ACWD service area. ACWD will develop and implement appropriate programs within the ACWD service area to protect and manage the groundwater basin as a long-term source of water supply for ACWD. ACWD will also actively protect the groundwater basin from activities outside the ACWD service area that may negatively impact the water quality and/or water supply of the basin.

This Policy is intended to serve as a guide to ACWD management in the continued development and implementation of programs to manage and protect ACWD water resources and as a nontechnical document to explain ACWD groundwater programs to members of the public. This Policy is not intended to create legal rights in any person or organization, or to impose legal obligations on ACWD. It may be amended or repealed by the Board of Directors at any time."

Policy Objectives

The purpose of the Groundwater Management Policy is to protect and improve ACWD's groundwater resources for the benefit of both ACWD's customers and private well owners by taking actions designed to meet the following objectives:

- Increase groundwater replenishment capability.

- Increase the usable storage capacity of the groundwater basin.

- Operate the basin to provide:
  - A reliable water supply to meet baseload and peak distribution system demands,
  - An emergency source of supply, and
  - Reserve storage to augment dry year supplies.

- Protect groundwater quality from degradation from any and all sources including: saline water intrusion, wastewater discharges, recycled water use, urban and agricultural runoff, or chemical contamination.

- Improve groundwater quality by:
  - Removing salts and other contaminants from affected areas of the basin, and
  - Improving the water quality of source water used for groundwater recharge.

4.3 GROUNDWATER MANAGEMENT PROGRAMS

The following eight major groundwater management programs have been developed and implemented by ACWD to achieve ACWD's Groundwater Management Policy objectives:

- Water Supply Management
- Groundwater Replenishment
- Watershed Protection and Monitoring
- Basin Monitoring
- Wellhead Protection Program
- Aquifer Reclamation Program
- Groundwater Protection Program
- Well Ordinance Administration

A brief summary of each of these programs is provided in Table 4-1. A detailed description of each program is included in the Groundwater Management Policy which is attached in Appendix A.

4.4 GROUNDWATER RECHARGE AND PRODUCTION

The primary components of the groundwater budget for the Niles Cone Groundwater Basin are: (1) pumping; (2) recharge; and (3) saline groundwater outflows. Groundwater pumping includes pumping at ACWD's Peralta-Tyson and Mowry Wellfields), private (non-District) pumping; and pumping from the District's Aquifer Reclamation Program (ARP) wells. Groundwater recharge occurs primarily through percolation at ACWD's recharge facilities and natural percolation of rainfall and applied water. Saline groundwater outflows represent the groundwater outflows from the Newark Aquifer to San Francisco. As is typical in coastal groundwater basins, groundwater outflows are required to prevent seawater intrusion from occurring.

As required by the District's Replenishment Assessment Act, the District meters all active wells in the District, and prepares an annual Groundwater Survey Report which summarizes the total well production, estimated recharge, and changes in groundwater storage. A summary of groundwater pumping, recharge and change in storage is provided in Table 4-2. As indicated in the table, annual groundwater supply from ACWD's production wells has ranged from 17,800 AF/Yr to 20,900 AF/Yr over the past eight years. Over the same period aquifer reclamation pumping has ranged from 4,300 to 11,100 AF/Yr and private groundwater pumping has ranged from 3,100 to 5,000 AF/Yr. Annual groundwater recharge has ranged from 34,000 AF to 52,500 AF/Yr.

Future Use of Groundwater

As described in ACWD's Integrated Resources Planning Study, ACWD will continue to rely on the Niles Cone Groundwater Basin as a source of supply for the service area. ACWD's plans are to continue to manage the groundwater basin in a balanced "put and take" mode whereby groundwater pumping and saline outflows are balanced with groundwater recharge. Year to year variations in recharge, pumping and saline outflows will occur due to variations in local hydrologic condition and other factors. Therefore, in some years recharge may exceed the sum of pumping and saline outflows resulting in a temporary imbalance. Similarly, in some years pumping and saline outflows may exceed groundwater recharge, also resulting in a temporary imbalance. However, over the long-term, the operation of the basin will be balanced to ensure that the basin is protected from seawater intrusion and that reclamation of the basin from previous seawater intrusion continues. It is anticipated that ACWD's future groundwater pumping will continue to occur at the Mowry Wellfield, Peralta-Tyson Wellfield, and the Aquifer Reclamation Program wells. ACWD's projected future use of groundwater under normal and dry year conditions is summarized in Chapter 8 – Water Supply Strategy.

Table 4-1
Summary of ACWD Groundwater Management Programs

Groundwater Program	*Description*
Water Supply Management	Planning, managing, and optimizing ACWD's sources of supply: watershed runoff, SWP water for recharge, SWP water for treatment, SFPUC water for blending, and water banking.
Groundwater Replenishment	Operation of ACWD groundwater recharge facilities to optimize 1) capture of local runoff, 2) replacement of water extracted from production and ARP wells, and 3) maintenance of groundwater levels to prevent salt water intrusion.
Watershed Protection and Monitoring	Assisting in the protection and monitoring of the watershed to optimize the quality of runoff water available for ACWD water supply.
Basin Monitoring	Sampling and measuring wells to assess and evaluate 1) groundwater quality, 2) water pressures within the basin, and 3) the direction of groundwater flow.
Wellhead Protection Program	Identify sensitive recharge and groundwater areas, maintain an inventory of potential threats within these areas, assess the vulnerability of source water, and develop management strategies to minimize the potential for groundwater quality impacts.
Aquifer Reclamation Program	Pump brackish water from degraded aquifers in order to 1) increase useable basin storage, 2) improve overall water quality, 3) prevent movement of brackish water toward ACWD production wells, and 4) provide (future) supply augmentation through treatment to potable water standards.
Groundwater Protection Program	Maintain an active role in 1) assisting with the identification of potential groundwater contamination, 2) implementing monitoring systems at hazardous materials storage sites, and 3) providing technical oversight for investigations and cleanups at hazardous materials spill sites.
Well Ordinance Administration	As enforcing agency for municipal ordinances governing construction, repair, or destruction of wells, ACWD provides inspection services, collects fees, and performs field searches for abandoned wells which could act as a conduit for contamination of groundwater.

Table 4-2
Groundwater Budget for the Niles Cone Groundwater Basin (AF/Yr)
(source: ACWD Annual Groundwater Survey Reports)

Groundwater Budget Item	*Fiscal Year*							
	1996/97	*1997/98*	*1998/99*	*1999/00*	*2000/01*	*2001/02*	*2002/03*	*2003/04*
Total Net Recharge[1]	34,500	52,500	38,300	34,000	35,200	35,200	36,900	35,900
Pumping								
Production Wells	19,300	17,800	19,000	20,200	20,800	18,200	20,900	20,100
ARP Wells	7,800	3,800	10,600	6,300	4,300	7,400	7,700	11,100
Other Pumping[2]	6,700	1,000	0	0	0	0	0	0
Private (non-ACWD) Wells	5,000	3,900	3,200	3,100	3,800	3,100	3,400	3,600
Total Pumping	38,800	26,500	32,800	29,600	28,900	28,700	32,000	34,800
Saline Groundwater Outflows	2,300	3,900	6,100	7,400	6,600	6,300	5,800	7,200
Change in Storage	-6,600	22,100	-600	-3,000	-300	200	-900	-6,100

Notes:

(1) Total Net Recharge is calculated as recharge from deep percolation of rainfall and applied water plus recharge at ACWD's groundwater percolation facilities less the sum of evaporation losses and "Other Outflows" (as described in ACWD's annual Groundwater Survey Reports).

(2) Other Pumping represents Quarry Pits dewatering that took place as part of the recharge ponds' rehabilitation project from 1996-1998.