WASHINGTON STATE
DEPARTMENT OF
ECOLOGY

WASHINGTON STATE DEPARTMENT OF ECOLOGY
MEMORANDUM

May 17, 2005

TO: Sheri Carroll

FROM: Jill Walsh

SUBJECT: Showing of Compliance – City of Ocean Shores G2-27566

Sheri, please send this to archives. The City of Ocean Shores has added Wells 11, 12 and 13 as additional points of withdrawal under water right certificate G2-27566.

Tracker

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
PO Box 47775 • Olympia, Washington 98504-7775 • (360) 407-6300

May 18, 2005

Miles Beach
City of Ocean Shores
PO Box 909
Ocean Shores, WA 98569

Dear Mr. Beach:

Re: *Showing of Compliance* – Additional Wells for City of Ocean Shores - Water System
Water Right Certificate G2-27766

This letter is to confirm that we've received your *Showing of Compliance with RCW 90.44.100(3)*. It is our understanding that you have constructed 3 additional wells under the authorization of Ground Water Certificate G2-27766. You have asserted that the additional wells comply with the provisions of the rule.

Your notarized statement will be made a part of the permanent record associated with the water right certificate, and no further action is needed on your part. The certificate now authorizes withdrawals from the original two wells – 4 and 5 (which has been abandoned) as well as the three new wells.

Sincerely,

Jill Walsh
Water Resources Program
Southwest Regional Office

JW:th

Cc: John Blacklaw, Department of Health, Southwest Drinking Water Operations
Adam Gravley – Buck & Gordon

WASHINGTON STATE DEPARTMENT OF ECOLOGY

RECEIVED
APR 1 5 2005
BUCK & GORDON

DEPARTMENT OF ECOLOGY

Showing of Compliance with RCW 90.44.100(3)

Water Right Certificate or Permit Number: G2-27566C

Parcel tax identification number: 090500080304

Landowner(s) name: City of Ocean Shores

Part of complying with RCW 90.44.100(3) is for the project proponent to notify the Department of Ecology (Ecology) that the statutory criteria of RCW 90.44.100(3) have been satisfied. Please attach to this document the water well report for the additional or replacement well and any additional information you have to support your affidavit.

Affidavit:

I, MILEST BEACH, do certify that I caused the well described in the attached water well report to be drilled as an additional or replacement well(s) for use under Water Right Number G2-27566C. This notice and attached documents describe and support my assertion that the replacement or additional well(s) complies with RCW 90.44.100(3) (a-g) and RCW 90.44.100(4):

a. The well is an additional or replacement well(s) that will tap the same body of public ground water as the original well;
b. If a replacement well is constructed, the use of the original well(s) shall be discontinued and the original well(s) shall be properly decommissioned;
c. The combined withdrawal of water from the additional or replacement well(s) and the original well authorized by the water right certificate does not enlarge the water right conveyed by the original water right certificate;
d. The construction and use of the additional or replacement well(s) does not interfere with or impair water rights with an earlier priority date;
e. The additional or replacement well(s) is located no closer than the original well to a well it might interfere with;
f. A specified manner of construction for the additional or replacement well(s) has been complied with, if required, and the new well was constructed in compliance with chapter 18.104 RCW and chapter 173-160 WAC;
g. The additional or replacement well(s) is located within the area described as the point of withdrawal in the public notice published for the original application for water right, or the most current legal description published for the right. Both the original well and the additional or replacement well(s) are located in SE ¼ SE ¼ of Section 3, Township 17, Range 12W.

Ecology is an equal opportunity and affirmative action employer

Therefore the well is in compliance with the requirements for a statutorily granted amendment to the water right permit or certificate.

I understand the acceptance of this affidavit, and any attachments, by the Department of Ecology shall not be construed as affirming the validity of any water right permit or certificate. The responsibility to comply with RCW 90.44.100(3) is with the water right permit or certificate holder asserting an amendment pursuant to RCW 90.44.100(3).

Miles T. Beach
Name

4/12/05
Date

Acknowledgement:

State of Washington
County of GRAYS HARBOR

I certify that I know or have satisfactory evidence that MILES T. BEACH *is the person who appeared before me, and said person acknowledged that (he/she) signed this affidavit and acknowledged it to be (his/her) free and voluntary act for the uses and purposes mentioned in the affidavit.*

Dated: 4/12/05

JO-ELLEN THOMAS
NOTARY PUBLIC
STATE OF WASHINGTON
COMMISSION EXPIRES
MAY 10, 2009

Jo-Ellen Thomas
(Signature) Jo-Ellen Thomas
OCEAN SHORES, WA
Residing in
NOTARY PUBLIC IN AND FOR THE
Title STATE OF WASHINGTON
My appointment expires: 5-10-09

If you have any questions please contact the Water Resources Section of the closest regional office. Please submit copies of new well logs and decommissioned well logs along with this completed and notarized form to the nearest regional office.

Northwest Regional Office
3190 – 160th Avenue SE
Bellevue, WA 98008-5452
(425) 649-7000; TDD (425) 649-4259

Southwest Regional Office
P.O. Box 47775
Olympia, WA 98504-7775
(360) 407-6300; TDD (360) 407-6306

Eastern Regional Office
N. 4601 Monroe, Suite 202
Spokane, WA 99205-1295
(509) 329-3529; TDD (509) 458-2055

Central Regional Office
15 W. Yakima Ave., Suite 200
Yakima, WA 98902-3452
(509) 575-2597; TDD (509) 454-7673

Vancouver Field Office
2108 Grand Boulevard
Vancouver, WA 98661-4622
(360) 690-7171; TDD (360) 690-7147

Nooksack Field Office
1204 Railroad Ave., Suite 200
Bellingham, WA 98225
(360) 738-6250; TDD (425) 649-4259

25th Anniversary
Buck & Gordon LLP
Attorneys at Law

2025 First Avenue, Suite 500
Seattle, WA 98121-3140
206-382-9540
206-626-0675 Fax
www.buckgordon.com

RECEIVED
DEPT. OF ECOLOGY/SWRO
'05 MAY -9 AM 11:21

April 28, 2005

Ms. Jill Walsh
Water Resources Program
Department of Ecology
Southwest Regional Office
P. O. Box 47775
Olympia, WA 98504-7775

Re: City of Ocean Shores

Dear Jill:

Enclosed please find the signed Showing of Compliance with RCW 90.44.100(3) form submitted on behalf of the City of Ocean Shores. This form covers wells 11, 12, and 13 as additional wells under Certificate No. G2-27566C. Please confirm that this compliance form is accepted by the Department, or call with any questions. Thank you very much.

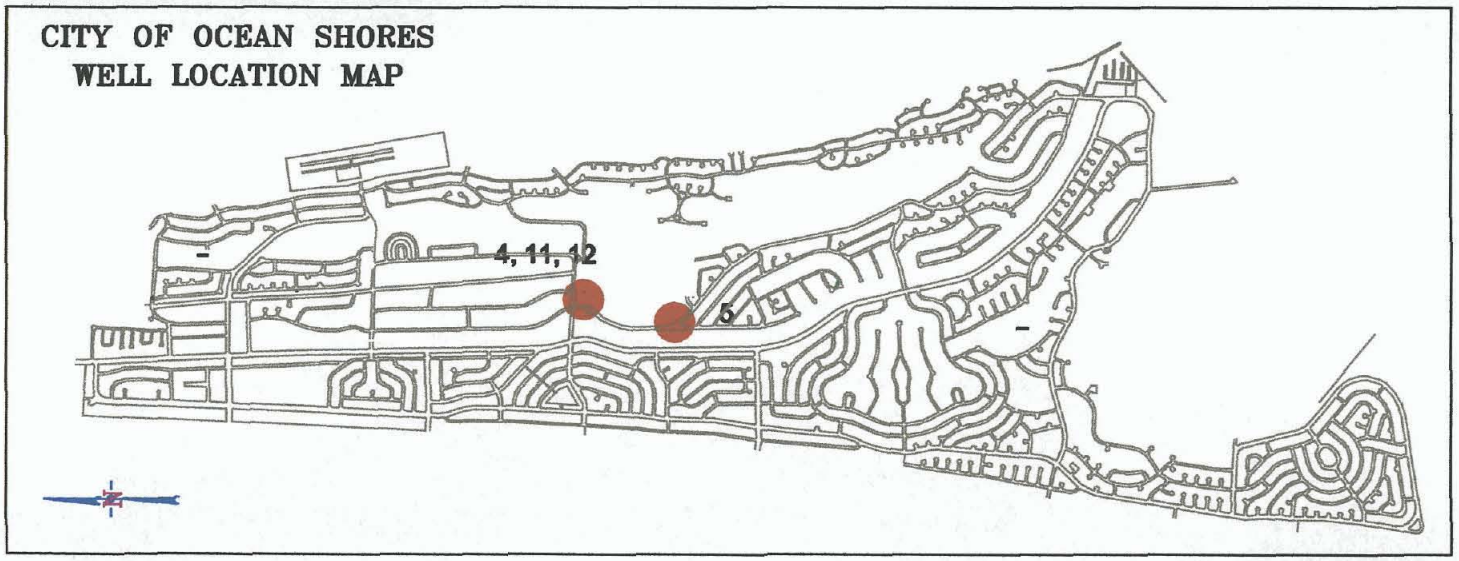
Very truly yours,

BUCK & GORDON LLP

Adam W. Gravley

AWG:JDR
Enclosure

Y:\WP\OCEAN SHORES\L042805.WALSH.DOC



CITY OF OCEAN SHORES

LOCATION MAP

FOR WATER RIGHTS TRANSFER

7/19/01

R/A
RONGEY/ASSOCIATES
HYDROGEOLOGY

PROJECT MEMORANDUM

PROJECT: **Shallow Well Development, Filter Plant Site**

DATE: **August 29, 2001**

TO: **John Gow, Public Works Director**

FROM: **Richard J. Rongey**

SUBJECT: ***Construction and Testing Wells No. 11, 12, and 13 With Hydrogeologic Analysis of the Filter Plant Well Site***

Scope and Purpose

The following summarizes the drilling and testing of wells No. 11, 12 and 13 with a hydrogeologic interpretation of findings. The well sites were chosen primarily to optimize the ground water withdrawal from a more productive area within the regional shallow ground-water reservoir. The filter plant site had been previously drilled and extensively tested by well No. 4. As discussed by Rongey/Associates' (R/A) earlier reports, this shallow ground-water reservoir underlies the whole of the Ocean Shores Peninsula, is well protected from underlying and peripheral saline water and has an extremely large annual water supply capability . The current wells are all similarly completed, as well No. 4, with 30 feet of screen set between approximate depths of 60 and 90 feet. Two of the new wells now have permanent pumping equipment installed and are "on-line". As a consequence testing procedures were by necessity tailored to accommodate the pumping schedule of these wells.

The test was concerned primarily with the long-term capability of the well field, incorporating all four of the completed wells, Nos. 4, 11, 12 and 13. For this purpose the test combined the added maximum withdrawal of well No. 13 to the concurrent stabilized withdrawals of wells No. 4 and 11 which had been pumping near continuously for 7 days prior to the test. Observation of the interaction of all wells was of a sufficient period to enable a reasonable projection of dry season well field capability. Well No. 12 with a previously determined lesser yield was not equipped for testing. Acquired data is, however, considered sufficient to enable a projection of well field capability incorporating this well.

Current water level elevations are calculated based on the 1989 surveyed elevations for well No. 4 and piezometer 4A. The static water level elevation in well No. 4, measured on 8/7/01 preliminary to this wells placement on-line, is assumed to be comparable to the static water level in all three of the adjacent new wells. It is noted that this elevation is 0.10 feet above the current elevation of the Grand Canal - Duck Lake drainage system which is controlled by a weir at the canal terminus, elevation 5.35 feet, referenced to mean sea level.

The test conducted on 8/16/01 utilized the pumping levels of wells No. 4 and No. 11 which followed a full week of their near continuous on-line service. The two wells were contemporaneously pumped; well No. 4 at 360, well No. 11 at 310 gpm on an approximate schedule of 20 to 30 minutes on and 8 to 10 minutes off. This schedule is controlled by the water treatment process.

An earlier, 24 hour test when well No. 11 was completed evaluated the interference between well No.s 4, 11 and 12. These data are incorporated in this current interference analysis.

Test Procedures and Findings

Preliminary to the start of test pumping, both wells No. 12 and 13 were monitored to determine the degree of water level interference resulting from the intermittent operation of well Nos. 4 and 11. The short-

term water level fluctuation was found to be about 3.5 feet in both wells and occurred largely within the first several minutes of the drawdown and recovery periods. This also resulted in a comparable change in each well's pumping water level. The pattern of these pumping water level fluctuations is best shown by the last 23 minutes of the linear hydrographic test plot for well No. 13, Figure 2, below. Note that the periodic decrease in the pumping rate during the test was required to maintain a pumping water level above the top of the pump.

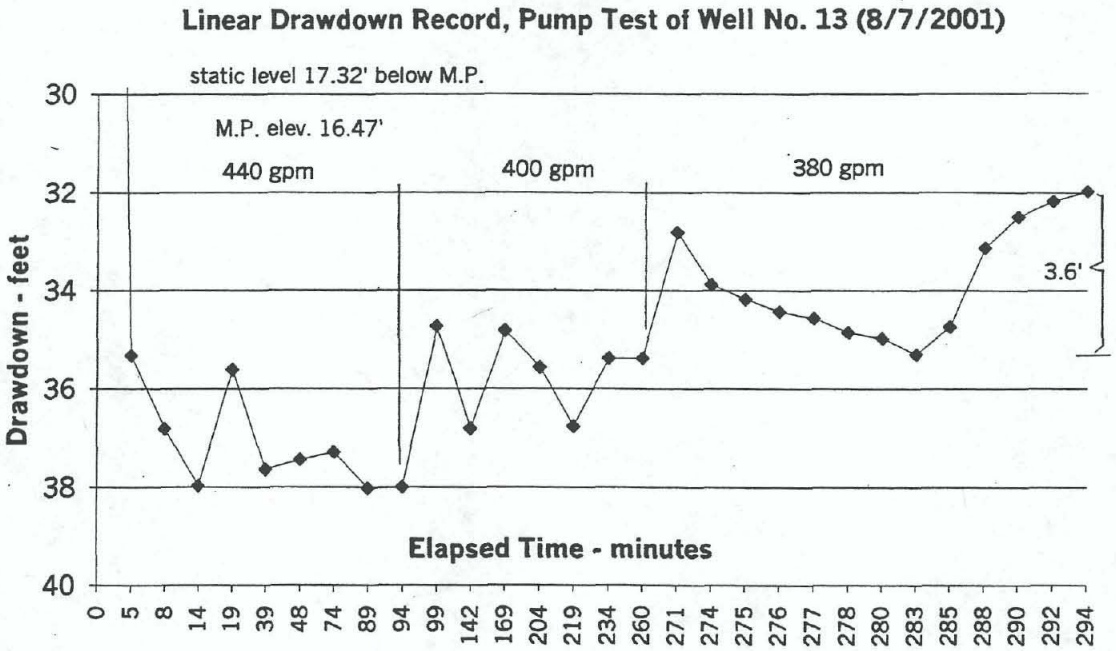


Figure 3 is a logarithmic plot of well No. 13's maximum pumping water levels adjusted via a specific capacity factor to a 380-gpm withdrawal rate. This hydrograph illustrates the water level decline in well No. 13 with all three wells; No.4, 11 and 13, pumping concurrently. In addition the pumping water level decline with the added withdrawal of well No. 12 producing 175 gpm is illustrated. During the final 1.5 hours of the test, well No. 13 was pumping 380 gpm; well No. 4, 340 gpm; well No. 11, 310 gpm. Wells No. 4 and 11 were, however, pumping intermittently on an approximate average of 22 minutes on and 8 minutes off. This schedule reduces the average discharge rate to about 264 gpm for well No. 4 and 227 gpm for well No. 11. The combined discharge for the three wells then is 870 gpm.

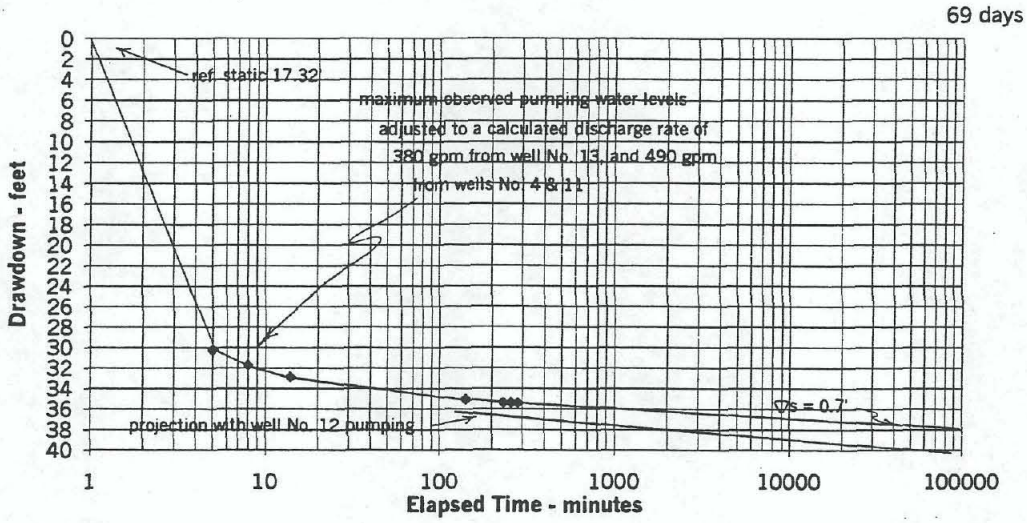
The long term projected drawdown of the pumping water level in well No. 13 as shown by Figure 3 reflects the rate of drawdown within all three pumping wells. A calculated plot is also illustrated with all four wells pumping. The rate of water level decline is based on the last 1.5 hours of apparent stabilization. Stabilization was rapid with the addition of well No. 13 since wells No. 4 and 11 had been continuously pumping for a week. The projection illustrates that the water level decline as the result of pumping would not likely exceed an additional foot through the summer season. This projected ratio of drawdown is generally confirmed by the previous testing of wells No. 4 and 5 which have both been continuously pumped for periods of 6 month to a year without apparent aquifer boundary effects.

Well No. 12 has not been formally tested with respect to yield and drawdown but has been previously successfully pumped at 200-gpm rate for a day or more. This withdrawal rate was monitored with an approximate 40-foot drawdown, but with no competitive withdrawals from neighboring wells. Assuming a decline in well field static water levels as observed with the competitive pumping of well No.s 4, 11 and 13 combined with a deeper pump setting well No. 12

should be capable of a sustained 175 gpm would appear probable. This added withdrawal would increase the total well field capability to 1,045 gpm.

Observed and Projected Drawdown With Three and Four Wells Pumping

Figure 3



Interference is significant between the wells. Based on the 8/16/01 test combined with an earlier test of well No. 11 this interference is calculated to result in a yield decline of 20 percent; with all wells producing. i.e. the wells if pumped individually would have a 20 percent greater yield than observed.

Water Quality

Water quality findings by R/A have been largely restricted to field analyses to facilitate the optimal placement of well screens. Excess salinity as indicated by chlorides and conductivity was the primary concern. The following Table 1, summarizing observed water quality parameters in well No. 13, appears generally typical as regards water quality stratification through the ground water reservoir. The 60 through 90-foot sample is a field test of water from the completed well at the end of a 5-hour test. The single depth samples are taken from the bottom of the driller's sand pump type bailer. Although several of these latter samples were filtered they remained excessively turbid and unsuitable for iron, nitrate and color determinations. As shown by Table 1, the field analyses reflect increasing conductivity with depth while chlorides are reasonably constant.

Table 1 – Test Well No. 13, Water Quality vs Depth

Sample Depth Feet	Conductivity umhos/cm	Fe	NO_3	CI	(ortho) PO_4	Hardness	Color cu	Remarks
		mg/l						
60 – 90	510	0.7	<1	25	4	40	10	Completed well
40	190	1/	1/	25	2	100	1/	Sampled at casing shoe
60	790	1/	1/	35	4	50	1/	" " "
80	760	0.2	<1	35	12	150	20	" " "
95	910	1/	1/	35	1/	30	1/	" " "

1/ Turbidity too high to permit analysis

Hydrogeologic Relationships

The current drilling program has not significantly altered hydrogeologic concepts developed through the completion and testing phase of well No. 4 in 1989-90. Essentially the shallow ground-water reservoir as occurs under the filter plant site is part of a regional formational unit underlying the whole of the Ocean Shores Peninsula. The more highly permeable, thicker and deeper sand/gravel sequence directly under the filter plant site likely represents an abandoned tidal drainage channel, trending between the bay and the open ocean. This probably was ancillary to the larger current channel between Damon Point and Westport. This channel fill is separated from an underlying slight to moderately saline sequence of highly permeable sand and gravel by a 10 to 50 feet of poorly permeable clay, silt and clayey gravel. These deeper aquifers have been tested by a number of wells on the Ocean Shores Peninsula and found unusable for domestic water use because of excessive salinity.

The variables in water quality and well yield within the shallow ground-water reservoir are extreme and difficult to predict. For example well No. 5, 1,500 feet south of the filter plant found a highly productive aquifer but with untreatable water because of excessive organic color. The present four wells on the filter plant site all appear to have comparable water within treatable limits for the constituents of primary concern, iron, manganese and color. Further north under the golf coarse the water quality is adequate but well yields are poor.

Aquifer permeability and transmissivity are more inconsistent than water quality. The best example is the differing aquifer capability between well No's 4, 12 and 11. As shown by the driller's logs Figures 4, 5, 6 and 7, well No. 12 has essentially no gravel in the same 60 to 90 foot interval screened in wells No. 4 and 11. As a result the maximum yield capability of well No. 12 is less than half that of the adjacent wells. Similarly, well No. 13, Figure 7 has much coarser sand and gravel in this interval with a maximum yield capability at least 20 percent more than wells 4 and 11.

Geophysical methods (electrical resistivity) were an aide in selecting the site for well No. 13. This system is likely to be of greater use in selecting further sites with regard to aquifer transmissivity. Water quality, however, is not predictable with this method. As a result short distance step-outs from existing wells remains the best option with respect to risk.

Concerning sources and volumes of recharge to the shallow aquifer system, this has been extensively evaluated and discussed via R/A's January 1990 report. This report compiles water level data over an 8-month period from more than 30 piezometers scattered widely across the city. It generally confirms the integration of Duck Lake and the canal surface water system with the shallow ground-water reservoir. It further concludes that during the driest years annual recharge accessible to shallow wells in the golf coarse and filter plant area is in excess of 7,000 acre feet. During the recharge season, generally November through May, precipitation recharge exceeds available ground-water storage and discharges immediately via the canal system and as ground-water sub-flow. In effect the city's water use through this period results in no net loss of ground water from storage.

Subsequent R/A research following 1990 report and published via the city's 1997 5-year plan stated as follows:

Based on the three stages of production scale shallow well testing it was concluded that higher yielding wells (250 gpm plus) with a water quality suitable for treatment could likely be developed on a combination of city properties near the north – south axis of the peninsula on and in the vicinity of the filter plant. Calculations suggest that because of the integrated surface and ground-water systems wells in this location in normal years would have access to recharge from approximately the northern half of the Ocean Shores Peninsula. During the extended 7-month dry season of the driest years, however, ground-water withdrawals in the filter plant area could influence nearly the whole of the peninsula. Assuming a projected seven-month dry season, the seasonal withdrawals as projected for 1997 + 20 years of 2,900 acre feet would result in a 2.2-foot water level decline. This decline would extend throughout the peninsula area including Duck Lake and the canal systems. During the driest years this would be followed by a minimum 10,000 acre feet of recharge, satisfying by a factor of three, the required water to annually recharge the system.

It has been concluded from previous studies that proximal shallow surface water reservoirs as the Grand Canal and Duck Lake are not exceptional sources of recharge. Calculations during the 1989 – 1990 pump test involving differing water levels in companion piezometers of varying depths suggest a unit permeability ratio of 20:1, horizontal vs vertical. Adjacent shallow surface water bodies in effect are equivalently perched as is water stored in the remaining ground-water reservoir. Either environment is controlled by vertical and lateral gradients which remain similar during all seasons.

Summary and Conclusions

The filter plant well field producing from the shallow ground water reservoir as now configured appears to have a six month dry season capability in excess if 1,000 gpm. The aquifer supplying this well field has hydraulic continuity with a regional shallow ground water reservoir capable of supplying a dry season ground-water draft far in excess of the present four well's yield. The current well field capability is projected to be about 800 acre-feet through a theoretical maximum 7-month dry season; i.e., non-recharge period.

As described by previous R/A reports the source of the ground-water recharge is direct precipitation on the Ocean Shores Peninsula. The wells have access to ground water from the greater part of the upgradient portion of the Ocean Shores Peninsula within the city area. Recharge with the first fall rains is immediate with available storage far less than available recharge. As a consequence, typically two thirds of the recharge season precipitation is discharged immediately via the Duck Lake – Grand Canal system and ground-water subflow. As a consequence the city's recharge season water withdrawal from the shallow ground water reservoir cannot subtract from available non-recharge season ground-water storage.

Finally, it is important to note that the cone of depression established by the well field's pumping withdrawal has restricted hydraulic continuity with adjacent surface water sources as the canal, Duck Lake, and on-site wash water pond. In effect these water sources because of their shallow nature and their restricted vertical permeability do not contribute a significant greater volume of water to the well field on a unit area basis than does storage in the general ground-water reservoir.

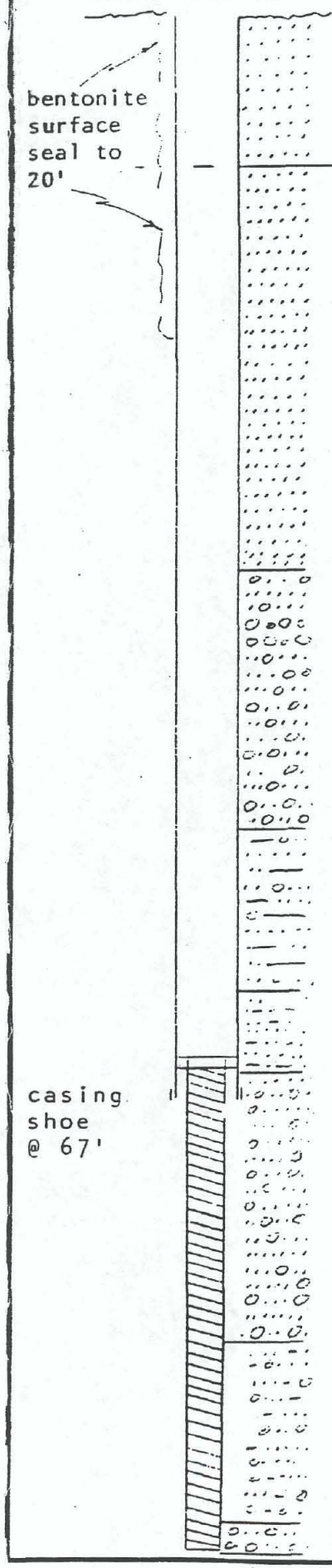
Concerning water quality, past experience with wells No. 4 and 5, which have previously been pumped continuously for many months at rates of 250 to 350 gpm indicates the quality of water as initially produced by a well remains reasonably consistent (either poor or good) throughout all seasons and periods of use. Further expansion of the well field is unquestionably possible but positioning wells at the most productive locations will continue to be a risk. Geophysics (electrical resistivity) was successful in locating the well No. 13 site, in part because there was room to space the electrode pattern and more importantly we now have a good data base for guiding data interpretation. Aquifer orientation at this point remains questionable but hopefully can be better defined by geophysics. Water quality variables, principally organic color and iron, are an equivalent risk in establishing well sites. The boundary between the area of reasonable water quality on the filter plant site and the poor water quality as in test well No. 5, located 1,500' to the south will require step-out drilling to establish.

Richard J. Rongey
Hydrogeologist

Attachments:

Figure 1,	Location Map
Figure 2,	Linear Drawdown Record
Figure 3,	Logarithmic Projection of Drawdown
Figure 4,	Construction Well No. 4
Figure 5,	" " 11
Figure 6,	" " 12
Figure 7,	" " 13
Figure 8,	Screen Analyses Well No. 11
Figure 8a	" " Well No. 12
Figure 9,	" " Well No. 13
Figure 10a, b, c,	State Water Well Reports, Wells 11, 12, and 13

TEST WELL NO. 1 FORMATION LOG



Static, 9.5' ±

Sand: fine with some silt, wood & shell fragments

Sand: fine to coarse with abundant pebble gravel. coarse pebble gravel 36'-38'

Sand: fine, silty with some clay and minor fine gravel

Sand: very fine, silty

Sand: fine to coarse with abundant fine gravel

Sand: silty and clayey with fine gravel

Gravel: small pebbles with fine to coarse sand

Screen: telescoping, stainless; .025", 65' - 80', .016", 80' - 95', "K" packer, no tail pipe or riser

OCEAN SHORES CONSTRUCTION - WELL NO. 4

DRAWN BY LCR
REVISED
APPROVED BY:
SCALE: 1" = 10'
DATE: 5/1/89

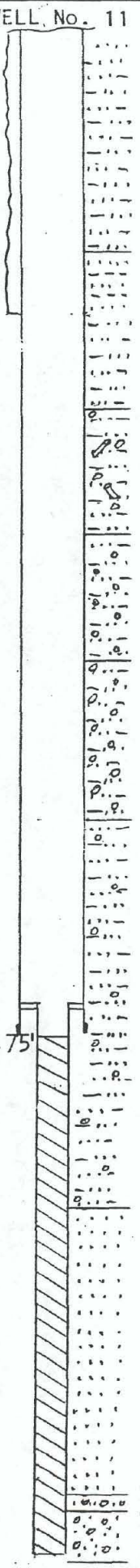
RONGEY/ASSOCIATES

DRAWING NUMBER

Figure 4

WELL No. 11

Driller's Log



8' Static, 4/25/01

Brown silty sand

14

Bentonite surface seal to 18'

Gray sand & silt

24

Gray silty sand, some gravel and wood

32

Gray silty sand, more gravel

40

Gray silty sand, still more gravel

50

Gray silty sand, some gravel

Top of "K" 60.75'

Casing shoe @ 64'

Screen: telescoping stainless, 8", 0.25" slot, 94-89, 0.16 slot, 89-79; 0.15 slot, 79-74; 0.16 slot, 74-64'
7" riser w/ top of "K" @60.75'

75

Sand

93

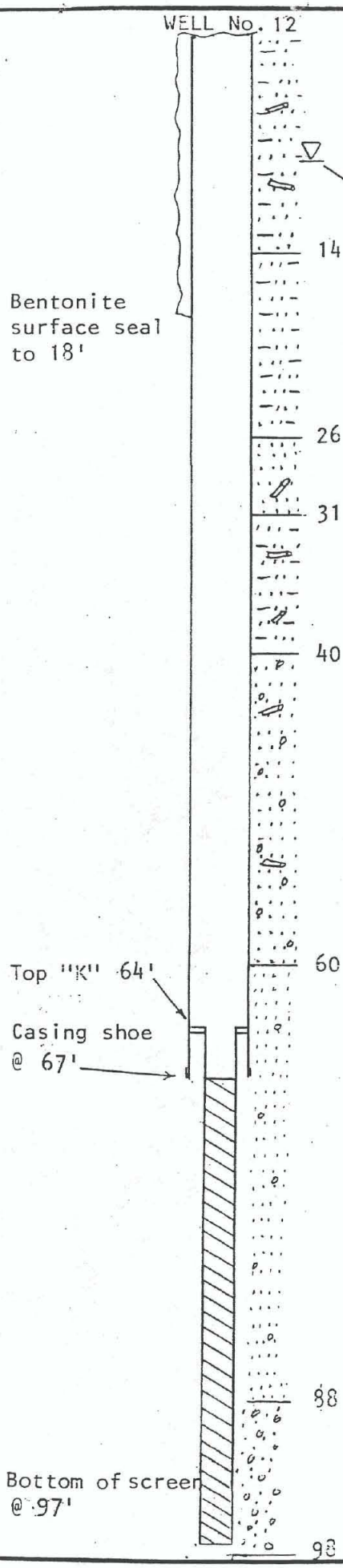
94 Gray sand & gravel, seashells & wood

Gray sand & gravel, seashells

97.5

CITY OF OCEAN SHORES CONSTRUCTION - WELL No. 11	DRAWN BY JER
	REVISED
	APPROVED BY:
	SCALE: 1" = 10'
	DATE: 8/26/01
Construction - Well No. 11	DRAWING NUMBER
Rongey/Associates	

Figure 5



Driller's Log

Brown silty sand w/ wood
Static, 8', 5/30/01

Gray silty sand

Darker fine sand w/ wood, gray water

Fine silty sand w/ wood, water

Small gray gravel w/ gray sand - water bearing, some wood

Silt (screen anal. indicates a preponderance of fine to medium sand w/ 10 to 25 percent coarse sand w/ few granules) see Figure 8a

Screen: telescoping, stainless, 8", 0.25 slot, 97'-92', 0.15 slot, 92'-67' 7" riser w/"K" to 64'

Gray sand & gravel, seashells

CITY OF OCEAN SHORES
CONSTRUCTION - WELL No. 12

DRAWN BY JER
REVISED
APPROVED BY:
SCALE: 1" = 10'
DATE: 8/26/01

Construction, Well No. 12

DRAWING NUMBER
Rongey/Associates

Figure 6

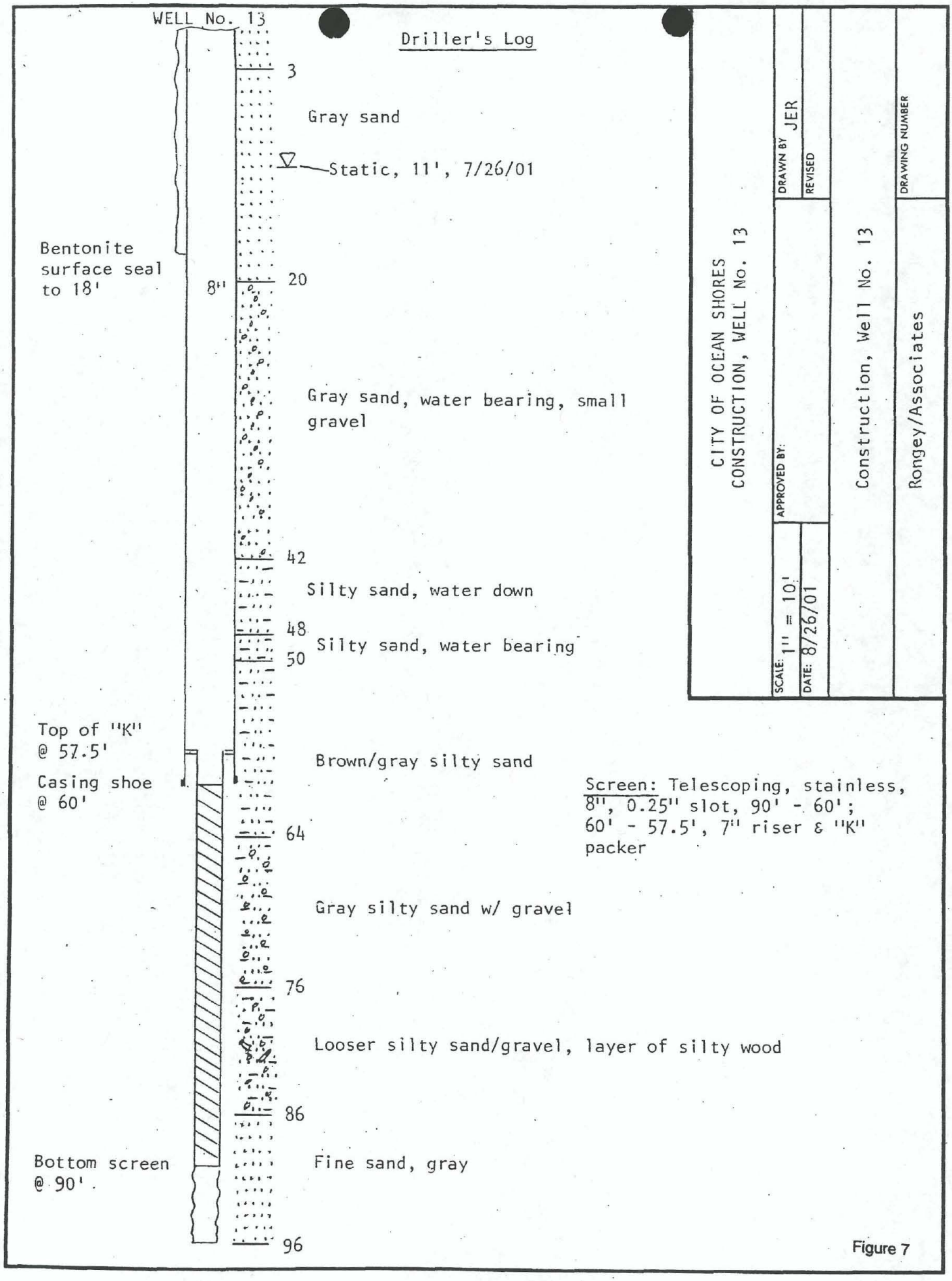

WELL No. 13
Driller's Log
3
Gray sand
Static, 11', 7/26/01
Bentonite surface seal to 18'
8"
20
Gray sand, water bearing, small gravel
42
Silty sand, water down
48
Silty sand, water bearing
50
Top of "K" @ 57.5'
Casing shoe @ 60'
Brown/gray silty sand
Screen: Telescoping, stainless, 8", 0.25" slot, 90' - 60'; 60' - 57.5', 7" riser & "K" packer
64
Gray silty sand w/ gravel
76
Looser silty sand/gravel, layer of silty wood
86
Bottom screen @ 90'
Fine sand, gray
96
CITY OF OCEAN SHORES
CONSTRUCTION, WELL No. 13
DRAWN BY JER
REVISED
APPROVED BY:
SCALE: 1" = 10'
DATE: 8/26/01
Construction, Well No. 13
DRAWING NUMBER
Rongey/Associates

Figure 7

File Original with Department of Ecology
Second Copy - Owner's Copy
Third Copy - Driller's Copy 94841

WATER WELL REPORT

STATE OF WASHINGTON

Notice of Intent WU68276
UNIQUE WELL I.D. # AEC 921
Water Right Permit No. G2-27566P

(1) OWNER: Name CITY of OCEAN SHORES Address PO BOX 909 OCEAN SHORES, WA 985

(2) LOCATION OF WELL: County GRAYS HARBOR SW 1/4 SW 1/4 Sec 2 T 17 N.R. 12 E W.M

(2a) STREET ADDRESS OF WELL: (or nearest address)

TAX PARCEL NO.:

(3) PROPOSED USE: ☐ Domestic ☐ Industrial ☑ Municipal ☐ Irrigation ☐ Test Well ☐ Other ☐ DeWater

(4) TYPE OF WORK: Owner's number of well (if more than one) #11
☒ New Well ☐ Deepened ☐ Reconditioned ☐ Decommission
Method: ☐ Dug ☒ Cable ☐ Rotary ☐ Bored ☐ Driven ☐ Jetted

(5) DIMENSIONS: Diameter of well 8" inches
Drilled 98 feet. Depth of completed well 98' ft.

(6) CONSTRUCTION DETAILS
Casing Installed:
☒ Welded " Diam. from ft. to ft.
☐ Liner installed " Diam. from ft. to ft.
☐ Threaded " Diam. from ft. to ft.

Perforations: ☐ Yes ☒ No
Type of perforator used
SIZE of perforations in. by in.
perforations from ft. to ft.

Screens: ☒ Yes ☐ No ☐ K-Pac Location 60' 9"
Manufacturer's Name Johnson
Type 8" telescopic Model No.
Diam. 8" Slot Size 25 from 94 ft. to 89 ft.
Diam. 8" Slot Size 16 from 79 ft. to 74 ft.
Gravel/Filter packed: ☐ Yes ☒ No ☐ Size of gravel/sand 16 74 64
Material placed from ft. to ft.

Surface seal: ☒ Yes ☐ No To what depth? 18 ft.
Material used in seal
Did any strata contain unusable water? ☐ Yes ☒ No
Type of water? Depth of strata
Method of sealing strata off

(7) PUMP: Manufacturer's Name
Type: H.P.

(8) WATER LEVELS: Land-surface elevation above mean sea level ft.
Static level 8' ft. below top of well Date 4/25/01
Artesian pressure lbs. per square inch Date
Artesian water is controlled by (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? ☒ Yes ☐ No If yes, by whom? by city eng.
Yield: 300 gal./min. with 40'6" ft. drawdown after 24 hrs.
Yield: gal./min. with ft. drawdown after hrs.
Yield: gal./min. with ft. drawdown after hrs.
Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level
7:02	40'6"	7:05	15'10"	7:08	14'½"
7:03	18'2"	7:06	14'10"	7:15	8"
7:04	16'6"	7:07	14'2"	7:17	8"

Date of test 4/26/01
Bailer test gal./min. with ft. drawdown after hrs.
Airtest gal./min. with ft. drawdown after hrs.
Artesian flow g.p.m. Date
Temperature of water Was a chemical analysis made? ☐ Yes ☒ No

(10) WELL LOG or DECOMMISSIONING PROCEDURE DESCRIPTION
Formation: Describe by color, character, size of material and structure, and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of information. Indicate all water encountered.

MATERIAL	FROM	TO
Brown silty sand	0	14
Gray sand & silt	14	18
Gray sand + silt	18	24
Gray silty sand - some gravel + wood	24	32
Gray silty sand - more gravel	32	40
Gray silty sand - still more gravel	40	50
Gray silty sand - some gravel	50	75
Sand	75	93
Gray sand + gravel, sea shells & wood	93	94
Gray sand + gravel, sea shells	94	97.5

RECEIVED
MAY 29 2001
Washington State
Department of Ecology

Work Started 4/24/01 Completed 4/25/01

WELL CONSTRUCTION CERTIFICATION:

I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

Type or Print Name DAVE CHARON License No. 1190
(Licensed Driller/Engineer)
Trainee Name License No.
Drilling Company CHARON DRILLING, INC
(Signed) Dave Charon License No. 1190
(Licensed Driller/Engineer)
Address 12719-224 ST EAST GRAHAM, WA
Contractor's Registration No. CHARODI133NE Date 5-20-01

(USE ADDITIONAL SHEETS IF NECESSARY)

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ECY 050-1-20 (11/98)

Figure 10a

File Original with Department of Ecology
Second Copy - Owner's Copy
Third Copy - Driller's Copy

95709

WATER WELL REPORT

STATE OF WASHINGTON

Notice of Intent W068297
UNIQUE WELL I.D.# AEC 922
Water Right Permit [redacted]2-27566 P

(1) OWNER: Name CITY of OCEAN SHORES Address PO BOX 909 OCEAN SHORES, WA 98569

(2) LOCATION OF WELL: County GRAYS HARBOR SW 1/4 SW 1/4 Sec 2 T 17 N.R. 12 E (WM)

(2a) STREET ADDRESS OF WELL: (or nearest address)

TAX PARCEL NO.:

(3) PROPOSED USE: ☐ Domestic ☐ Industrial ☒ Municipal ☐ Irrigation ☐ Test Well ☐ Other ☐ DeWater

(4) TYPE OF WORK: Owner's number of well (if more than one) 12
☒ New Well ☐ Deepened ☐ Reconditioned ☐ Decommission
Method: ☐ Dug ☒ Cable ☐ Rotary ☐ Bored ☐ Driven ☐ Jetted

(5) DIMENSIONS: Diameter of well 8" inches
Drilled 98 feet. Depth of completed well 98 ft.

(6) CONSTRUCTION DETAILS
Casing Installed:
☒ Welded 8" Diam. from 0 ft. to 98 ft.
☐ Liner installed Diam. from ft. to ft.
☐ Threaded Diam. from ft. to ft.

Perforations: ☐ Yes ☒ No
Type of perforator used
SIZE of perforations in. by in.
perforations from ft. to ft.

Screens: ☒ Yes ☐ No ☐ K-Pac Location 64'
Manufacturer's Name Johnson
Type 8" telescopic Model No.
Diam. 8" Slot Size 15 from 67 ft. to 92 ft.
Diam. 8" Slot Size 25 from 92 ft. to 97 ft.

Gravel/Filter packed: ☐ Yes ☒ No ☐ Size of gravel/sand
Material placed from ft. to ft.

Surface seal: ☒ Yes ☐ No To what depth? 18 ft.
Material used in seal Bentonite
Did any strata contain unusable water? ☐ Yes ☒ No
Type of water? Depth of strata
Method of sealing strata off

(7) PUMP: Manufacturer's Name
Type: H.P.

(8) WATER LEVELS: Land-surface elevation above mean sea level ft.
Static level 8 ft. below top of well Date 5/30/01
Artesian pressure lbs. per square inch Date
Artesian water is controlled by (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? ☒ Yes ☐ No If yes, by whom? by city eng.
Yield: gal./min. with ft. drawdown after hrs.
Yield: gal./min. with ft. drawdown after hrs.
Yield: gal./min. with ft. drawdown after hrs.
Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test
Bailer test gal./min. with ft. drawdown after hrs.
Airtest gal./min. with ft. drawdown after hrs.
Artesian flow g.p.m. Date
Temperature of water Was a chemical analysis made? ☐ Yes ☐ No

(10) WELL LOG or DECOMMISSIONING PROCEDURE DESCRIPTION
Formation: Describe by color, character, size of material and structure, and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of information. Indicate all water encountered.

MATERIAL	FROM	TO
Brown silty sand w/ wood	0	14
Gray silty sand	14	26
Darker fine sand w/ wood - gray water	26	31
Fine silty sand w/ wood - water	31	40
Small gray gravel w/ gray sand - w.b. some wood	40	60
Silt	60	88
Gray sand & gravel sea shells	88	98

JUN 07 2001
Washington State Department of Ecology

Work Started 5/17/01 Completed 5/30/01

WELL CONSTRUCTION CERTIFICATION:

I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

Type or Print Name DAVE CHARON License No. 1190
(Licensed Driller/Engineer)

Trainee Name — License No. —
Drilling Company CHARON DRILLING, INC.
(Signed) Dave Charon License No. 1190
(Licensed Driller/Engineer)
Address 12719-224 ST EAST GRAHAM, WA 9833
Contractor's Registration No. CHARODI133NF Date 5/30/01

(USE ADDITIONAL SHEETS IF NECESSARY)

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ECY 050-1-20 (11/98)

Figure 10b

WATER WELL REPORT
STATE OF WASHINGTON

Start Card No.
Water Right Permit No.

(1) OWNER: Name City of Ocean Shores Address P.O. Box 909 Ocean Shores WA98569

(2) LOCATION OF WELL: County Grays Harbor
(2a) STREET ADDRESS OF WELL (or nearest address)

NW	SW	Sec	T	N., R	WM
SW	SW	2,	17		12W

(3) PROPOSED USE:

(4) TYPE OF WORK: Owner's Number of well (If more than one) 13
Method:

(5) DIMENSIONS: Diameter of well 8 inches
Drilled 96' ft. Depth of completed well 90' ft.

(6) CONSTRUCTION DETAILS:
Casing installed: 8 " Dia. from 0 ft. to 60' ft.
" Dia. from ft. to ft.
" Dia. from ft. to ft.

Perforations: none
Type of perforator used
SIZE of perforations in. by in.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.

Screens:
Manufacturer's Name Johnson
Type stainless Model No.
Diam. 8" slot size .025 from 60 ft. to 90 ft.
Diam. slot size from ft. to ft.

Gravel packed: no Size of gravel
Gravel placed from ft. to ft.

Surface seal: To what depth? 18' ft.
Material used in seal bentonite
Did any strata contain unusable water?
Type of water? Depth of strata ft.
Method of sealing strata off

(7) PUMP: Manufacturer's Name
Type H.P.

(8) WATER LEVELS: Land-surface elevation 13' above mean sea level .... ft.
Static level 11' ft. below top of well Date
Artesian Pressure lbs. per square inch Date
Artesian water controlled by

(10) WELL LOG

Formation: Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change in formation.

Brown sand	0	3
Gray sand	3	20
Gray sand, w.b., small gravel	20	42
Silty sand, water down	42	48
Silty sand, w. b.	48	50
Brown/gray silty sand	50	64
Gray silty sand w/ gravel	64	76
Looser silty sand/gravel, layer of silty wood	76	86
fine sand, gray	86	96

Work started Completed

(9) WELL TESTS: Drawdown is amount water level is lowered below static level.
Was a pump test made? yes If yes, by whom? staff
Yield: 400 gal./min with 40 ft. drawdown after 5 hrs.

Recovery data

Time	Water Level	Time	Water Level	Time	Water Level

Date of test / /
Bailer test gal/min. ft. drawdown after hrs.
Air test gal/min. w/ stem set at ft. for hrs.
Artesian flow g.p.m. Date
Temperature of water Was a chemical analysis made?

WELL CONSTRUCTOR CERTIFICATION:
I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

NAME Dave Charon
(Person, firm, or corporation) (Type or print)

ADDRESS 12719- 224 St. East, Graham, WA 98338

[SIGNED] _____ License No.

Contractor's Registration No. CHARODI133NF Date 8/7/01

Figure 10c

R/A
RONGEY/ASSOCIATES
HYDROGEOLOGY

PROJECT MEMORANDUM

PROJECT: **Ocean Shores Filter Plant Backwash Water Disposal System**

DATE: **November 16, 2001**

TO: **John Gow, City of Ocean Shores, Public Works Director**

FROM: **Richard J. Rongey, Hydrogeologist, Rongey/Associates**

SUBJECT: ***Shallow Aquifer Waste Disposal***

PURPOSE, SCOPE AND PROCDURES

The following describes the hydrogeology of the shallow ground-water reservoir supplying wells 4, 11, 12 and 13 as it relates to the current and proposed future location of the backwash water storage ponds. This study endeavors to establish the past and future impact of this backwash water disposal on the shallow ground-water reservoir. The investigation incorporates pertinent hydrogeologic data acquired via past exploration and well development supplemented with current well data and piezometer observations collected specifically for this analysis. The work is additive to earlier studies by Rongey/Associates (R/A) describing backwash water pond – ground-water relationships; see letter report, *Rongey to Mike Pence, 10/18/89,* Attachment "A" and confirms conclusions as outlined in the January 1990 R/A report, *Hydrogeologic Investigation Shallow Ground-Water Reservoir;* excerpts, Attachment "B".

Essentially this study addresses potential pollution problems resulting from the disposal of an average 140,000 gallons per day of filter plant backwash water directly to the shallow ground-water reservoir. Currently two thirds of this water volume is discharged directly to the Grand Canal and one third percolates from a small storage pond to shallow ground water. The following analysis tracks this latter water volume via piezometers and operating shallow production wells and describes the geochemistry of this water movement.

HYDROGEOLOGY

Geologic, hydraulic and chemical relationships on and in the vicinity of the filter plant area are understood via the history of a combination of 12 shallow piezometers 10 to 50 feet in depth combined with the records of the 4 production wells directly on the filter plant site and an additional 6 production well completion attempts at locations north and south of the site. All of these wells produce from the shallow ground-water reservoir between depths of 50 to 100 feet. Currently on the filter plant site, 4 shallow production wells are operational and three nearby piezometers are available for water level and quality observations. Pertinent data with regard to the remaining wells and piezometers are herein referenced to previous R/A reports, Attachment "A", and "B".

Geology

The geology of the shallow ground water reservoir at the filter plant site, broadly generalized on the basis of stratigraphy, consists of an upper 30 to 40 foot thickness of fine sand with abundant organic debris as stumps, logs, and peat, herein termed Zone A. Generally this organic rich sequence is underlain by fine sandy gravels and gravelly sands described as Zone B; see Section A-A', Figure 2. These deeper materials typically

have negligible organic debris but contain abundant shell fragments and comprise the principal aquifer contributing to the shallow well system at the filter plant. The whole of the above sequence typically terminates over a 10 to 60 foot thickness of poorly permeable silt and clay over underlying sands and gravels with excess salinity. From current drilling data the Zone B portion of the shallow ground water reservoir appears to be a gravel fill in what was at one time a narrow, bay to ocean estuary, ancillary to the present, much broader Damon Point – Westport channel. Overlying fine sands with peat and abundant wood debris (Zone A) are representative of backbay organic accumulations merging with dune sands and storm detritus accumulating following the natural migration and closure of the estuary.

Hydrology and Geochemistry

This two layer depositional sequence results in two chemically distinct horizons within a single hydraulically contiguous ground-water reservoir; see Section A-A', Figure #2. The upper sand sequence generally contains abundant decaying organic debris, creating highly colored tannic acids which actively leach iron and manganese from the mineral rich sands. Conversely the immediately underlying more highly permeable coarse sands with minor organic material, have abundant calcium and magnesium carbonate shell fragments, which with decomposition creates a bicarbonate rich alkaline water with a ph greater than 8. Under natural conditions the relative isolation of the two chemically distinct systems is maintained by their differing permeability; generally less than 50 gpd/ft^2 for the overlying Zone A fine sands and 500 + gpd/ft^2 for the underlying coarser sands and gravels in Zone B. Seasonal precipitation acts to recharge first the Zone A sands which with their lesser permeability enables ground-water storage. The result is a seasonal buildup of Zone A ground-water levels with an elevated hydrostatic head several feet higher than in the underlying more permeable Zone B. The consequence is a preponderance of vertical ground-water movement Zone A to Zone B which in turn discharges laterally to tidewater. The underlying clay unit facilitates this path of ground-water movement enabling the maintenance of a sufficient hydrostatic head to prevent seawater intrusion.

At the Zone A – Zone B interface iron and manganese together with some of the organic color reaches a maximum concentration and then with neutralization precipitates out to the limits of available oxygen. These relationships are illustrated by the water quality variables at various depths as shown by Section A-A'; Figure 2. Piezometer 5A screened in peat with intake at 22 feet, samples water with a pH of 6.9, Fe @ 32 mg/l, Mn @ 22 mg/l, organic color of 900. Nearby piezometer 6A1, screened in gravel at 51 feet, samples water with a pH of 8.4, Fe @ 0.14, and color of 40. During the course of drilling recently completed production well 13 first sampled water at the 30 foot depth. The pH at this depth is 6.7, with Fe @ 20+ mg/l. At the 60 foot depth water sampled by this same well had a pH of 8+ with Fe @ 0.3mg/l. The water quality of this well after 3 weeks of continuous pumping @ 325 gpm was producing with water of pH 8.3, Fe @ 0.3 Mg/l.

The organic acids are neutralized by the extreme alkalinity of the larger water volume in the more permeable, underlying coarser sands and gravels. The result is the precipitation of the iron and manganese to the limits of available oxygen. Organic color is only partially reduced, probably limited to the extent of the combined iron in the organic complex. Essentially, these are the same chemical reactions as are promoted more thoroughly by the filter plant.

The extend of this isolation of the producing portion of the shallow ground-water reservoir (Zone B) from the overlying, highly mineralized upper portion (Zone A) is best illustrated by the 1989 extended test of well No. 4 positioned 150 feet from piezometer 5A and 75 feet from piezometers 11A, B and C at the backwash pond. As described by Attachment "B" well No. 4 was pumped continuously at a 270 gpm rate for 5.5 months. The water quality record as shown by Plate 52 of Attachment "B", sampled weekly, maintained Fe @ <0.3 mg/l, Mn @ <.035 mg/l and color typically less than 50 units, with a pH averaging about 8.5.

In some areas as at the location of attempted production well No. 5 and 9 organic color is extreme and cannot be sufficiently removed to permit water treatment. The assumption is that Zone A in these areas is associated with very large quantities of organic debris, probably including widespread peat accumulations.

BACKWASH POND – GROUND WATER RESERVOIR RELATIONSHIP

The foregoing, Zone A vs. Zone B water quality relationships are particularly pertinent to concerns regarding the disposal of the two-filter plant's backwash water. It is noted that each plant's filter system treats and is backwashed by untreated water from its assigned wells i.e., Plant #1 receives well 1, 2 and 3 water, Plant 2, well 4, 11, 12 and 13 water. The backwash water passing through the filters acts to mechanically remove the filtered colloids. Essentially there are no chemical additives in this process to modify the dissolved constituents in the backwash water itself. This is illustrated by the attached chemical analyses, Figures 3a, 3b and 3c, which compare this wastewater with the original source water from the wells. Wastewater sampling was conducted after approximately 5 hours of colloidal settling time. As shown the wastewater is essentially comparable to the average of untreated well water before filtration.

Under current conditions approximately a third of this backwash water seeps from the storage pond and is returned to the Zone A portion of the shallow ground-water reservoir which is acidic with a pH of 6+ to $7^{\pm}$ and much more mineralized in all constituents. The elevated pH (7.5 – 8.5) of the wash water is rapidly diluted but in the process reacts with the Zone A water to precipitate both iron and manganese at the margins of the dilution plume. This mineral removal mechanism via backwash water dilution is evident under the existing wastewater pond. As shown by Section A-A'; Figure 2, the three piezometers drilled almost directly in the pond encountered significant differences in iron content and pH with depth. The shallowest (11C) at 15 feet found iron at 0.14 mg/l, pH of 7.8; 11B at 20 feet found iron at 0.78 mg/l and pH of 7.5; 11A at 30 feet found iron @ 11 mg/l and pH of 6.9. In effect the increasing degree of dilution of the high pH wastewater with depth is reflected by increasing acidity with greater dissolved iron and manganese typical of Zone A ground water.

The lateral influence of the wastewater plume appears to be similarly restricted. As shown by Section A-A', Piezometer "B" positioned 35 feet south of the pond found water with a pH of 6.9 and iron at 7.65 mg'/l; see IOC analysis, Figure 3e. This is similar to Zone A water remote from the disposal site as at piezometer 3d. In effect at a distance of 35 feet from the washwater pond the water quality is comparable to the regional water quality in Zone A. Note that this limited aerial distribution of wastewater has existed after more than 30 years of disposal at this site.

PROPOSED NEW BACKWASH WATER DISPOSAL SITE

Current data appears to be sufficient to extrapolate the foregoing to a site fully dedicated to waste water disposal via the deep percolation of naturally sand filtered water. The selected site as shown by Figure 1 is positioned approximately 60 feet south of the new storage tank. The existing shallow ground water chemistry at this location, acquired from the on-site piezometer at the screen depth of 27 feet, is summarized by the complete inorganic drinking water analysis, Figure 3d.

First, with regard to the required area to achieve total wastewater disposal, unit percolation rates as observed from staff readings in the existing wastewater pond are assumed to be applicable. Two sets of data, relating percolation rates before and after cleanout, are available. Rates before the recent cleanout work following a year or more of filter plant waste accumulation together with the deposition of iron and manganese from the peripheral ground-water reservoir were on the order of 3.6 gpd/ft^2. This was equivalent to 8.6 percent of the total daily backwash water volume. Current percolation rates, observed a month after cleanout are now about 14 gpd/ft^2, which equates to 36 percent of the total daily waste volume. Based on the above the required area for total disposal of all backwash water after a significant accumulation of filter waste solids would require an expansion of the current 3,400 ft^2 pond area to about 40,000 ft^2. The required area shrinks to 10,000 ft^2 if periodic cleanout could maintain bottom permeability as achieved in the existing pond. Ideally a design incorporating compartmentalization to restrict the settlement of solids to a smaller retention area before discharging to a percolation pond would be more efficient and also aid in the disposal of the added direct precipitation.

It is noted that the vertical permeability of sands immediately below the bottom of the existing basin, after cleanout remains only 10 percent of that calculated from screen analyses, Figure 4, of near surface sand assembled in a shallow test pit at the proposed relocated disposal site. This suggests that there is significant deposition of colloidal iron and manganese around the present disposal site unreachable by current cleanout procedures.

Concerning the influence of this added water volume from a relocated disposal pond the impact is not expected to be greatly different from that currently observed in the area immediate to the existing pond. The alkaline wastewater with minor mineralization merges laterally and vertically with more acidic water with major mineralization along a front extending only a few tens of feet from the disposal site. Iron and manganese carried in the shallow ground-water reservoir is precipitated in this contact zone. The chemical interaction of these two water types is so rapid and thorough that there is no extended wastewater plume from the disposal area. All colloidal material in the wastewater remains on and in the very fine sand forming the bottom of the percolation pond. The alkaline water plume is totally destroyed laterally and vertically within a few feet and is not of sufficient volume to locally or regionally upgrade the more highly mineralized water in the upper half of the shallow ground-water reservoir.

SUMMARY AND CONCLUSIONS

In summary, backwash water from the two filter systems is, after the settlement of colloidal solids chemically equivalent to the alkaline untreated well water supplying the system. A portion of this water is currently and all of it in the future is proposed to be injected into that portion of the shallow ground-water reservoir which is moderately acidic and as a result is extensively mineralized with iron, manganese and organic color. In effect on the basis of drinking water suitability, water with lesser mineralization is being disposed of as waste into a ground-water system with much poorer water quality.

This more mineralized poor water occupies the upper half of the shallow ground-water reservoir underlying the greater portion of the Ocean Shores Peninsula. The lower half of this reservoir as developed by production wells 4, 11, 13 and 14 at the filter plant site has water chemically dissimilar with high alkalinity and comparatively minor mineralization. The two chemically distinct, but hydraulically contiguous ground-water systems maintain their independence primarily because of the lesser permeability of the overlying fine sands. This permits a lower rate of vertical water transfer, enabling neutralization by the much more mobile alkaline water at depth. These relationships have resulted in the long-term chemical stability of the Zone B aquifer and development of the shallow wells system.

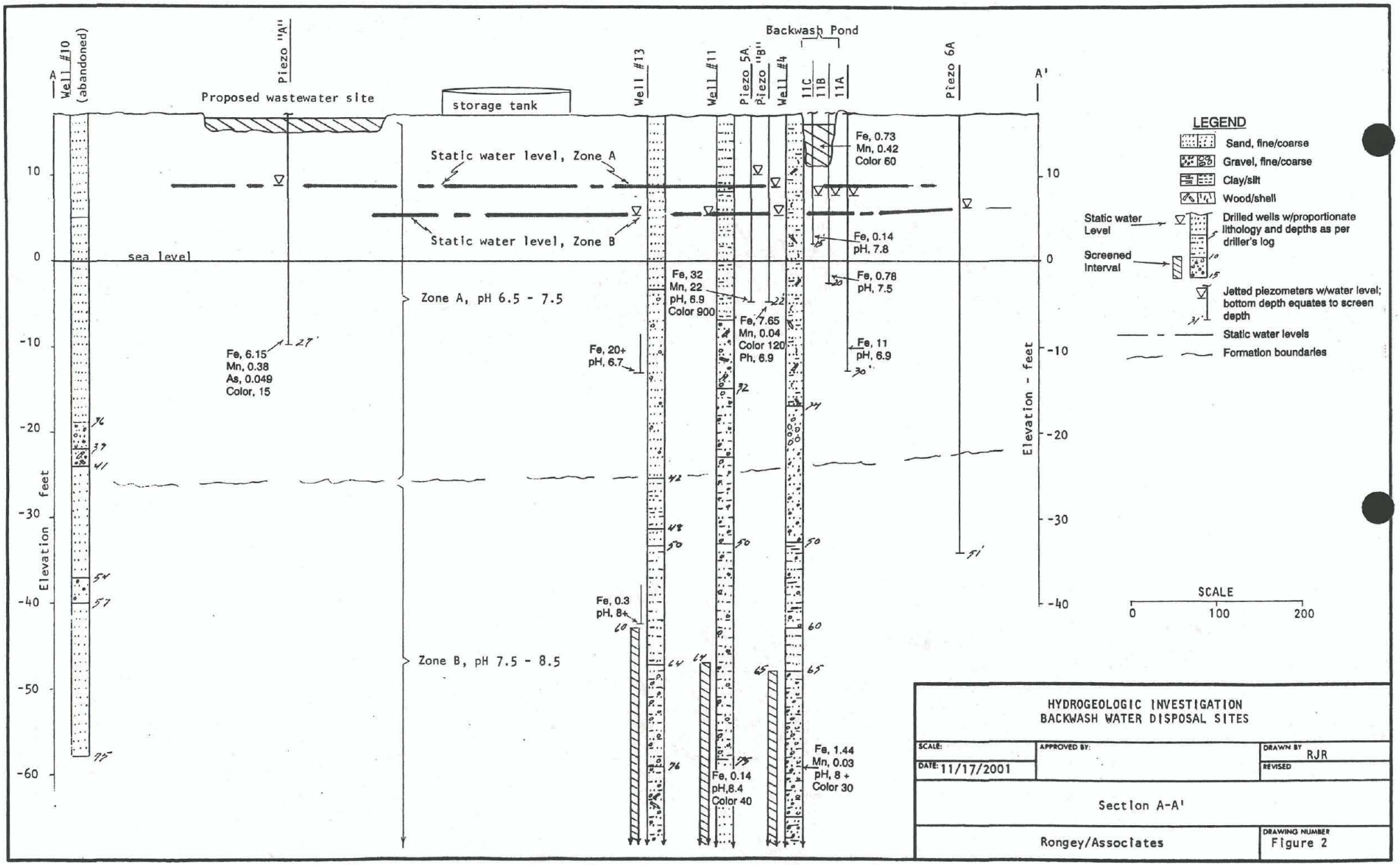
These same geochemical relationships guarantee the success of the proposed wastewater filtration and percolation pond. Return wastewater to Zone A of the shallow ground-water reservoir will have no effect on the shallow production well system. This return water will in the future, as it does now, lose its identity in close proximity the disposal site without either improving or degrading the well water as is now being withdrawn from Zone B.

Richard J. Rongey
Hydrogeologist

Enclosures:

	Page	
Figure 1	5	Site location map
Figure 2	6	Section A-A'
Figure 3a, 3b, 3c, 3d, 3e	7 – 11	Complete IOC Drinking Water Analyses
Figure 4	12	Test Pit Screen Analyses, Proposed Washwater Pond Site

Attachment "A"	Letter report R. Rongey → M. Pence, Potential Contaminant Sources, Filter Plant Site, 8/18/89
Attachment "B"	Report Excepts, Hydrogeologic Investigations Shallow Ground-water Reservoir, January, 1990


A
Well #10 (abandoned)
Piezo "A"
Proposed wastewater site
storage tank
Well #13
Well #11
Piezo 5A
Piezo "B"
Well #4
Backwash Pond
11C
11B
11A
Piezo 6A
A'
Static water level, Zone A
Static water level, Zone B
sea level
Zone A, pH 6.5 - 7.5
Zone B, pH 7.5 - 8.5
Fe, 6.15
Mn, 0.38
As, 0.049
Color, 15
Fe, 20+
pH, 6.7
Fe, 32
Mn, 22
pH, 6.9
Color 900
Fe, 7.65
Mn, 0.04
Color 120
Ph, 6.9
Fe, 0.3
pH, 8+
Fe, 0.14
pH, 8.4
Color 40
Fe, 0.73
Mn, 0.42
Color 60
Fe, 0.14
pH, 7.8
Fe, 0.78
pH, 7.5
Fe, 11
pH, 6.9
Fe, 1.44
Mn, 0.03
pH, 8 +
Color 30
Elevation - feet
10
0
-10
-20
-30
-40
-50
-60
LEGEND
Sand, fine/coarse
Gravel, fine/coarse
Clay/silt
Wood/shell
Static water Level
Screened Interval
Drilled wells w/proportionate lithology and depths as per driller's log
Jetted piezometers w/water level; bottom depth equates to screen depth
Static water levels
Formation boundaries
SCALE
0
100
200
HYDROGEOLOGIC INVESTIGATION
BACKWASH WATER DISPOSAL SITES
SCALE:
APPROVED BY:
DRAWN BY RJR
DATE: 11/17/2001
REVISED
Section A-A'
Rongey/Associates
DRAWING NUMBER
Figure 2

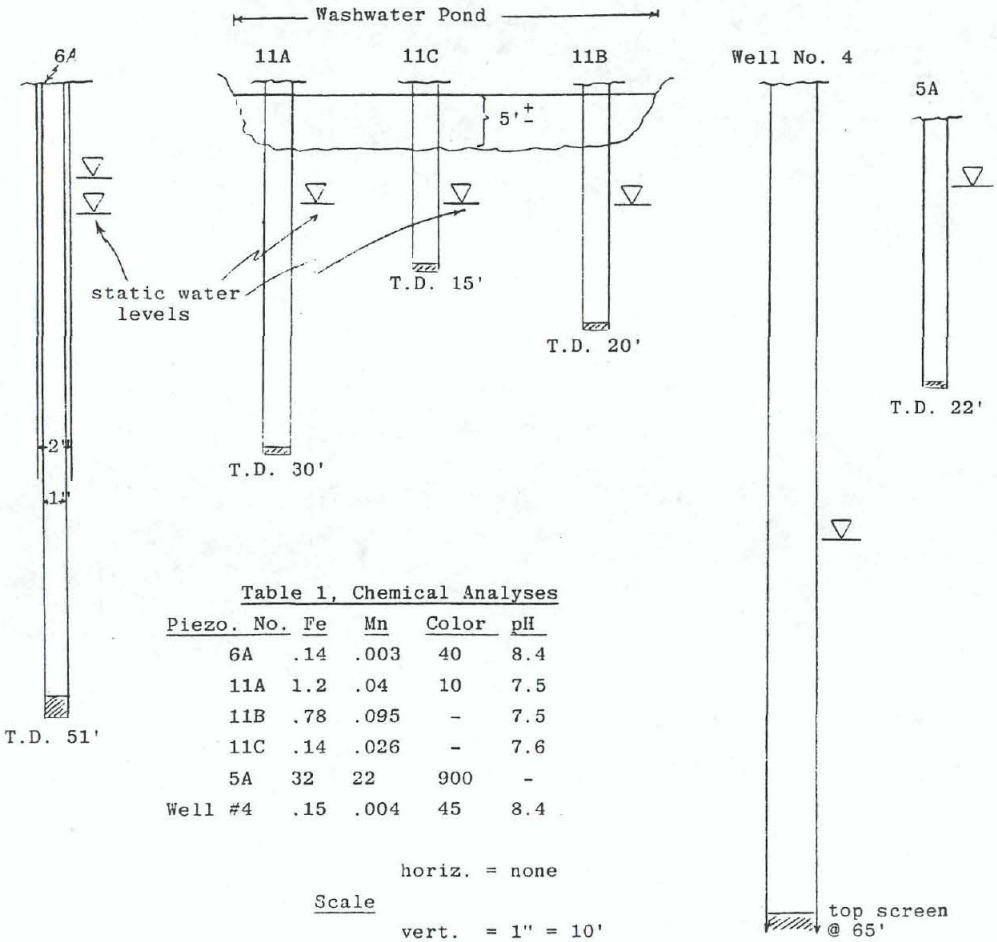


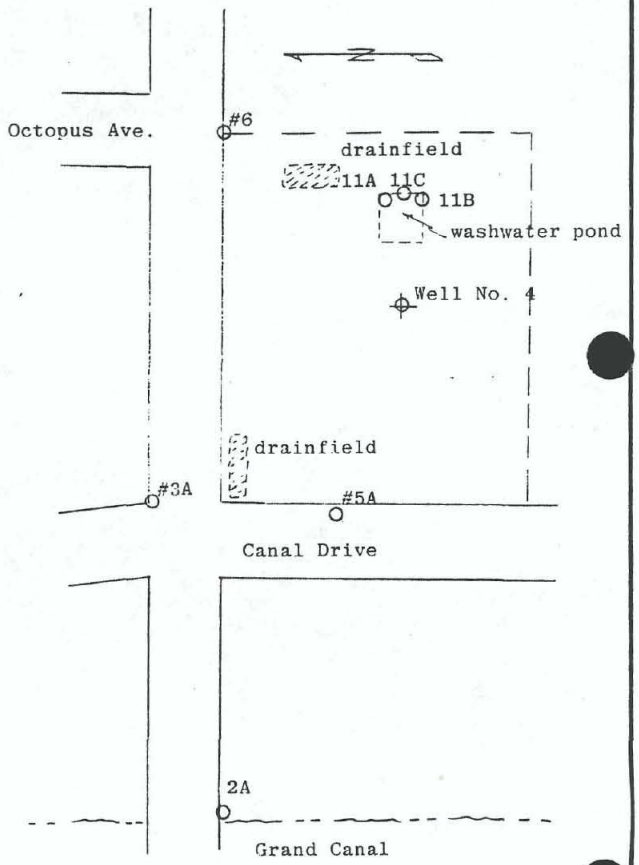
Table 1, Chemical Analyses

Piezo. No.	Fe	Mn	Color	pH
6A	.14	.003	40	8.4
11A	1.2	.04	10	7.5
11B	.78	.095	-	7.5
11C	.14	.026	-	7.6
5A	32	22	900	-
Well #4	.15	.004	45	8.4

Scale

horiz. = none

vert. = 1" = 10'



Map scale: 1" = 100'

HYDROGEOLOGICAL INVESTIGATIONS
OCEAN SHORES FILTER PLANT SITE

SCALE:	APPROVED BY:	DRAWN BY
DATE: 8/18/89		REVISED
Rongey/Associates		
		DRAWING NUMBER

11 X 17 PRINTED ON NO. 1000H CLEARPRINT

Excerpts

Hydrogeologic Investigations Shallow Ground-Water Reservoir

B, Test well and Associated Piezometer Observations

This portion of the investigation aimed primarily to evaluate the long-term effects of pumping on water quality and the influence of well water withdrawals on the neighboring surface water system. The map, Plate 2, illustrates the position of the pumping well and surrounding piezometers monitoring the cone of depression. Plates 4 and 5 describe the piezometer logs and Plate 2A the construction of well No. 4, the pumping well. Hydrographs, Plates 13 through 22 summarize the observed water levels during the pumping period.

Note that because of the long-term nature of the pumping period a short term test to provide a non-equilibrium analysis of formation permeability and theoretical boundary conditions was not considered necessary. A short-term stage drawdown test is proposed for future evaluation of well efficiency, however.

1. Water Quality

Analyses of water quality conducted by city personnel at the city's on site laboratory are summarized by Plate 52. In addition to the diagrammed constituents, hydrogen sulfide was also checked but because of the test procedure, values obtained are not considered sufficiently accurate for inclusion. Water quality from the piezometers was not monitored although several spot tests were made to evaluate differences between water at near surface and deeper levels.

As shown by Plate 52 all tested constituents exhibit reasonable stability throughout the six month period of observation. Although small trends are evident, specific conductance shows only a gradual rise from about 450 to 500 umhos/cm. Fluctuations as in November probably reflect short term periods of rapid recharge following heavy rainfall.

Chlorides were remarkably consistent at 22 ppm until the start of the fall rains, increasing sharply to 27 plus ppm, then rising further during a period of heavy precipitation in late November and early December. The assumption here is that salinity builds slightly in the surface soils from ocean spray, fog, etc., during the dry season and is flushed downward into the ground-water reservoir during the wet season. In some cases, as early December during very stormy periods, ocean spray is blown directly across the peninsula.

Color gradually increased with some unknown causes of irregularity during the dry season. Beginning with the early September rains color declined apparently because of the diluting influence of recharge. Color currently appears to be rising slightly, possibly reflecting the late December dry period.

Iron has exhibited remarkable stability and does not appear to have been significantly influenced by the fall and winter recharge. This, in spite of the occasional very high iron content of shallow sands above the 40 foot depth. Similarly manganese, although somewhat irregular, has remained well below state and federal limits despite the presence of high levels of manganese at shallow depths. The assumption here, as regards both of these constituents, is that the very high pH of the deeper ground water tends to buffer the system. Low pH but high iron and manganese water at shallow depths percolating downward and entering the high pH environment immediately drops these constituents at the interface. Neither can remain at significant levels in a high pH environment.

The source of the small amount of turbidity encountered is assumed to be silty clay from the "dirty" gravel interval screened between 87 and 93 feet, Plate 2A. Although this level of

turbidity is not likely to be a problem future production wells may require more selective screening.

The pH is similarly consistent, exhibiting only variables within the accuracy of the test equipment. The assumption again, is that the ground water system is so well buffered in the high pH range that variables in recharge sources are not significant at the rates observed.

Hydrogen sulfide is evident from the odor of the well discharge but generally tests in the 0.1 ppm range. The test is a visual chart type of color comparison and quite subjective. As a consequence the several isolated instances of 0.2 and 0.3 ppm are considered questionable.

The piezometers constructed to monitor drawdown around the pumping well were for the most part not designed for water quality sampling. Exceptions are 5A, 6A1 and 11A, B and C; all of which yielded water with wide quality variation, depending on depth and location. Piezometer 5A, 22 feet deep and located 200 feet west of the pumping well, yields water with 32 ppm iron, 22 ppm manganese, pH of 6.9 and 900 units of color. Piezometers 11A, B and C bottomed at depths of 30, 20 and 15 feet respectively, yield in order, iron of 11, .78 and .14 ppm, and pH of 6.9, 7.5 and 7.8. The deepest nearby piezometer, 6A1, at 53 feet produces water comparable to well No. 4 with .14 iron and 40 units color and pH of 8.45.

From the above, water at 30 feet and less is obviously highly variable in pH and mineral content. This was the condition encountered during the early stages of project development in the 1960's. A shallow well field at this same filter plant site using a number of 30 foot wells found the water quality rapidly deteriorating after a season of use. Iron was initially less than .3 ppm but rapidly but rapidly increased to more than 1 ppm. The difference between this past experience and the current well appears to be the well buffered, high pH character of the deeper ground water. The greater pH results in the immediate precipitation of any iron and manganese entering via ground-water recharge from shallow sources.

2. Well No. 4, Piezometers and Cone of Depression

The construction history of well No. 4 is outlined by the letter report of 4/30/89. The well now has been producing near continuously for 5.5 months with only a few hours of down time due to electrical failure. The current production is 270 gpm with the present 40 foot pumping level approximately 30 feet below the original static in April. The yield is now about 10 gpm less than that measured in mid July 10 days after startup. Maximum well yield with the drawdown to 5 feet above the screen (60 foot pumping level) is estimated in the 450 to 500 gpm range. Well efficiency tests will be required, however, for confirmation.

Water level measurements in the surrounding piezometers during the pumping period to date are illustrated by Plates 13, through 22. As shown by Section A-A', Plate 3, the piezometers are bottomed at several depths and depth has a significant influence on the observed drawdown. This is best illustrated by the hydrograph of 6A1 and 6A2. 6A2, bottomed at 34 feet with an initial static only several inches higher than its companion 6A1, maintained a water level separation of 2 to 3 feet throughout the test. The lower water level in piezometer 6A1 bottomed at 53 feet reflects the anisotropic nature of the shallow ground-water reservoir and the gradient requirements to move water from the near surface to the depth of the more permeable gravel intervals screened by the well.

The area of influence around the pumping well is reasonably symmetrical but strongly influenced by the presence of surface water sources of recharge. As shown by Plate 2, west of well No. 4 the cone of depression in the shallow piezometers steepens to the canal. The deeper piezometer, No. 2A1 drew down 0.55 feet below the minimum observed canal water level, while water levels remained above canal levels in more distant piezometers 8A and 9A. The deeper of n\most distant piezometer, 7A1, located 1400 feet east on the shoreline of Duck Lake, drew down a maximum of 0.1 feet below the minimum lake level. The water level in the companion shallow piezometer, 7A2, tracked the lake level.