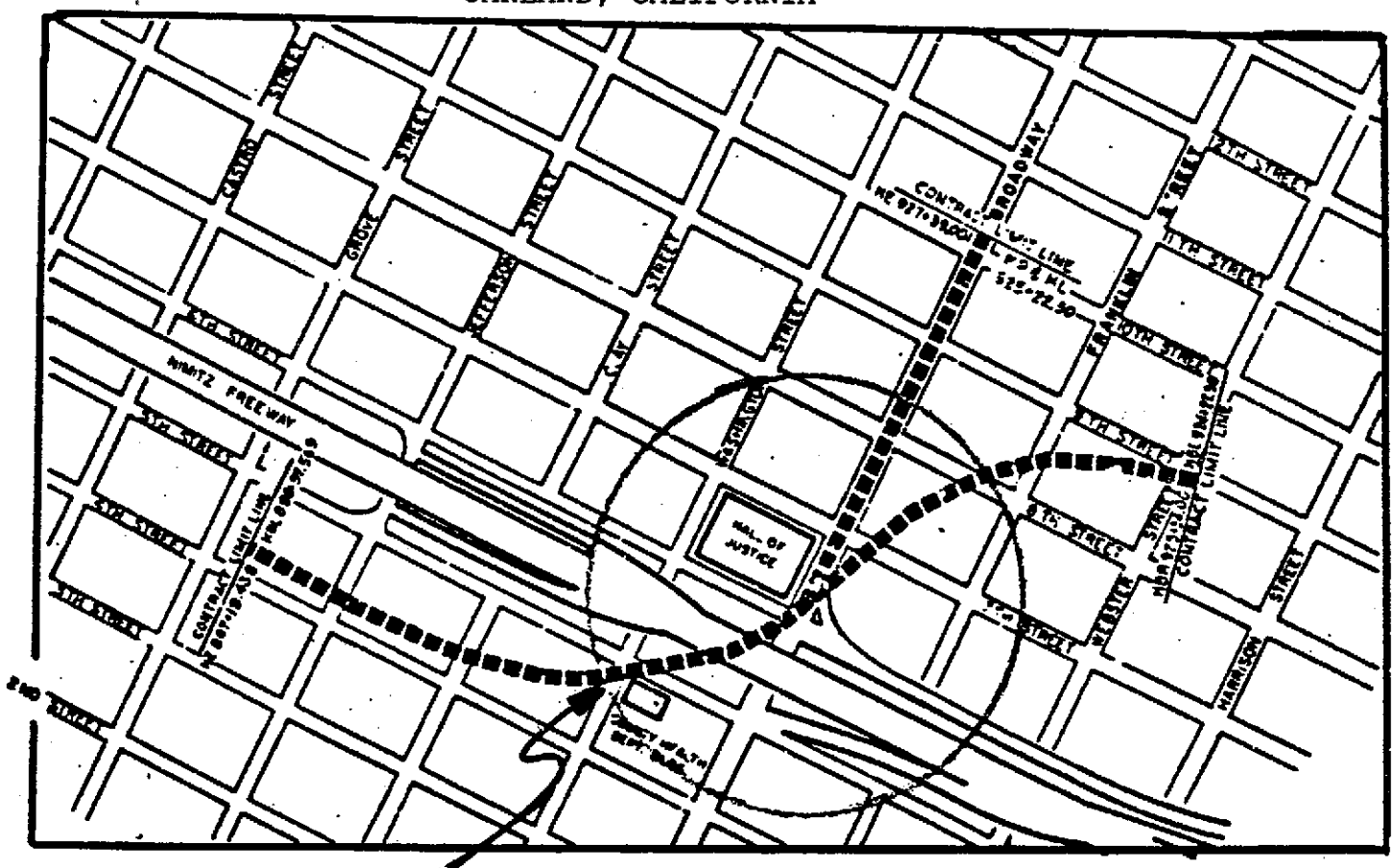
Site: Oak 461
Prof. ☐ Rem ☐
1☐ 2☐ 3☐

GROUNDWATER TECHNOLOGY, INC.

CONSULTING GROUNDWATER GEOLOGISTS

COPY

CONSIDERATIONS ON
INFILTRATION OF GASOLINE
INTO BART
K E LINE
7TH AND BROADWAY
OAKLAND, CALIFORNIA



Study Area

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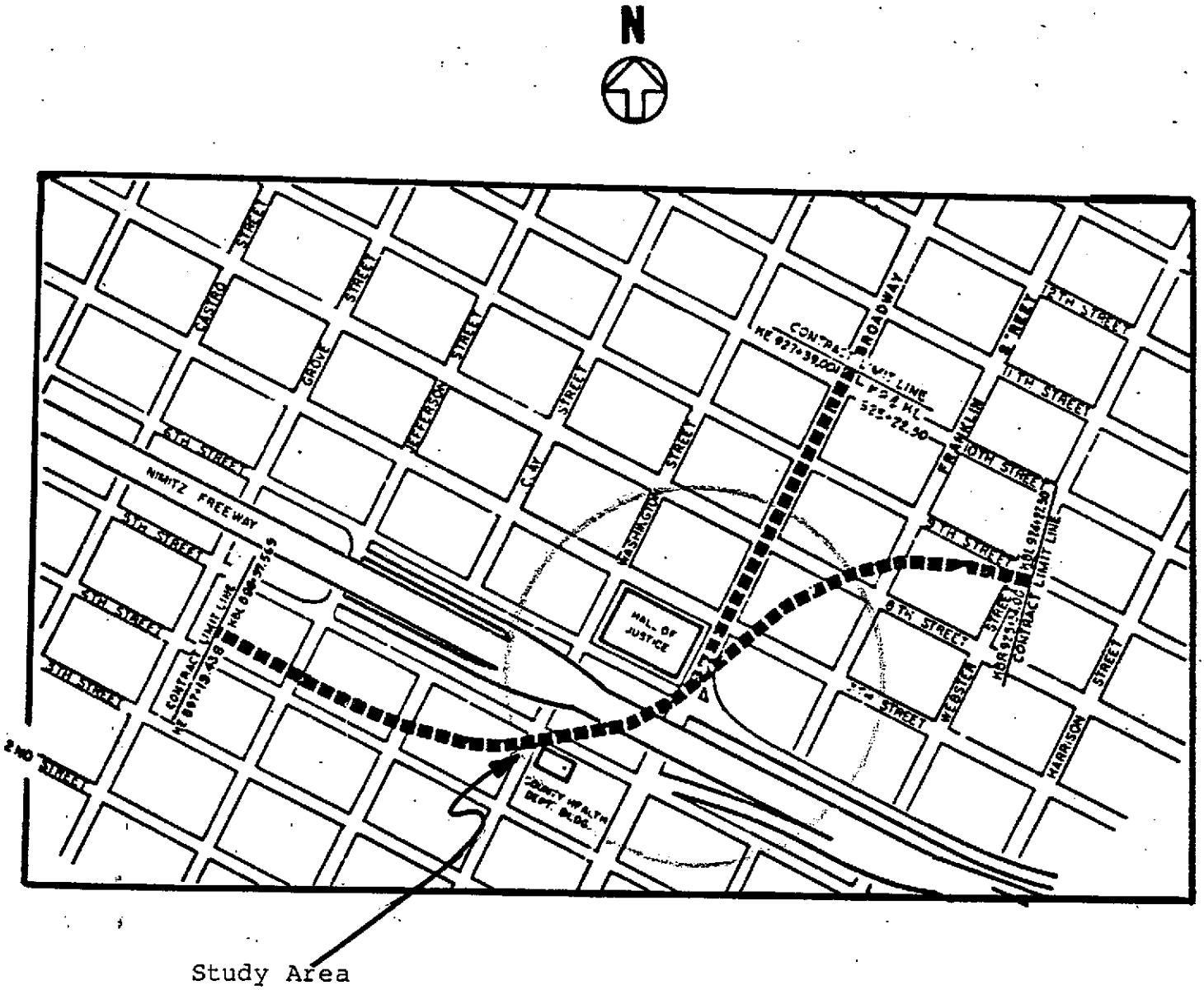
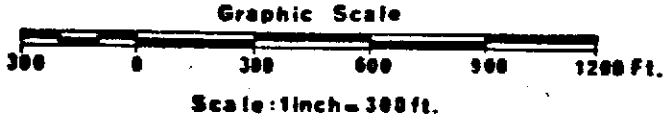


General Construction Site Plan



Scale: 1 inch = 300 ft.

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TABLE OF CONTENTS

FIGURES AND TABLES

GROUNDWATER TECHNOLOGY, INC.
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BACKGROUND:

In late 1978 early 1979 gasoline type hydrocarbons were discovered infiltrating into Bart's K.E. line below the intersection of 7th and Broadway Streets in Oakland, California.

In early 1979 Shell Oil Company, who operated a service station near the intersection of 8th and Broadway was notified of the problem and subsequently conducted a tank and line testing program that located a pressure leak on the line.

A well is reported to have been drilled on the Shell property to a depth of 25' subsequent to the suspect loss but did not encounter the water table.

Note: Available data indicates the depth to water to be 25'-30' below surface in a silty sand.

Estimated loss at the time of testing is reported at 1800 gallons from a records inventory check. Subsequent activities, post January, 79, have involved drawing off a mixture of gas and water through ports in the K.E. tube amounting to more than 80 (55 gallon) barrels of liquid estimated to contain up to 50% hydrocarbons.

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In late 1979 the problem appeared to abate only to reappear in January of 1980 possibly associated with a minor earthquake. At the current time, two spigots have been installed in the driven section of the tube, one of which yields raw product and the other an apparent mixture of dissolved gasoline and water. Seepage of the hydrocarbon/ water mixture currently enters the tube and collects and inflows into drains that convey the mixture across the active tube to a sump and pump station located on the southeast corner of 7th and Broadway. The liquid is then pumped to the surface and reported to be discharged to the storm sewer system.

Where? not on site or area map

As a result of the ongoing chronic problem, it was determined that a groundwater investigation be undertaken to assess potential sources of the product, determine mode of movement and assess potential recovery methodologies.

No

Shell will always do this inhouse

DISCUSSIONS:

Hydrocarbon contaminations of groundwater in recent years have been found to occur more frequently related both to accidental tank and line leakage. Increasing dependence of the public on groundwater wells in general, let alone groundwater use in areas adjacent to fuel storage have made this problem eminent.

Commonly the contamination problems associated with hydrocarbon loss are: odors in basements, taste or odors in wells, infiltration into storm and sanitary sewers, and seepage into utility lines. During any leak or loss of hydrocarbons, the dominating controlling force is gravity, causing product to move downward until it meets some restrictive horizon. In many cases gravity induces the product to move downward from the surface until it reaches groundwater, causing contamination of the groundwater system. In areas of low permeability, movement of product if often restricted. In these areas, product will often seek zones of increased permeability created by excavation and back fill.

This phenomenon often accounts for highest concentrations occurring in tank pits and service line trenches. However, even in areas of low permeability where some product is adsorbed on soil and earth materials, product will infiltrate through soil and rock materials until it intercepts the water table. The quantity that reaches the water table is dependent both on quantity of loss and the silt and clay fractions in the profile, i.e. greater the loss and the coarser the earth materials, the larger amount of free product that will reach groundwater. Product reaching groundwater generally exhibits itself in two ways: 1. As free product in a saturated zone atop the water table and 2. As dissolved or emulsified product in the aquifer system.

Product reaching groundwater ~~can~~ exist as ~~either~~ dissolved ~~or~~ free product ~~or both~~ moving in the subsurface along the gradient of the water table to discharge zones either natural (springs and streams) or artificial, i.e. wells, sewers and trenches. Discharge points such as springs, streams or wells that are affected by hydrocarbon contamination will generally show a series of effects ranging from increased iron and manganese which relates to reducing effects associated with the decomposition of hydrocarbons, to trace amounts of emulsified and dissolved hydrocarbons, which may lead to taste and odor problems. Eventually, if significant free product was lost partially weathered hydrocarbons and free product will evidence themselves. (See Fig. #1 and #2)

CLEAN-UP OF HYDROCARBON CONTAMINATION

In approaching clean-up and abatement of hydrocarbon contaminations one must first assess the magnitude and nature of the problem, as solutions differ according to type of problems. Once the source is stopped and the extent and magnitude known from detailed groundwater analysis, a program for recovery can be developed.

1. Where free product remains, a physical separation process using a two pump systems is most effective with 1 (one) pump creating a cone of depression and the other removing free product. (See Fig. #3&3a) GTI/ORS has successfully applied this technique in tens of cases.
   (a) As determined by Regulatory Agencies it may be necessary to secure a permit for discharge of the water or provide treatment (i.e. air stripping or granular activated carbon)

2. Alternatives to the two pump system include development of an interception trench with 1 (one) skimming pump (Fig #5) and a 1 (one) pump system pumping a mixture of oil and water to a separator (Fig. #4). There exist many variants to these types of systems. GTI's experience has been that these are applicable in some cases but not intrinsically safe from an explosion or accident standpoint and often times plaqued with problems. B.S.

3. Where dissolved product proves to be the problem, solutions tend to be more difficult and require more detailed groundwater information which is significantly more cost intensive.

   (a) One methodology of dealing with dissolved product relies on establishing a cone of depression to encompass all impacted groundwater, then passing the discharge through a coalescer unit then an air stripping unit and/or granular activated charcoal. This approach is significantly more complicated than presented here and air stripping is most effective on volatiles and carbon is quite costly due to disposal/regeneration costs.

   (b) Bio-degradation-hydrocarbons are organic compounds and like other organic compounds will degrade. From examination of groundwater systems, it has been observed that there exist a number of biologic organisms that will degrade hydrocarbons. By detailed analysis of groundwater conditions and controlling nutrients levels and oxygen levels it is possible to achieve biologic breakdown of dissolved hydrocarbons in groundwater, accelerating clean-up and return to use of the water supply. GTI's experience with bio-reclamation is that it can be a most effective tool for returning groundwaters affected by dissolved hydrocarbons to domestic use under the properly controlled conditions.

WORKSCOPE:

The scope of the work conducted by GTI was to provide investigative service to enhance definition of subsurface hydrogeological conditions, and to enhance the definition of areal extent and magnitude of hydrocarbon contamination of groundwater in the area along Broadway between 6th and 8th streets in Oakland.

WORK ITEMS CONDUCTED INCLUDED:

1. Initial onsite meeting and investigation of Bart's tube to observe first hand, existing conditions related to the infiltration of product into the K.E. tube.

2. Meeting with Bart, Shell, Crowley Environmental, City Fire and Municipal Personnel to discuss background on the case, proposed scope of action and other pertinent matters.

3. Secure permits and clearance for the location and construction of observation wells. ~~Within the suspect area of contamination~~ 7 (seven) wells ~~were constructed~~ along Broadway ~~.~~ their location is ~~shown on Fig. # 6~~)

   (a) Well logs were maintained of all materials encountered in the subsurface. Any unusual conditions were recorded in detail and are shown in Tables 1A - 1G

   Note: Well locations were based on available information indicating the site to be free of utilities. A great degree of difficulty was encountered in securing all necessary approvals for well locations.

4. The top of casing of groundwater observation points were surveyed to nearest .01 ft. and recorded in the Table and shown on the blue print designated as Figure # 11

5. Bart's existing plot plan was modified to show location and elevation of groundwater points and also to provide necessary data to Bart to assure well locations were clear of the tube.

→ not requested for chem analysis

6. Three detailed onsite sampling surveys at all observation wells were conducted to define depth to water and thickness of product. This data is shown in Table #2 and presented graphically in Figure #6.

7. Water table contour maps of area were prepared to define direction of movement of groundwater and assess migratory routes for the apparent gasoline loss.

Isopach (thickness)

8. Isopleth maps of areal extent and thickness of product were not possible to prepare (free product) as the wells constructed showed no free product accumulations.

9. Sampling and analysis of product retrieved from observation wells for comparative analysis with major product lines in area was also not possible as none accumulated in the wells. Soil samples contaminated with gasoline were collected and analysed, however, the laboratory used was not able to determine concentrations. This was related to an apparent lack of sensitivity of the analytical equipment used.

Not part of their contract

PRE-DRILLING ACTIVITIES:

Prior to initiation of any drilling activities, lengthy delays were encountered in securing clearances and easements to drill at desired locations. } Already stated

In many cases desired drilling locations could not be secured due to below ground utilities, traffic patterns and multiple jurisdiction of public agencies and private parties.

Parties whose clearances were necessary included:

Agencies	Concerns
1. Bay Area Rapid Transit	Subway Safety
2. East Bay Mud Water District	Water System
3. Pacific Telephone and Telegraph	Communication Lines
4. City of Oakland	Water Sewer & Electric Fire & Safety
5. California Transportation Authority	Edge of Right of Way
6. Pacific Gas and Electric	
7. Wells Fargo Bank	Land owner of former Shell Station
8. Oakland Police Department	Site Access Location

(Other utilities and public service organizations were also contacted but required no formal response)

In addition to permits and approvals for each of the locations GTI and the driller on the job, Cowhey Pacific Drilling, were required to secure significant additional insurance coverages. Further, local safety codes required the development of specialized drilling and waste cuttings removal techniques to meet enforced safety standards. The drilling technique used is described in Appendix #1.

TOPOGRAPHY:

The study area is within the down town area of the City of Oakland located along Broadway between 5th and 8th Streets. The area is within a zone of the city that is under going some renovation so that localized changes in topography are created daily. Despite local earth moving activities the general topographic feature by which the site would be classified is a very gentle north to south slope to flat lying terrain.
(should have included topo)

GEOLOGY:

The site as related to the problem being evaluated is underlain by recent unconsolidated sediments. The top few feet within the immediate study consist of manmade land that is basically re-worked building rubble and roadway materials. Immediately beneath the rubble is found an approximate 30' - 40' sequence of fine sands to silty sands. Below the base of the fine sandy sequence the "Bay Muds" are found, a dense plastic clay sequence.

what is geo history? Depos. Environ?

HYDROGEOLOGY:

The aquifer affected by the gasoline and seeping into the tube is under "water table" conditions within the unconsolidated sands. The average depth to water in the immediate study area varies from 14' at the southern end of the work area to a depth of 21' to 23' in the area of 7th and Broadway where the product is infiltrating into the Bart Tube. The gradient of the water table as expected from structural information and review of existing data is from north to south. i.e. Higher numbered streets to lower numbered streets. The rate of groundwater movement in the native silty sands would be expected to be in the range of 10^{-2} to 10^{-4} CM/SEC. The presence of disturbed zones from excavation and back fill with more permeable material would of course accelerate movement.

probably is estimating K not v $v = \frac{K I}{\phi}$

should estimate T + S

OBSERVATIONS AND COMMENTS:

- Product entering the Bart tube gains access at the juncture of the cut and cover section of the tube with the driven or tunneled section of the tube. not always so

- Neopreme seals in the driven portion of the tube show evidence of deterioration from the gasoline allowing greater in-flow of water and product.

- Remedial measures initiated by Crowley Environmental Services to treat the symptoms of gasoline within the tube have been effective in controlling the impacts but, do not deal with the source.

- Review of available documents and discussions with Bart Personnel and the contractor involved in the construction of the tube indicate that sections of the driven portion of the tube were grouted (back filled) with pea gravel. also cement This method of construction is reported to have been used from 7th street north.

- Logs of auger borings for the construction of the tube along Broad ~~street~~ way indicate the presence of fine sands and silty sands to depths of 25' to 30'.

- Construction documents reviewed with one of the contractors on the Bart tube development provided information that the cut and cover section of the tube is built within a bentonite slurry wall. This method of construction is reported to have been used from 7th street south. (questionable)

- A pre-drilling "crack survey" was conducted within the area of anticipated drilling with results supplied to Shell. The pre work survey indicated the presence of numerous subsidence and tension related features. The pre-work inventory documented their existnece so as to assure no causal relation to our drilling activities. I never saw this,

- All observation wells were constructed in accordance with the procedures outlined in Appendix 1. Individual drill logs and well construction are shown in Table 1A - 1G

- Sub-surface profiles encountered in the seven wells evidenced somewhat similiar profiles. General conditions encountered were medium to fine sands and clayey sands that were brown to yellow-brown in coloration.

- In wells # 1 - 6 the water table was generally encountered between 20' and 23'. At well #7, field evaluation of retrieved cuttings indicated water at higher levels, approximately 12' to 15' below grade.

- Wells # L-1 through L-6 with the exception of L-4 exhibited odors of gasoline type hydrocarbons.

- Where gasoline odors were detected they were generally observed to first occur approximately 14'-17' below grade.

- Well #4 although yielding readings of 3-5% on the combustible gas detector did not evidence any gasoline odor or product in the soil. This is not out of line with our understanding of the problem as well #4 is actually located on the other side of the tube from where gasoline is entering.

- Well #7 located along the same side of the tube as the observed seepage, but 2 blocks to the south likewise showed no evidence of gasoline. This well is located adjacent to the "cut and cover" section of the tube.

- Of the wells showing evidence of product wells #2 and #3 located along the Broadway side of the former Shell Station property indicated the greatest apparent concentrations. This is inferred in that during construction of well #2, 100% explosibility readings were noted. It also became necessary to purge well #2 with nitrogen to reduce explosive readings. Well #3 exhibited levels of explosibility at approximately 40% of LEL but also showed a thin (approximately 1 mm) accumulation of product on the well at the time of penetrating the 12' to 14' level (See Table 1B)

Should have analyzed soil samples

- Well L-5 located on the northwest corner of 7th and Broadway, closest to the inflow point of gasoline to the tube, also evidenced strong gasoline odors and explosibility levles at 80% of the LEL. Core samples recovered from 19'-22' showed gasoline saturated sand.

- Well L-6 located on the southwest corner of 7th and Broadway showed some sign of gasoline hydrocarbons but, at lower levels than at wells #1,#2,#3, or #5.

- Well #7 located on the northeast corner of 5th and Washington showed no evidence of any gasoline hydrocarbons.

already stated

SUMMARIZED CONCLUSIONS:

- Groundwater within the study area is under "water table" conditions in an unconsolidated sand to silty sand. The gradient or slope of water table trends northwest to south-east in essence moving from the higher numbered streets to the lower numbered streets. Figure # 6

- The depth to the water table in the area of study is 20'-25' below grade, such that it coincides with the depth below grade of the Bart tube.

- The reported pea gravel grout used to fill the void between the driven section of the tube and the native materials would have a significant permeability differential to the native fine grained silty sands i.e. the gravel having a much greater permeability.

- The reported bentonite slurry wall surrounding the cut and cover section of the tube would also exhibit a permeability differential to the native insitu fine sands i.e. the bentonite being much less permeable.

- The combination of pea gravel back fill behind the plates along the driven section of the tube in conjunction with the bentonite slurry wall along the cut and cover section of the fill could produce a "permeability trap" where by product moving through the native sediments adjacent to the tube could be lured to the more permeable pea gravel grout against the tube and then become pocketed where the low permeable bentonite comes in contact with the gravel fill.

- No free product was observed in the wells on 3 (three) sampling surveys conducted subsequent to the monitoring well construction. The presence of strong gasoline odors in cuttings retrieved during well development along with explosibility readings and physical appearance of the retrieved water samples at the time of drilling shows greatest traces of gasoline in the area of wells #1,#2, #3,#5 and #6.

resid. gasoline

- Greatest apparent concentrations were noted at wells # 2,#3 and #5 respectively suggesting a nearby source of product.

already stated

- Wells #2 and #3 located on the corner of 8th and Broadway at the site of the old Shell station provide the most evidence of any past loss from this site.

- It should be noted that there currently exists no data (wells) up gradient from these locations, # 2 & 3, to refute other sources further up water table gradient. It should also be noted, that if other up gradient sources of product existed they too would have the tendency to migrate toward the disturbed pea gravel zone adjacent to the tube and would not likely show up at the location of wells #1, #2, and #3 in the native sediments.

gasoline analyzed as Shell

RECOMMENDATIONS:

1. To provide assurance of no outside source of product flowing onto the former Shell station property. Three (3) additional observation well locations could be considered:

No

   (a) One (1) well should be located on the northwest corner of Broadway and 8th street.
   (b) One (1) well should be located west of well #1 toward the intersection of 8th and Washington.
   (c) One (1) well should be located to the west of well #5 toward the intersection of 7th and Washington.

2. As existing wells show no evidence of standing free product but, do indicate strong odors of gasoline, it could be possible to develop an isopleth map of dissolved gasoline concentrations that would aide in defining the source and likely current area of concentrations. This would involve a detailed sampling program for gasoline hydrocarbons. Samples collected would be analysed for gasoline hydrocarbons particularly BTX components by volatile organic analysis via gas chromatography.

No

   (a) Results obtained would be plotted on the same base map as used for water table gradient in the form of a dissolved product isopach map and be used to determine probable plume configuration.

3. Assuming that our collected information on apparent concentration and area of contamination is correct and that a permeability trap exists adjacent to the tube, a retrieval system could be developed to pull the product away from the tube. This would be accomplished via construction of a well with a pumping level lower than the base of the tube. This is a technique that has been applied many times by GTI with good sucess. If free product remains in the area it will be pulled toward the center of the cone of depression created by the pumping well. As free product collects within the cone of depression, a second product pump is used to remove the accumulated hydrocarbon. Considerations that need to be made in employing this process include:

(a) Development of a good sound well of sufficient depth and integrity of construction to allow creation of a cone of depression that will contain further movement of the lost product and re-direct it toward the pumping well. ~~Based~~ upon current data a recovery well located near L-5 would have to lower the water table at least approximately 13'-15' drop, the water level below the base of the K E Line.

Not completely true

(b) Sufficiently sized pump and setting to allow the lowering of the water table below the base of the tube to such elevation as necessary to stop further inflow of product to the subway system.

(c) Location of the well in as close a proximity to the center of the plume as possible, if product is trapped in the pea gravel adjacent to the tube, this luxury will not be available as it would have to be in the center of the intersection of 7th and Broadway. It will therefore, be necessary to locate a recovery well along the northwest corner of 7th and Broadwary. For safety purposes, all plumbing and wiring should be laid below grade in a vault.

subsidence will be minor since not much clay & little drawdown

(d) Water discharge considerations will have to be made. In the area there will likely be concerns of subsidence related to pumping activities which may dictate re-circulation of the water at a point outside the plume of contamination, but within the influence of the pumping well. If subsidence concerns are appeased and surface discharge of the water is chosen, it will likely require some form of permit or approval.

No possible subsidence problem

(e) Recovered product will have to be stored in the area of the recovery well until sufficient volume is retrieved to warrent removal. This storage tank should be located within a protected area or buried below ground.

Note: A schematic of the type of system described is attached as Figure # 3 and 3A for your further reference, a literature package on Oil Recovery Systems hadrware for physical recovery of hydrocarbons is also included.

Should surface discharge of the produced water be chosen it may be required to treat the discharge for dissolved gasoline prior to release. Success has been achieved in this area with the use of air stripping towers and granular activated carbon.

4. Should the amount of free gasoline remaining be small (this is not indicated by the product entering the tube) or the problem be more of a dissolved gasoline nature bio-degradation can be employed and be effective in resolution of the problem. The principle employed is one of accelerated biologic breakdown of the gasoline by increasing the numbers of gasoline utilizing bacteria through a program of nutrient and oxygen addition to the groundwater system. This is normally employed, once the majority of free product has been removed, which does not appear to be the situation at this location. A schematic of the process is attached as Figure # 8.

Not at this location

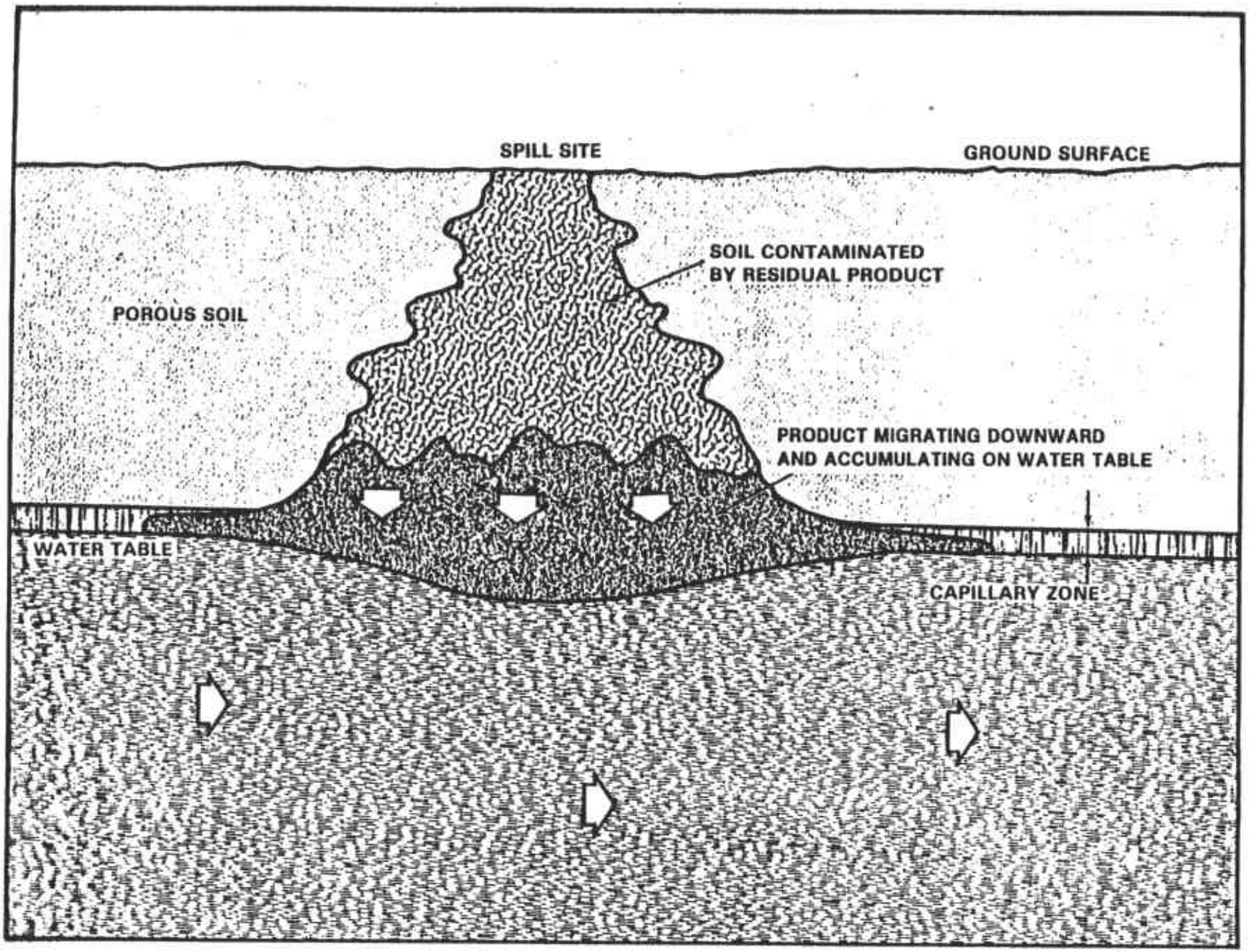

Figure #1— Typical Behavior in Porous Soil Following a Sudden, High Volume Spill

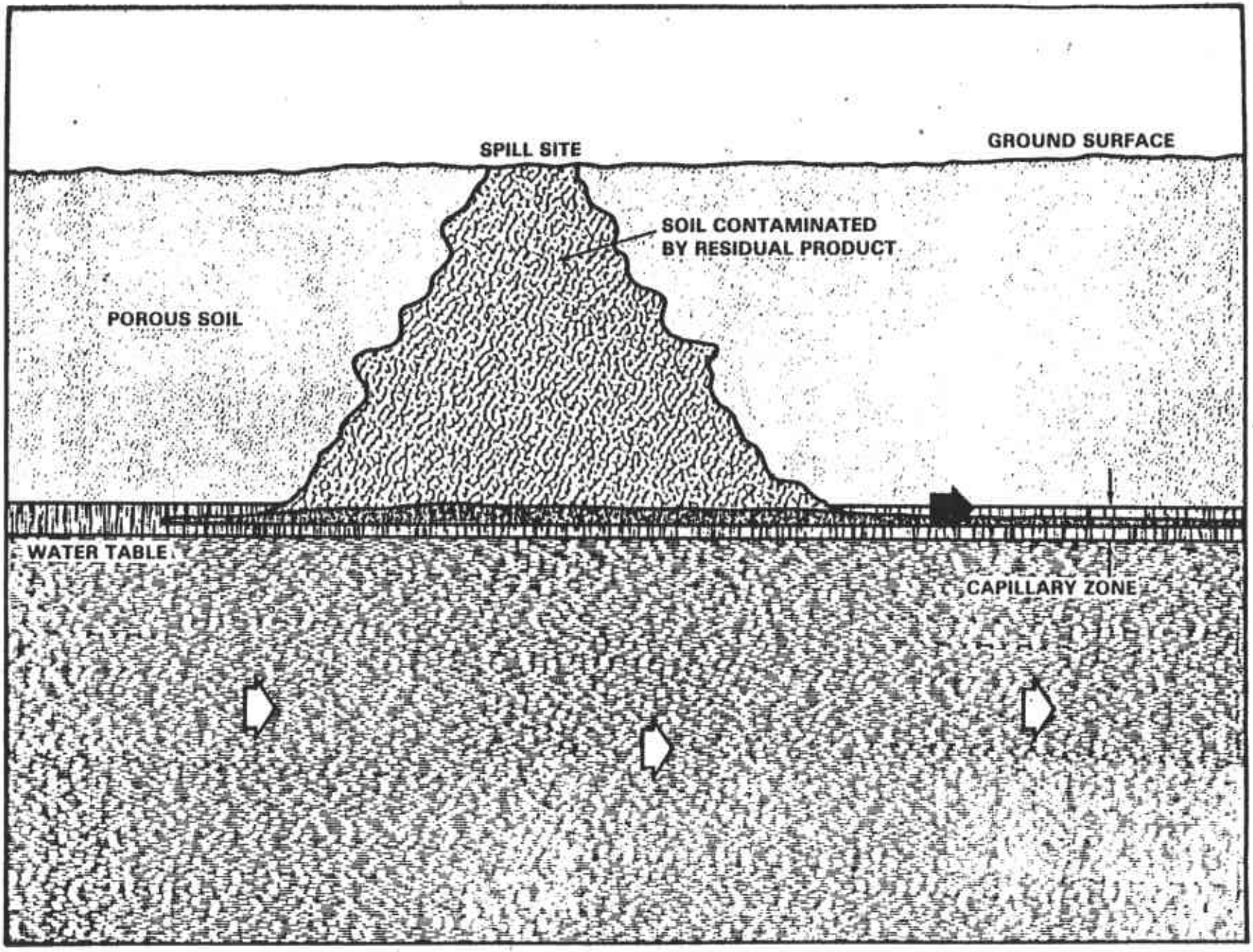

Figure # 2 - Behavior of Product After Spill Has Stabilized

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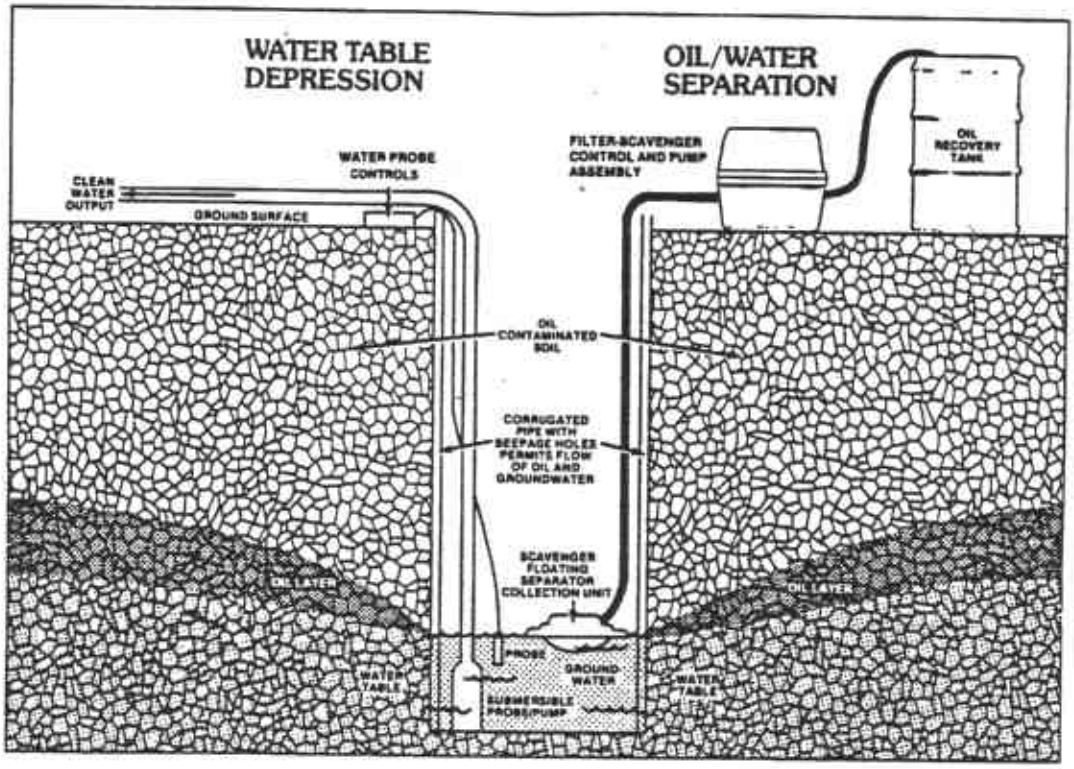
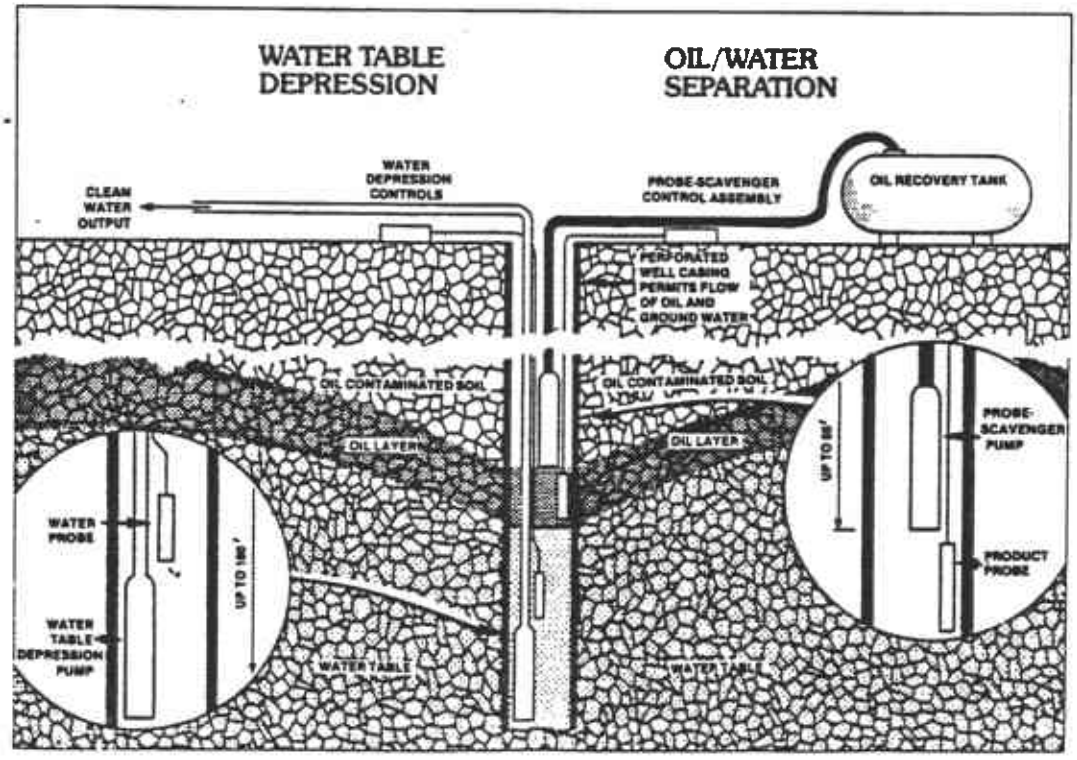
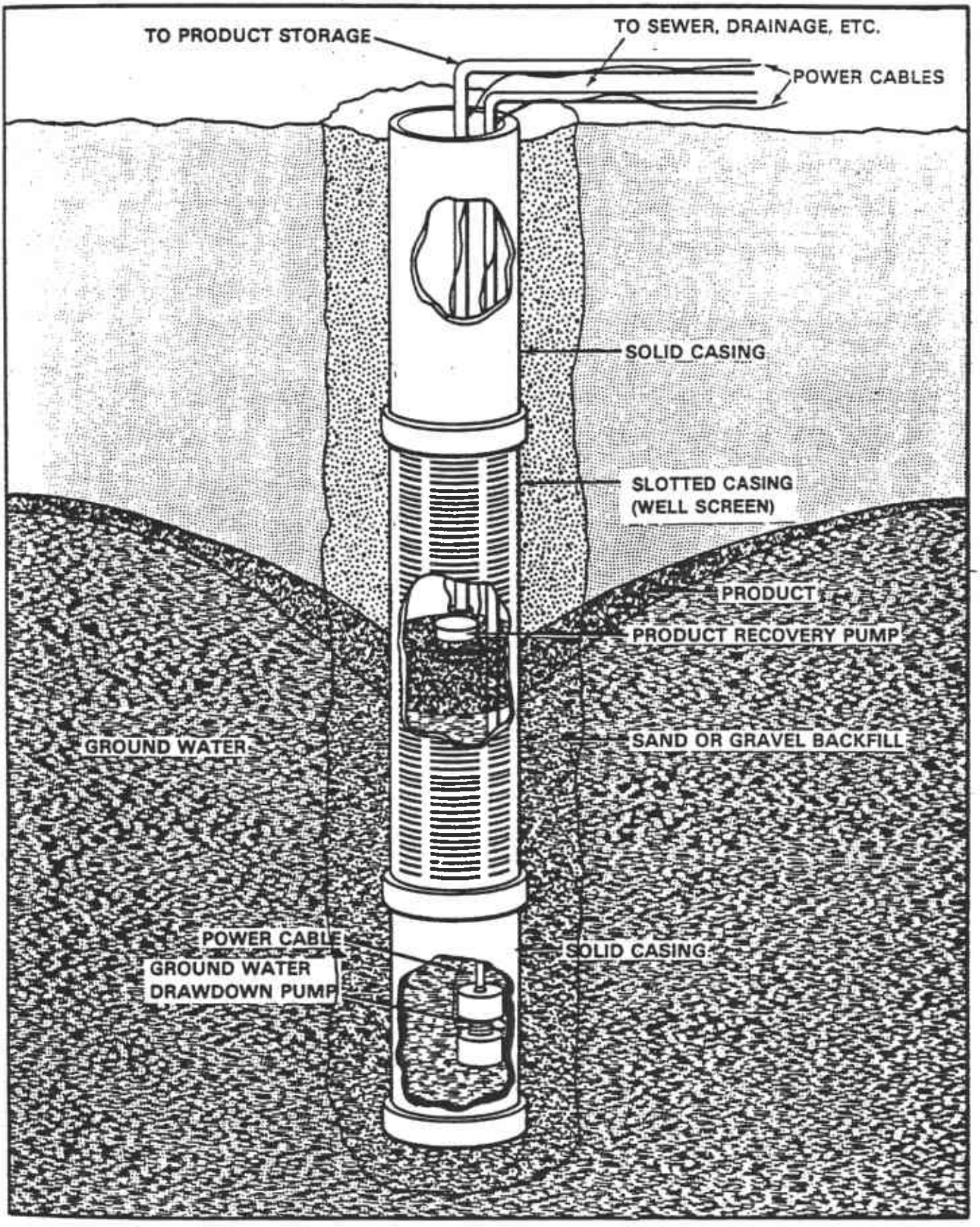


Recovery from ground water spill using Filter-Scavenger and Water Table Depression Probe- Pump.

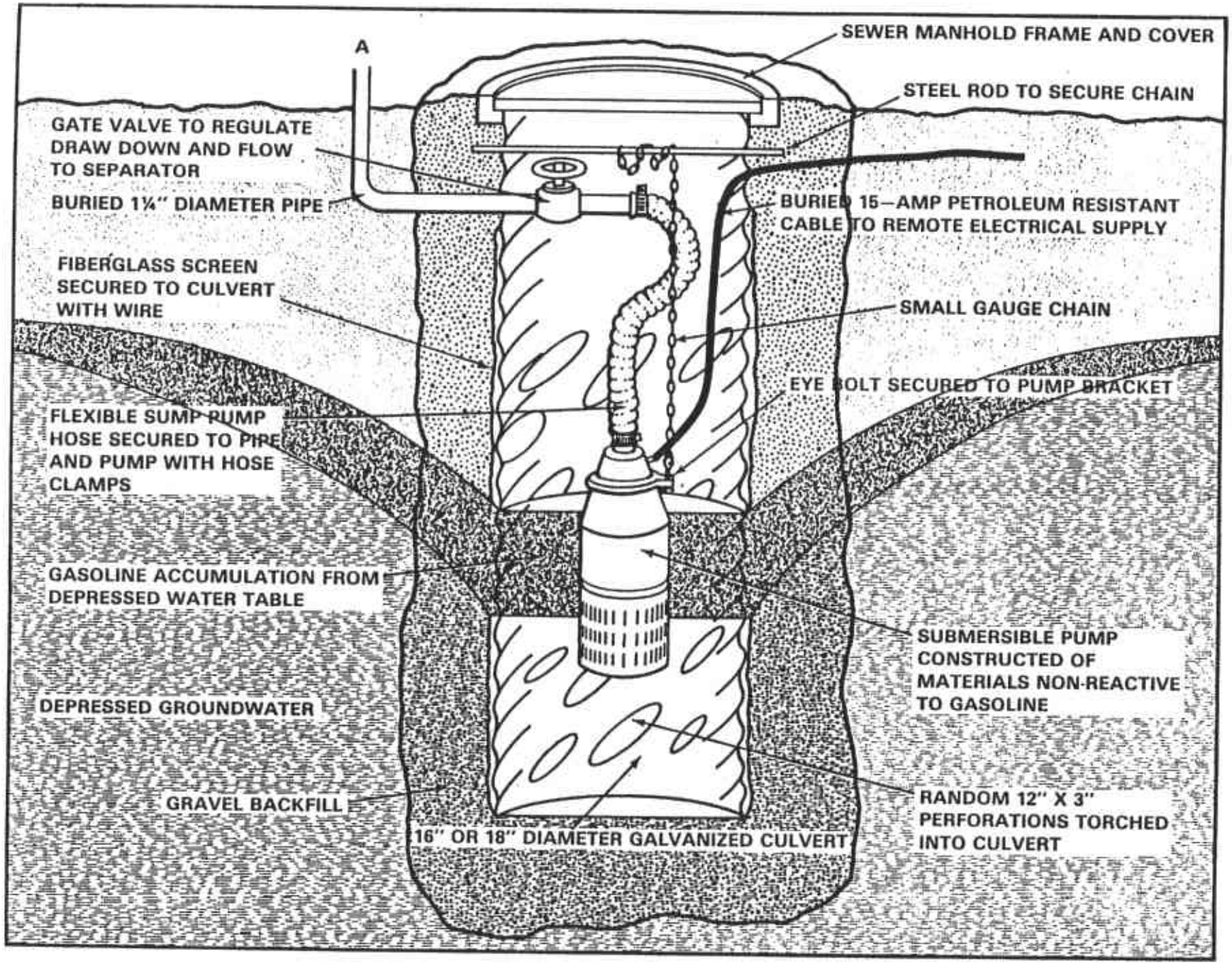


Recovery from ground water spill using Probe-Scavenger and Water Table Depression Probe-Pump.

Figure # 3

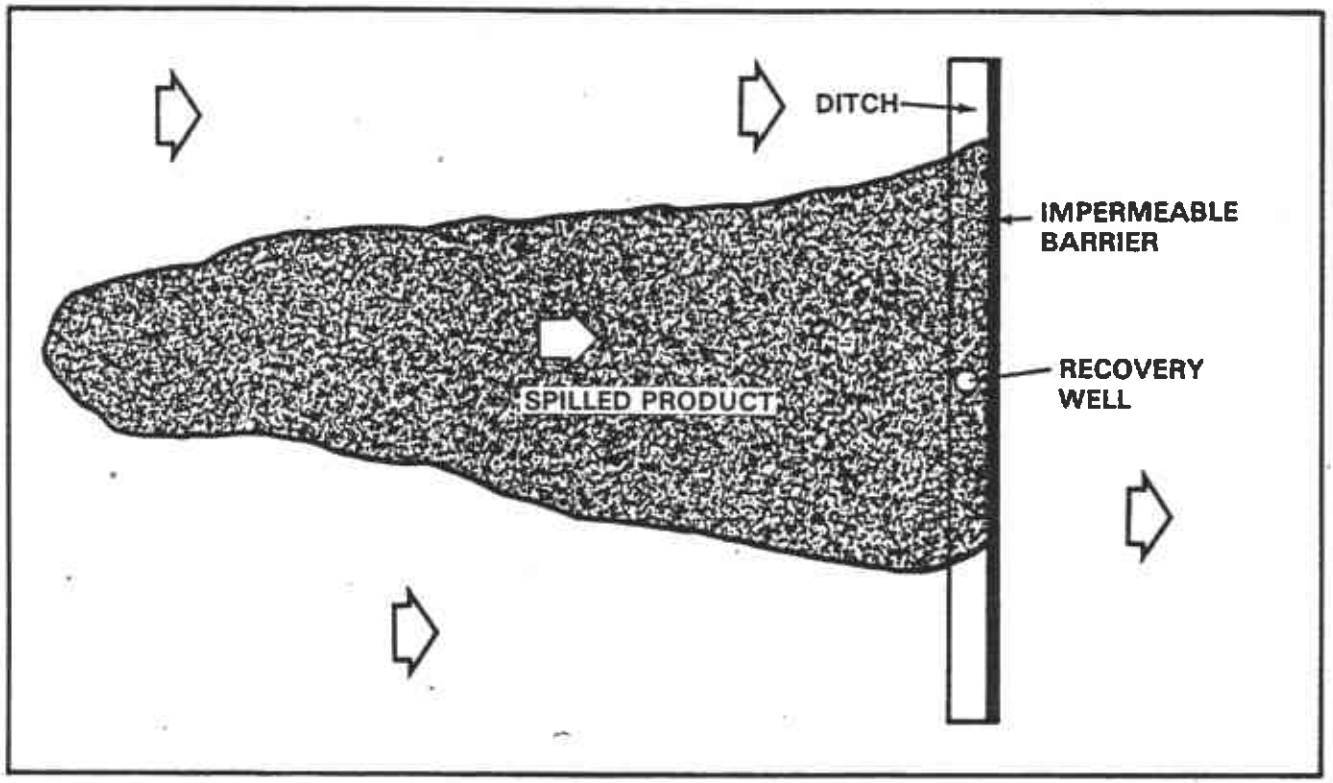


Figure# 3A - Double Pump Recovery Well

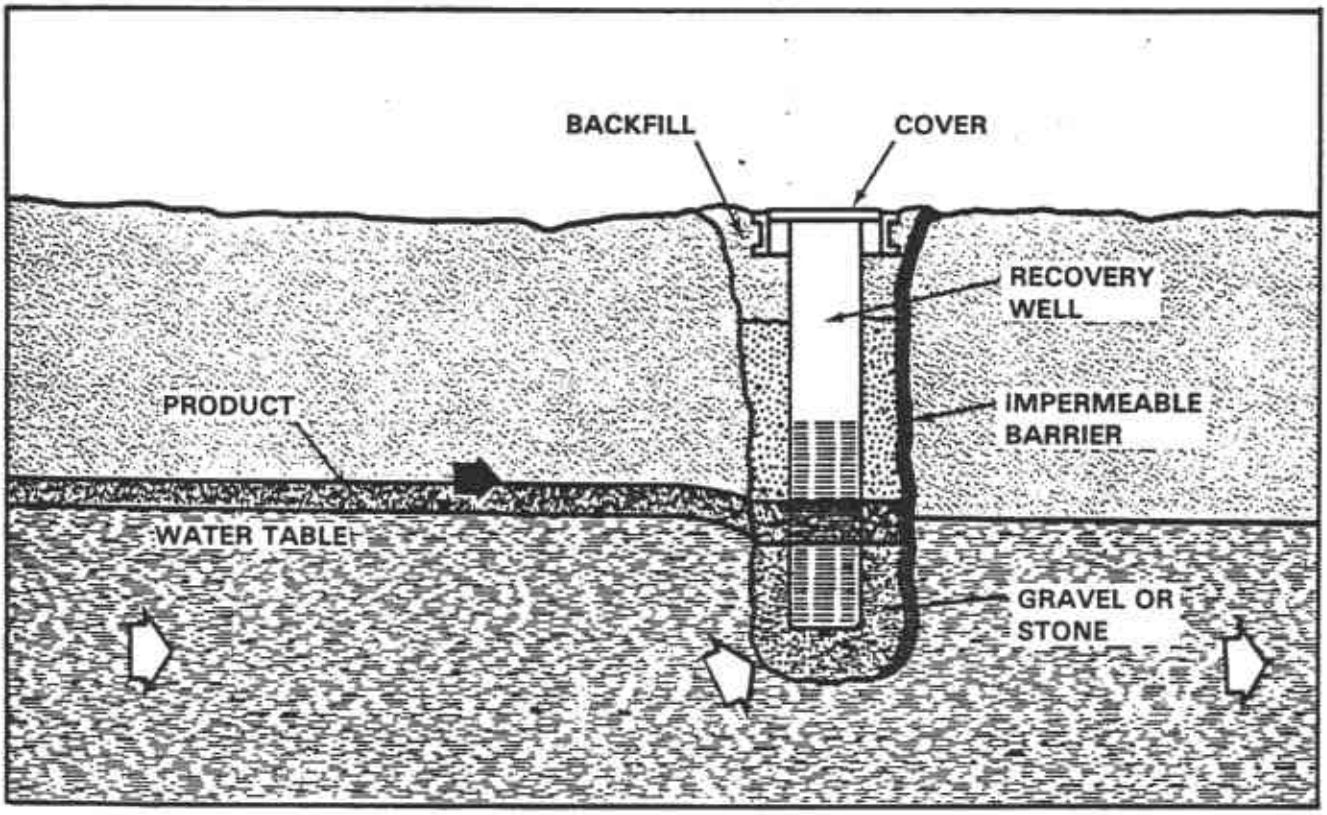


RECOVERY WELL

Figure # 4



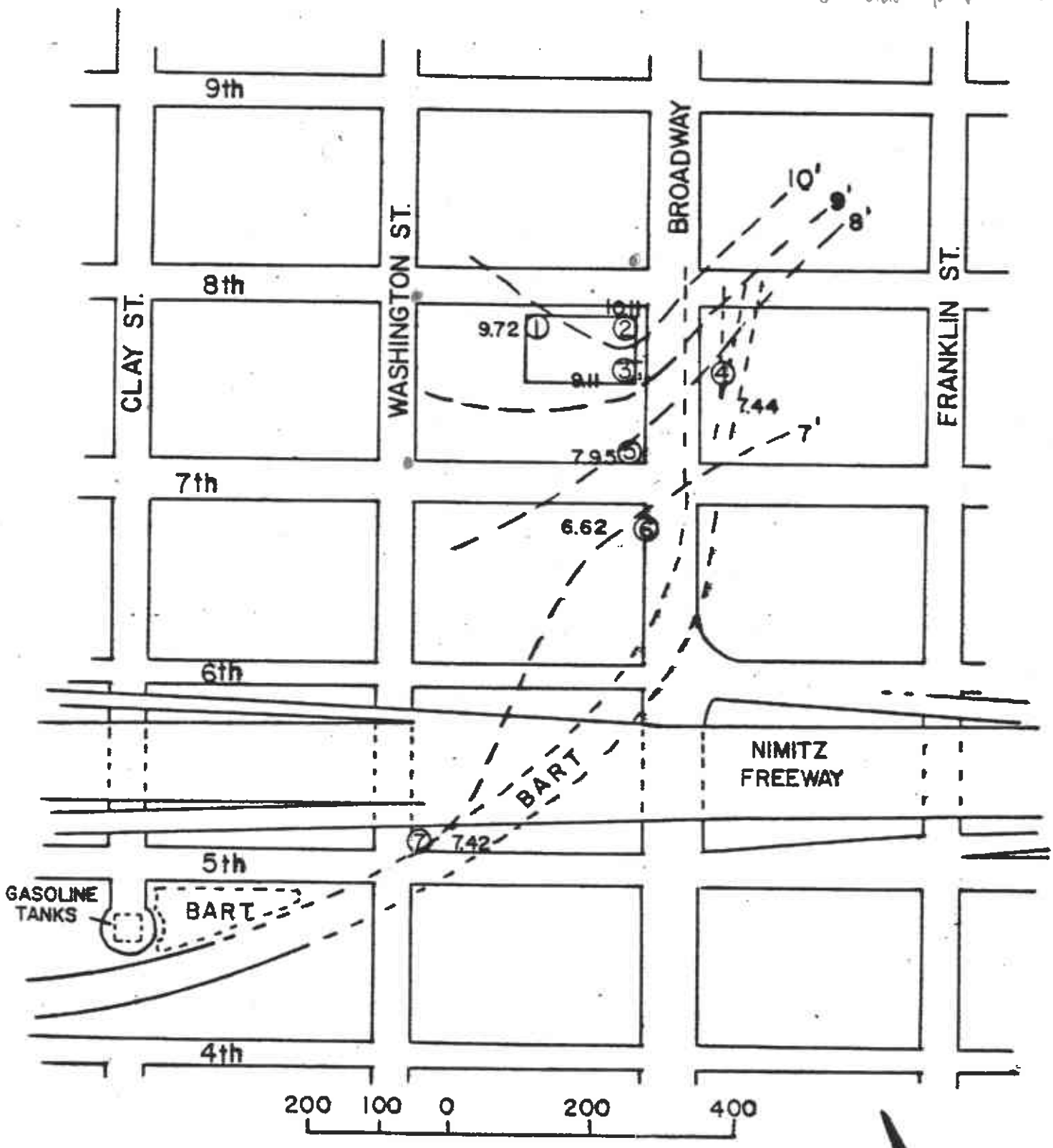
PLAN VIEW



CROSS SECTION

Figure #5 - Interceptor Trench

addnl prop. wells



WATER-TABLE GRADIANT MAP from 9/14/81

Figure # 6

- Well Locations

(2.)

Note: Water level contours are tied into verticle datum B.M.# KB 64748 at 5th & Broadway, Oakland

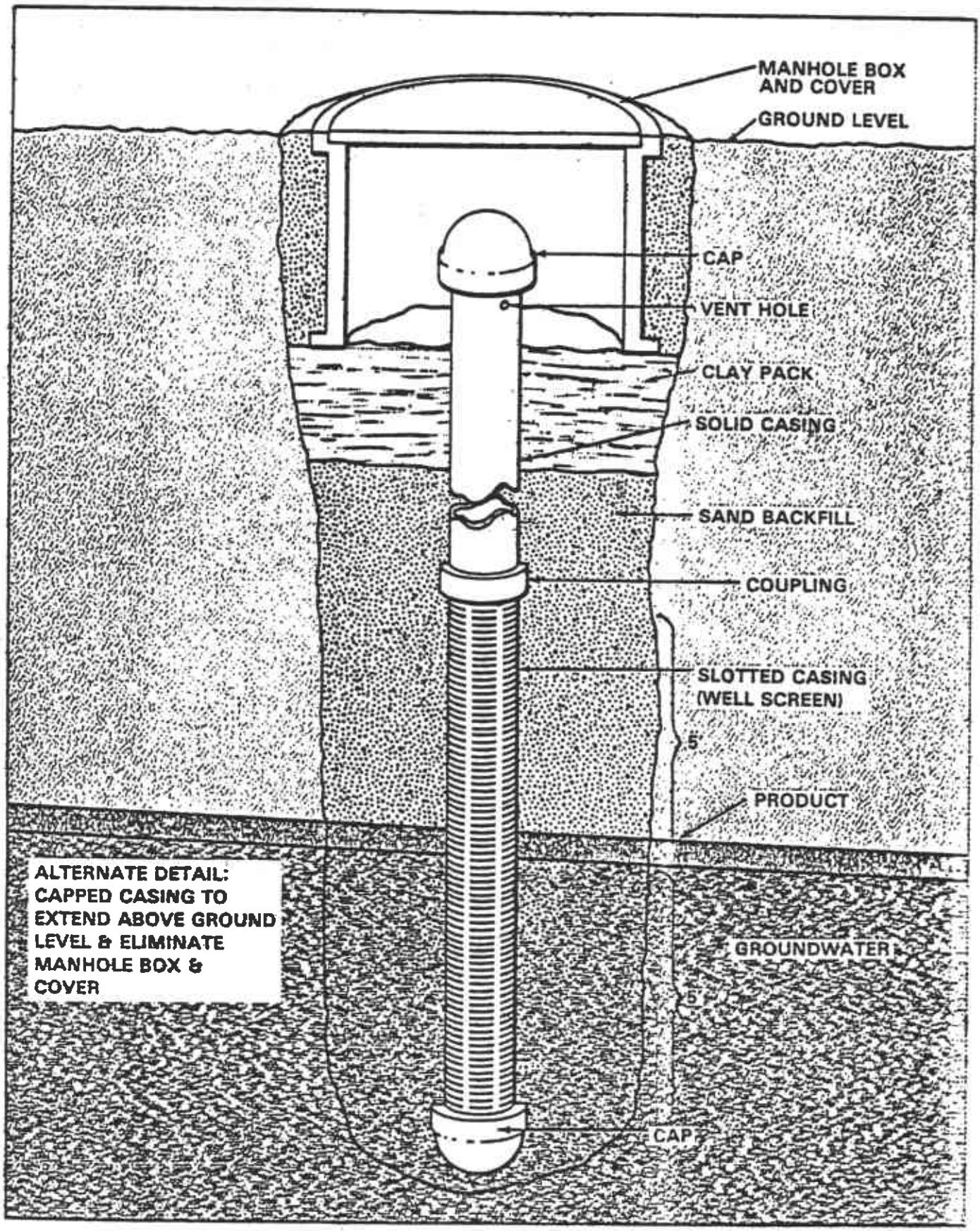


Figure # 7 – Typical Test Well

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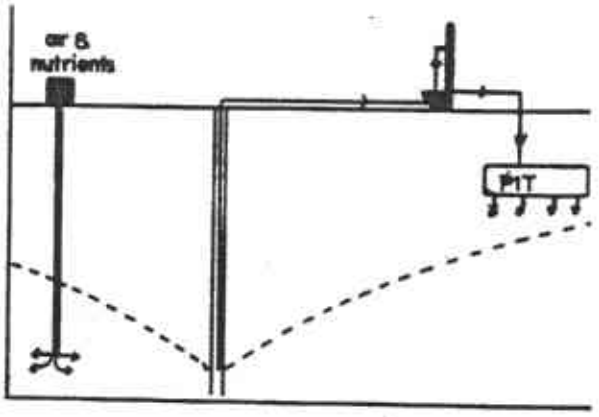

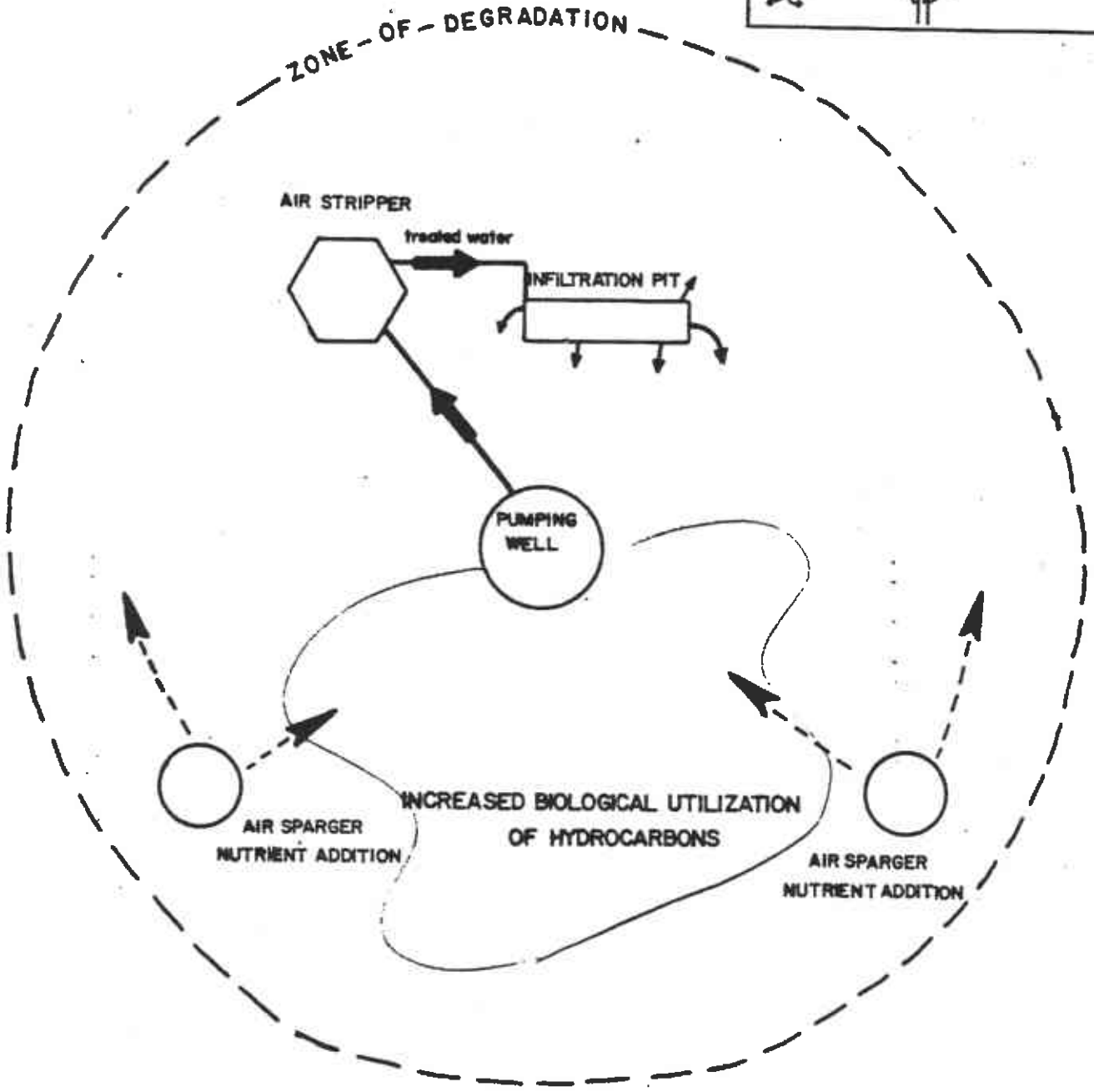

FIGURE#8 SCHEMATIC FLOW DIAGRAM AIR STRIPPING and BIORECLAMATION

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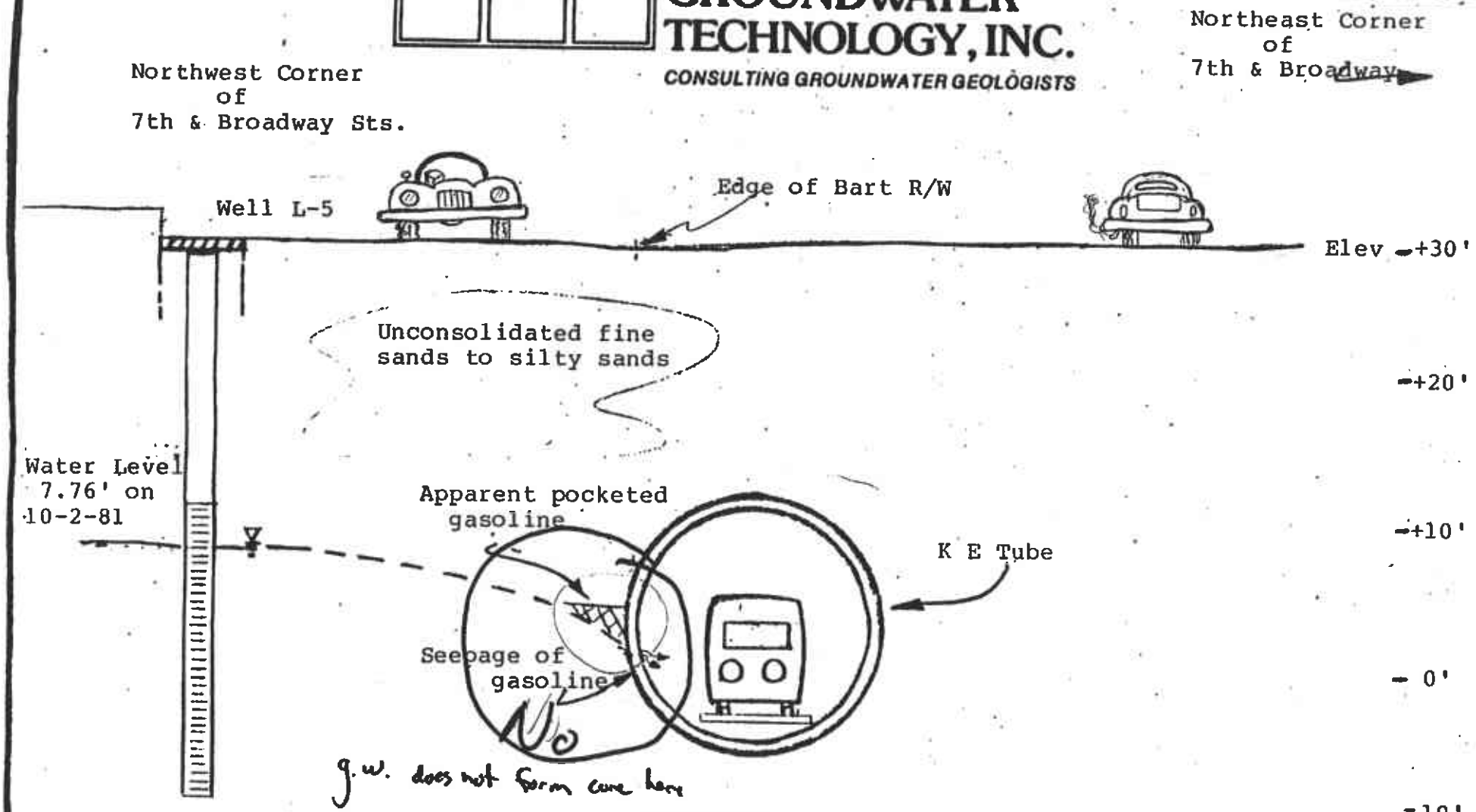

SCHEMATIC

CROSS SECTION SHOWING
INFERRED

RELATIONSHIP OF GROUNDWATER TO

BART K E LINE

Figure # 9

10-22-81 PMY

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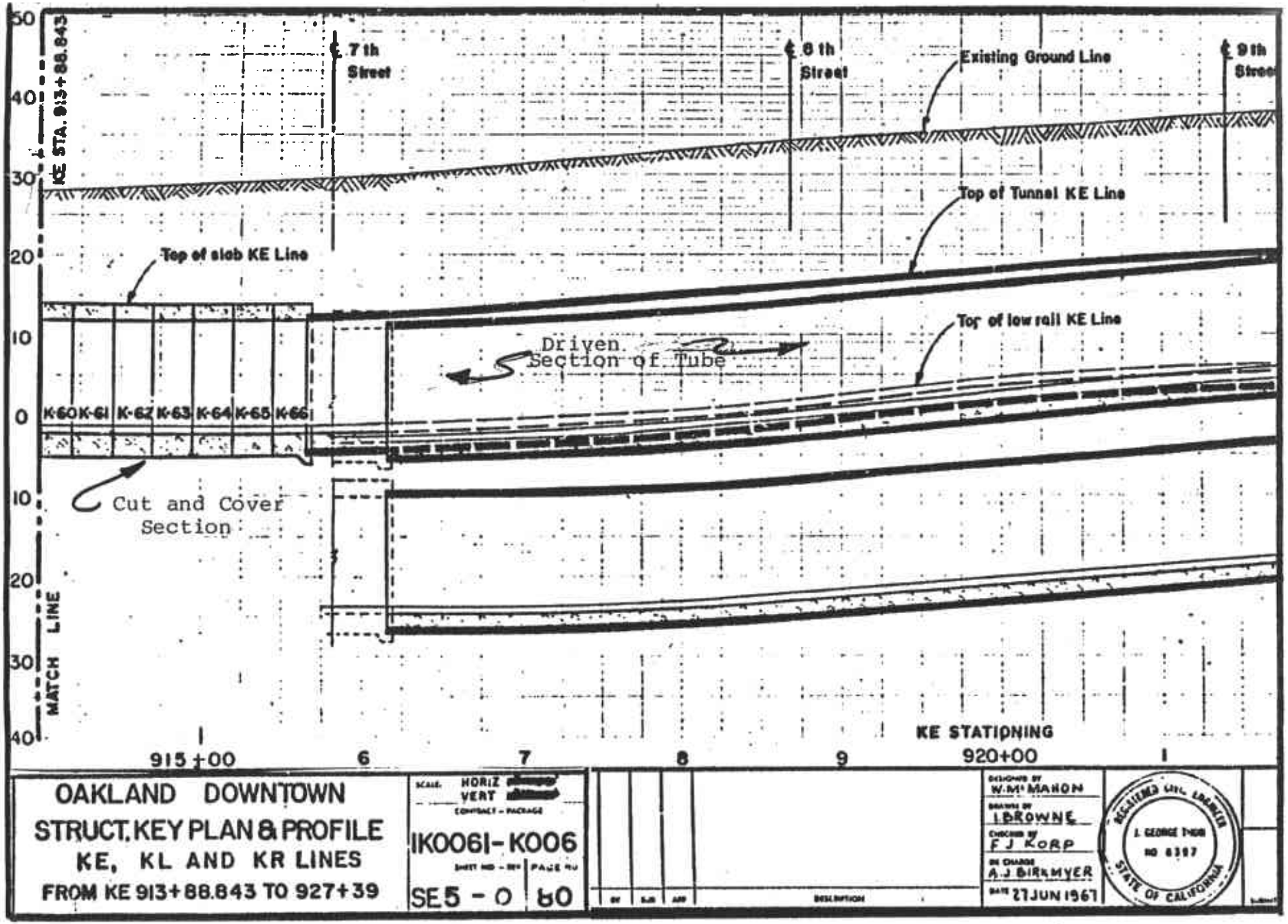


Figure # 10

Copy of portion of plans for Bart K.E. line showing contact between cut & cover section of the tube and driven section of the tube at 7th and Broadway in Oakland, California

GROUNDWATER TECHNOLOGY, INC.

Table 1A

DRILLING LOG

Project: Bart/Shell
Name: Oakland, California
Date: 8/25/81

Well Designation: L-1
Driller: Powell
Equip. Used: LDH Hughes 50' Auger

Geologist: J. Ballerino

Time	Diam	Bar	At	Interval from	Interval to		Description of Rock Cuttings	Remarks (e.g. Soft Spots)	SAMPLE #
300	12"			0	4'		Artificial Fill -	silt, sand and clay some small Pieces of brick	
				4'	7'		Yellow-brown to brown sand	- slightly damp	
				7'	10'		Becoming moist, plastic, clayey sand		
				10'	17'		Increasing in clay: clayey	sand	
					17'	Lowered Gas	Tech probe: reads 40%	What is sand g.s.?	
				18'	22'	Damp brown	sand yellow & red streaks	smells of gasoline	
				22'	24'	continues	lt. brown sand - water table	begins @ 23'	
300	12"			24'	30'	cont'd sand	and water		
							Hole cased w/4" PVC; 10'	of .020" screen and 20' of unslotted PVC	
							Gravel packed w/ pea gravel		
									Sample No. L-1

32

GROUNDWATER TECHNOLOGY, INC.

Table 1B

DRILLING LOG

Project: Bart/Shell
Name: Oakland, California
Date: 8/26/81

Well Designation: L-2
Driller: Powell
Equip. Used: LDH Hughes 50' Auger

Geologist: J. Ballerino

Time	Diam	Bar	At	Interval from	Interval to		Description of Rock Cuttings	Remarks (e.g. Soft Spots)	SAMPLE #
0945	12"			0	6'		Artificial fill: brown sand - concrete, asphalt and rock		
				6'	7'		begin clayey sand: light brown to yellow brown, damp		
				7'	10'		well sorted brown sand, some darker streaks		
				10'	12'		small fraction of clay binder		
				12'	15'		loose, unconsolidated uniform sand - moist	(what is g.s ?)	
				15'	16'	Gas detector reads 14% slight gasoline smell			
				16'	18'		cont'd brown, uniform sand, damp		sample no. L-2
				18'	19'	gas detector reads greater than 100% - purged with nitrogen			
				19'	23'	no smell cont'd damp brown sand - (well sorted)			
				23'	24'	begin water seepage			
				24'	26'	hole caving from water			
1530	12"			26'	30'	hole kept open only to 26'			
							cased with 4" PVC 10' of slotted .020" screen 20' of regular PVC;		
							gravel packed.		
						Note:	It was necessary to drive casing 4' into sand due to caved condition		
							at bottom of hole.		

GROUNDWATER TECHNOLOGY, INC.

Table 1C

DRILLING LOG

Project: Bart/Shell
Name: Oakland, California
Date: 8-27-81

Well Designation: L-3
Driller: Powell
Equip. Used: LDH Hughes 50' Auger

Geologist: J. Ballerino

Time	Diam	Bar	At	Interval from	Interval to	Pressure	Description of Rock Cuttings	Remarks (e.g. Soft Spots)	SAMPLE #
900	12"			0	4'		Sand, silt and clay, fill, bits of debris and rock		
				4'	6'		begin uniform grained, damp yellow brown sand		
				6'	9'		some clayey sand		
				9'	11'		cont'd brown sand slight gasoline smell		
							detector reads: 10%		
				11'	12'		damp, uniform sand - some gray sand		L-3 #1
				12'	14'		slight gasoline smell(thin 1mm seam on water of gasoline)		#2
				14'	16'		gas detector reads: 10% sand		
				16'	18 1/2'		gas detector reads: 40% sand		#3
				18 1/2	19 1/2		slightly stiff w/ clay - sand	g.s.?	
				19 1/2	21'		some gray sand mostly brown sand		
							stronger gasoline smell		#4
				21'	27		water infiltration		
				27'	30'		caving in water-logged sand -re drill		
							several passes to 37' - casing lowered		
							10' of slotted 4" PVC; 20' of reg. PVC		
00	12"						Gravel packed -		

3st

GROUNDWATER TECHNOLOGY, INC.

Table 1D

DRILLING LOG

Project: Bart/Shell
Name: Oakland, California
Date: 8/31/81

Well Designation: L-4
Driller: Powell
Equip. Used: LDH Hughes 50' Auger & Barrel

Geologist: J. Ballerino

Time	Diam	Bar	At	Interval from	Interval to	Description of Rock Cuttings	Remarks (e.g. Soft Spots)	SAMPLE #
:00	12"			0	4'	Fill: sand-silt-clay, rock, debris, concrete and bricks		
				4'	7'	light brown sand (backfill?) some clayey sand		
						slightly moist clayey sand - gas detector: Nil		
				7'	13'	cont'd moist sand - some gray sand mixed		
						detector reads: 3%		
				13'	16'	cont'd moist sand - minor clay, detector reads: 5%		
				16'	21'	brown moist sand - layered gray sand		
				21'	23'	cont'd sand - spoon sample - wet		L-4 #1
				23'	24'	bucket grinding put on auger - clear		
				24'	31'	caving from water at 22' -	g.s.?	
						cont'd drilling out to 35' +		
						able to place 30' of casing:		
						10' slotted PVC @ .020"		
						20' regular PVC		
:00	12"					Gravel packed - no evidence of gasoline		

35

GROUNDWATER TECHNOLOGY, INC.

Table 1E

DRILLING LOG

Project: Bart/Shell
Name: Oakland, California
Date: 9/2/81

Well Designation: L-5
Driller: Powell
Equip. Used: LDH Hughes 50' Auger

Geologist: J. Ballerino

Time	Diam	Bar	At	Interval from	Interval to		Description of Rock Cuttings	Remarks (e.g. Soft Spots)	SAMPLE #
00	12"			0	5'		Inside drop inlet - storm drain broadway		
							invert elev: -5' below street level		
				5'	7'		fill sand - gas detector: 7%		
				7'	13'		moist brown sand; gas detector: 10%		
				13'	14'		begin wet sand - smells of gasoline		
				14'	15'		gas detector: 15%		#1
				15'	19'		spoon sample-loose sand		
					19'		detector reads: 50%		#2
				19'	22'		sand saturated with gasoline; reads: 80%	g.s ?	
				22'	23'		encountered water - begin revert		
				23'	27'		caving sand - revert not holding well		
				27'	32'		cont'd sand - in water table		
							strong gasoline fumes		
				32'	40'		becoming more compact sand		
							some clay- (gray to gray-green)		
				40'	42'		dense, stiff clay- bay mud - bottom hole		
							cased with 20' slotted PVC .020" (4")		
00	12"						17' regular PVC & gravel packed		

36

GROUNDWATER TECHNOLOGY, INC.

Table 1F

DRILLING LOG

Project: Bart/Shell
Name: Oakland, California
Date: 9-3-81 & 9-8-81

Well Designation: L-6
Driller: Powell
Equip. Used: LDH Hughes 50' Auger

Geologist: J. Ballerino

Time	Diam	Bar	At	Interval from	Interval to	Description of Rock Cuttings	Remarks (e.g. Soft Spots)	SAMPLE #
.000	12"			0	2'	Street concrete and old cobblestones		
				2'	4'	mixed fill and cobbles		
					4'	begin brown sand -		
				4'	10'	sand fill some small pieces brick and rock		
				10'	16'	cont'd sand and clayey sand - moist		
					16'	slight gasoline smell ?	- stopped	#1
:30						hole 9-3-81 to prepare revert		
:00	12"	9-8-81		16'	20'	cont'd sand, gas detector reads: 35%		#2
				20'	24'	slightly clayey sand		
					24'	top of water table - caving sand	(g.s)	#3
				24'	30'	revert introduced		
				30'	34'	wet gray-brown clayey sand		#4
				34'	40'	sand to clay - top of bay mud		
				40'	42'	stiff, dense clay - bay mud		
						placed 40' of casing: 20' slotted PVC .020'		
						and 20' reg. PVC - collar of casing 2" below street level		
:00	12"					Gravel-packed		

GROUNDWATER TECHNOLOGY, INC.

Table 1G

DRILLING LOG

Project: Bart/Shell
Name: Oakland, California
Date: 9-10-81

Well Designation: L-7
Driller: Powell
Equip. Used: LDH Hughes 50' Auger

Geologist: J. Ballerino

Time	Diam	Bar	At	Interval from	Interval to		Description of Rock Cuttings	Remarks (e.g. Soft Spots)	SAMPLE #
1030	12"			0	5'		2" asphalt - damp, loose light brown sand		
				5'	12'		cont'd loose brown sand		
				12'	16'		gas detector: Nil - moist sand		
				16'	17'		spoon sample - no gasoline smell		#1
				17'	18'		wet sand becoming slightly clayey-mottled		
					18'		top of water table caving sand		
				18'	24'		cont'd caving - placed revert		
					24'		much water - "quicksand"		#2
				24'	34'		cont'd slow drilling with revert		
					34'		sand - brown - some gray revert "weak"	g.s?	#3
				34'	40'		becoming clayey sand - (no gasoline smell)		
700	12"			40'	41'		end hole in clayey sand - gray to brown		
							cased with 20' slotted PVC .020" (4")		
							and 20' regular PVC		
							Gravel packed		

Table # 2

GROUNDWATER TECHNOLOGY, INC.
CONSULTING GROUNDWATER GEOLOGISTS

Project: Shell - Bart
Date: _____

Well: _____

PRODUCT THICKNESS KEY
0 - Slight odor of Product
1 - Thin film of product
2 - Slight odor neither product or sewage
3 - Sewage odor

Depth to water measured in Monitoring Wells

Date	Note	1	2	3	4	5	6	7						
	ELEV.	33.54'	32.69'	31.94'	31.94'	28.96'	28.10'	20.04'						
		30.45'	30.3'	31.38'	27.55'	20.8'	40.35'	38.55'						
8-28-81	DTW	23.75	22.40	22.72										
	DTOP	23.75	22.40	22.72										
	Product Thick.	0[1]	0[2]	0[2]										
	Elev. of water	9.79'	10.3'	9.22'										
9-14	DTW	23.82'	22.58'	22.83'	24.5'	21.01'	21.48'	12.62'						
	DTOP	23.82'	22.58'	22.83'	24.5'	21.01'	21.48'	12.62'						
	Product Thick.	0[1]	0[1]	0[1]	0	0[1]	0[3]	0[3]						
	Elev. of water	9.72'	10.11'	9.11'	7.44'	7.95'	6.62'	7.42'						
10-2	DTW	23.83'	22.63'	22.75'	24.6'	21.20'	21.51'	14.72'						
	DTOP	23.83'	22.63'	22.75'	24.6'	21.20'	21.51'	14.72'						
	Product Thick.	0[1]	0[1]	0[2]	0[4]	0[1]	0	0[3]						
	Elev. of water	9.71'	10.06'	9.16'	7.34'	7.76'	6.59'	5.32'						

Note: Elev. is street grade

Total Depth Drilled

Should show schematics of wells w/ samples. Where are screens set?

APPENDIX 1

DRILLING SCHEDULE

1. Obtain clearance on all drill sites from appropriate parties.

2. By detailed land survey, locate the perimeter of the Bart tube.

3. Spot locations of observation wells on Bart base map drawings for assurance of location outside the subway structure.

4. Cut concrete or macadam with core barrel.

5. Advance drill rate slowly for top 10' of well, with regular hand probing attend to determine presence of utilities.

6. Sample air in boring for combustible gases with a portable down hole explosimeter.
   (a) If combustible gases were detected, back-up safety equipment was maintained on site to deal with potential problems which included:
      1. Let hole stand for 10 minutes and re-sample. If explosive concentrations persisted on site equipment included:
         - Nitrogen tank wagon to flood hole with an inert gas
         - Back-up foaming equipment to smother any potential fire.

7. Once the water table was encountered hole stability became a problem due to the development of "quick" conditions.

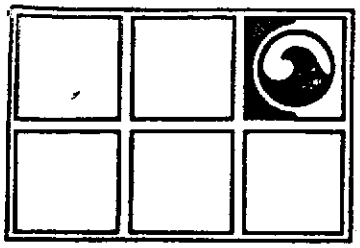
B.S.

(a) In order to rectify this problem the use of a drilling fluid "revert" was employed to stabilize the hole until the screen and casing could be set. The "revert" is a regressive polymer that has a high density when mixed and reverts back to the density of water in 2-3 days. It also helps to minimize the potential of developing explosive conditions.

Note: All equipment was maintained as stand-by on each hole, only 1 (one) incident warranted application of the nitrogen (well L-3).

8. Wells were completed using .02 PVC well screen and solid PVC casing above the water table. The annulus between the 4" casing and the bore hole were filled with pea gravel to within 3' of the surface. The remainder of the annulus below grade was filled with cementaceous grout. Typical well construction is shown as Figure # 7.

9. All cuttings were contained within a specially designed chamber to catch cuttings falling off the drill bit with any contaminated materials transported off site in a leak proof roll-off container for proper disposal.



GROUNDWATER
TECHNOLOGY, INC.
CONSULTING GROUNDWATER GEOLOGISTS

10 August 1981

Mr. Frank Linville
BART District
800 Madison Street
Oakland, California 94607

Dear Mr. Linville:

The following paragraphs describe proposed locations of test wells to be drilled near BART facilities. These wells, drilled for Groundwater Technology, Inc., by Cowhey-Pacific Drilling Co., are to be drilled in the general vicinity of 7th and Broadway, Oakland, California.

The purposes of the wells are three-fold:

1. To determine the depth and configuration of the water table;

2. To determine the thickness of hydrocarbon product floating on the water table;

3. To establish the most practical location of a well for removal of the product.

Sincerely,

Paul Yaniga
General Manager

Test Wells 1, 2 and 3 are to be drilled on the site of the Shell Station at the southwest corner of 8th and Broadway.

Test Well 1: 5 feet south of the south edge of sidewalk along 8th Street and 5.5 feet east of wall of existing building. (These locations are fields staked and tied with blue ribbon.)

2: 11.5 feet south of south edge of sidewalk along 8th Street and 5 feet west of west edge of sidewalk along Broadway.

3: 14.25 feet north of Bank of America building (about 75 feet south of test well 2) and 5 feet west of west edge of sidewalk along Broadway.

4: On BART property at southeast corner of 8th and Broadway. 63 feet east of edge of sidewalk along Broadway and 33 feet west of fence line, Bank of Canton, and 50 feet south of parking meters at curb of 8th Street. Roughly, the site lines up with the second parking meter on 8th Street, projected southward parallel to Broadway, and between a tree and the A in the word Canton, on the baknk building.

5: On the northwest corner of 7th and Broadway, in a storm-sewer along the west side of Broadway, adjacent to the sidewalk, and just north of the walkway (pedestrian crossing) along the north side of 7th Street.

6: Near the southwest corner of 7th and Broadway. Original Site was 36 feet south of fire hydrant and 18½ feet east of planter at Hall of Justice, in gutter near paving joint.

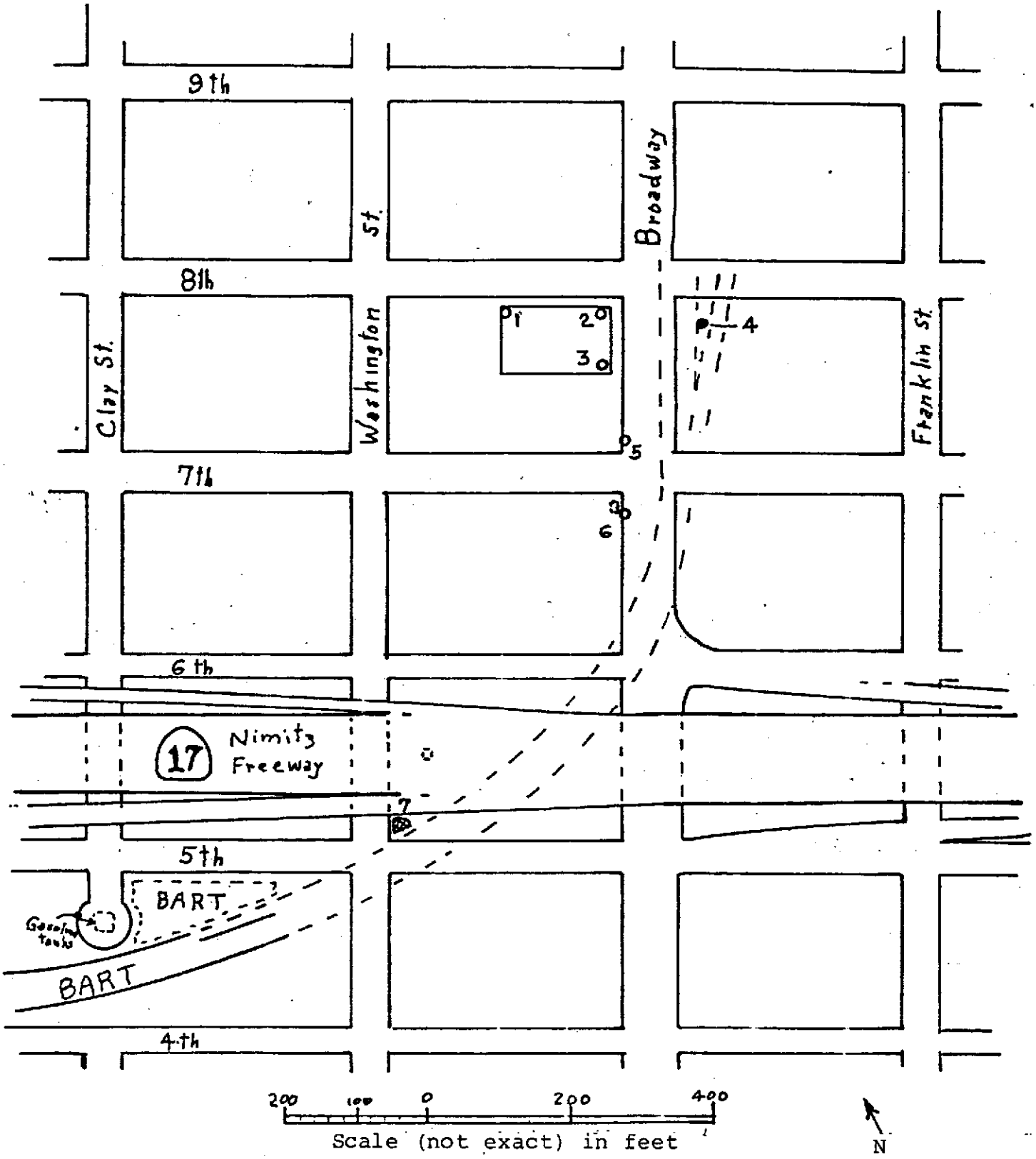
A secondary choice is the BART dry standpipe marked
"KBR/KR/KE 915"
SW Cor. 7th & B
Fire Dept Conn.

This is about 15 feet northwest of the original site. We would propose to drill parallel to the west side of the standpipe.

7: Original site was between 5th and 6th Streets, about 100 feet east of Washington under freeway divider.

Proposed alternate (preferred) site is northeast corner of Washington and 5th Streets, in Police Department parking lot near parking slots, 55-59, near edge of main driveway. Dan Dorman, engineer for the Police Department has approved this site, pending approval of CalTrans from whom the property is leased.

Another alternative is to drill on the BART property between Washington and Clay, south of 5th, north of the BART track right-of-way, and west of the BART D Switching Station (Southwest corner 5th and Washington). This site would put us near the Police Department fuel tanks and outside of CalTrans property.



Map of part of Oakland, California
Showing location of proposed
Test wells to be drilled

8-7-81
CFB

BROWN AND CALDWELL
CONSULTING ENGINEERS

ENVIRONMENTAL SCIENCES DIVISION

D. H. CALDWELL, PE Chairman
T. V. LUTGE, PE President
R. C. ABERLEY, PE Exec Vice Pres
S. A. FISHER, Vice Pres

September 30, 1981

Mr. Terry Cowhey, President
Cowhey Pacific Drilling
Pier 33
San Francisco, CA 94111

705-4

Dear Mr. Cowhey:

Enclosed are the results from the gasoline fingerprinting work performed on soil samples received for the period of 8/25-9/10/81.

In spite of reported field observations and extensive attempts by our laboratory personnel, no gasoline aliphatic or aromatic hydrocarbons were observed above our detection limit of 250 ppm. The sample handling and analytical methodologies employed in our laboratory are described below. Dr. Steve Havlicek, our technical director, reviewed these methods with the staff members who performed the analytical work to give you the best possible effort. One item which has just recently come to our attention is that if aluminum foil is used to line the caps in order to protect against possible absorbtion of the gasoline on plastic or cardboard liner, the foil must be cut to size and not permitted to hang out over the edges of the container. We have noted a very surprising amount of leakage around foil liners which are not cut to size and plan to be more specific in providing instructions regarding the use of such liners in the future.

This or other sampling/sealing problems may explain why no gasoline oders were noted in the samples as received. We are willing to work more closely with you in your field investigations to help you get to the root of this problem. Perhaps a down hole charcoal tube sampling may be more productive. The sample handling and methodologies are described below.

Sample Handling

Samples were collected in the field by Cowhey drilling personnel. Upon receipt at the laboratory, they were assigned a Brown and Caldwell log number for sample control purposes, then immediately refrigerated. Samples were brought to our

laboratory on seven different occasions. Holding times before analysis ranged from 2 to 5 days for each sample. Samples were kept refrigerated and capped until that time.

Analytical Methodologies

Several separate techniques were employed in an attempt to confirm the presence of gasoline in the soil. Liquid/Liquid Extractions were conducted using three separate solvents; cyclohexane, hexadecane, and freon. Fifty (50) grams of soil were extracted in each case with 25 mL of solvent. These extracts were then analyzed by gas chromatography utilizing a flame ionization detection. We also used a purge and trap technique by placing 5 grams of soil into a warmed sparging vessel, then analyzing by gas chromatography photoionization detection. This method employs the same type of detection which you used in your field testing. Best results were seen with the Liquid/Liquid Extraction, hexadecane technique, and was subsequently used to screen all of the samples.

Samples were spiked with gasoline at 54 and 540 ppm of gasoline. The low level spike was not detected. The high level spike had a recovery of 83 percent.

We share your concern regarding the negative results and are eager to work with you to improve sample integrity and detectibility.

Very truly yours,

BROWN AND CALDWELL

Edward Wilson
Laboratory Director

EW:ms

BROWN AND CALDWELL
CONSULTING ENGINEERS

ENVIRONMENTAL SCIENCES DIVISION

D. H. CALDWELL, PE Chairman
T. V. LUTGE, PE President
R. C. ABERLEY, PE Exec Vice Pres
S. A. FISHER, Vice Pres

September 30, 1981

Mr. Terry Cowhey
Cowhey Pacific Drilling
P.O. Box 11252
Santa Rosa, CA 94506

705-4

TRANSMITTAL OF GASOLINE FINGERPRINTING RESULTS

Date Sampled: As Noted
Date Received: As Noted

Log No.	Sample Description/Identification	Results
79D1	Gas Standard; 8/25/81	Standard
79D2	Soil Sample L-1; 8/25/81	None Detected
79M2	Soil Sample L-2; 8/26/81	None Detected
80D1	Soil Sample L-3 #1; 8/28/81	None Detected
80D2	Soil Sample L-3 #2; 8/28/81	None Detected
80D3	Soil Sample L-3 #3; 8/28/81	None Detected
81A1	Soil Sample L-4 #1; 8/31/81	None Detected
81A2	Soil Sample L-3 #4; 8/31/81	None Detected
81A3	Gasoline Pump East Oakland; Police Department; 8/31/81	Standard
82W1	Soil Sample L-5 #1; 9/3/81	None Detected
82W2	Soil Sample L-5 #2; 9/3/81	None Detected
82W3	Soil Sample L-6 #1; 9/3/81	None Detected
84E1	Soil Sample L-6 #1; 9/8/81	None Detected
84E2	Soil Sample L-6 #2; 9/8/81	None Detected
84E3	Soil Sample L-6 #3; 9/8/81	None Detected
84E4	Soil Sample L-6 #4; 9/8/81	None Detected

Log No.	Sample Description/Identification	Results
85M1	Soil Sample L-7 #1; 9/10/81	None Detected
85M2	Soil Sample L-7 #2; 9/10/81	None Detected
85M3	Soil Sample L-7 #3; 9/10/81	None Detected

Positive identifications would have been made if the concentration of gasoline had been greater than 250 ppm.

Reported by: _____
Edward Wilson
Laboratory Director

cc Mr. James Ballerino, Cowhey Pacific Drilling

WELLS FARGO

Wells Fargo Bank, N.A.Agent
Trust Real Estate Dept.
415 20th St., Oakland, CA 94612 10/7/81
OFFICE DATE

WE ARE PLEASED TO ENCLOSE: for your records a fully executed copy of the July 8,1981 Letter Agreement.

Re: Southwest Corner-8th & Broadway, Oakland, CA
Observation Wells

MAIL TO

Paul M. Yaniga
Groundwater Technology, Inc.
Rts. 1 & 100
Chadds Ford, PA 19317

W.E. Callan
Asst. Vice President
(415) 464-2190
By: Ray Ashby

MI5-14 (7 78) 100/PAD

Since 1852

WELLS FARGO BANK
NATIONAL ASSOCIATION

TRUST REAL ESTATE DEPARTMENT
OAKLAND MAIN OFFICE
415 TWENTIETH STREET
P.O. BOX 2068
OAKLAND, CALIFORNIA 94604

July 8, 1981

Paul M. Yaniga
Groundwater Technology, Inc.
Rts. 1 & 100
Chadds Ford, PA 19317

Dear Mr. Yaniga:

Re: Observation Wells
Southwesterly corner 8th & Broadway,
Oakland, CA
Assessor Parcel No. 1-201-15

This letter gives approval to you and your subcontractor, Cowhey-Pacific Drilling, and your respective employees and agents to enter the above referenced property as stated herein.

1. Drill three (3) observation wells approximately thirty-five (35) feet in depth and eight (8) inches in diameter along the street frontages of the property.

   a) Subcontractor to provide drawing showing exact location of proposed wells and receive written acceptance of same prior to drilling.
   b) PVC casing, appropriate valves and valve boxes to be installed, all to be level with adjacent ground and/or sidewalk surface.

2. Wells will be monitored by periodically removing water samples.

   a) Water and/or other liquid samples to be disposed of off site.

3. Upon completion of monitoring, but in no event later than November 20, 1981, all valves and valve boxes shall be removed, the well holes backfilled with a wet sand and cement grout mixture, and the property left at an elevation and in the condition as existed prior to work being commenced, all to the satisfaction of Wells Fargo Bank, N.A.

Paul M. Yaniga
Groundwater Technology, Inc.
Rts 1 & 100
Chadds Ford, PA 19317

Re: Observation Wells
Southwesterly corner 8th and Broadway, Oakland CA
Assessor Parcel No. 1-201-15

~~b) In event of future subsidence caused by wells, Ground~~ water Technology Inc.(G.T.I) and/or Cowney-Pacific Drilling (CPD) will do the necessary to bring the ~~property to the level and condition that existed prior to drilling~~.

PLEASE INITIAL

4. G.T.I. and CPD respectively are to furnish Certificate of Insurance naming J. Weston Havens (Owner) and Wells Fargo Bank,N.A., (Agent) as additional insureds.

   a) Said insurance to provide at least two million dollars combined single limit liability and property damage coverage.
   b) Said insurance to be primary to any existing coverage of Havens and Wells Fargo Bank.
   c) Said insurance coverage to not be cancelled without ten (10) days writtennotice to Wells Fargo Bank, Trust Real Estate Department, 415 20th Street, Oakland,CA 94612.

5. G.T.I. and CPD acknowledge that Owner and Agent anticipate developing subject property to parking lot or other use and that the activities of G.T.I. and CPD will be conducted in such a manner as to not interfere with use or development of the property.

6. G.T.I. and CPD agrees to indemnify and save harmless Owner and Agent against all loss, damage and expense which Owner or Agent may sustain, incur or become liable for, including loss of or damage to property or injury to or death of persons and fines or penalties imposed upon or assessed against Owner or Agent arising in any manner out of (a) the use of the Premises or Improvements by G.T.I. and CPD, (b) any breach by G.T.I. and CPD of the terms of this letter, or (c) the sole or contributing acts or omissions of G.T.I. and CPD or the employees, agents, patrons or invitees of G.T.I. and CPD in, or about the subject property.

7. G.T.I. and CPD are to pay a one-time contract preparation fee of $250.00.

8. G.T.I. and CPD agree to keep subject property free of liens or claims of liens on account of their activities.

Wells Fargo Bank, N.A.

W.E. Callan, Asst. Vice Presiden

J. Weston Havens

7-10-81
Date

AGREED AND ACCEPTED:
Groundwater Technology, Inc.

Paul M. Yaniga General Manager

Cowhey-Pacific Drilling

Terrence P. Cowhey

7.10.81
Date