Appendix E.

Analysis of Flooding and Water Quality Effects in Little Bear Creek Following a Major Earthquake

DRAFT SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT

Brightwater Regional Wastewater Treatment System

Technical Appendices

Brightwater
King County TREATMENT SYSTEM

Appendix E

Analysis of Flooding and Water Quality Effects in Little Bear Creek Following a Major Earthquake

April 2005

Prepared for King County by
CH2M Hill

Alternative formats available upon request
by calling 206-684-1280 or 711 (TTY)

King County
Department of Natural Resources and Parks
Wastewater Treatment Division
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TECHNICAL MEMORANDUM

Analysis of Flooding and Water Quality Effects in Little Bear Creek Following a Major Earthquake

1. Introduction

This memorandum presents the results of the technical analysis that was conducted to simulate the escape of flow resulting from a hypothetical sudden release of wastewater from above-ground tanks at the Brightwater treatment plant following a hypothetical earthquake. There are six aboveground digester tanks, plus one biosolids storage tank in the Phase II, 54 mgd plant. The digester tanks are used to further stabilize the wastewater solids that are removed by the treatment processes used to treat the wastewater. The water and associated solids stored in these tanks are referred to as "wastewater solids". Together, these tanks represent the largest potential for escape of process water and potential impact to surface waters, in the event of a catastrophic earthquake at the project site (Figure SW-1). Conceivably, cracks could develop in one or more of the tanks due to ground deformation along a hypothetical fault underneath this area and thereby release the tank contents. Since the larger portion of the height of each tank is located above ground, the majority of the tank contents would spill onto the ground and impact surface waters. Each tank holds approximately 1.25 million gallons (MG); approximately 1.0 MG, 133,500 cubic feet, of which lies aboveground and would escape in the event of a tank rupture. Scenario C: surface water release is the worst-case Surface Water scenario and assumes that four of the wastewater solids digester tanks rupture simultaneously due to a seismic event.

The concrete digester tanks have extensive steel reinforcement around the circumference of the tanks, as well as vertically. As a result, under a worst case event, Scenario C: surface water release, complete failure is not realistic, but cracks might develop in one or more tanks and that could be wide enough to allow sudden release of the contents.

The analysis was carried out in three steps:

1. The FLDWAV Model was used to simulate the escape of the digester contents (wastewater solids) from the crack in the tank (Attachment 1).
2. The XP-SWMM Model was used to characterize the flood effects of the escaping wastewater solids across the project site and then into nearby Little Bear Creek.
3. A simple mass-balance equation was used to determine the water quality impacts to Little Bear Creek.

Assumptions

Several assumptions were made in conducting this analysis including:

1. Under the worst case scenario, C (surface water release), four tanks would be damaged. Cracks in the tank walls up to 12 inches in effective width were assumed to run the full height of each tank (Figure SW-2).

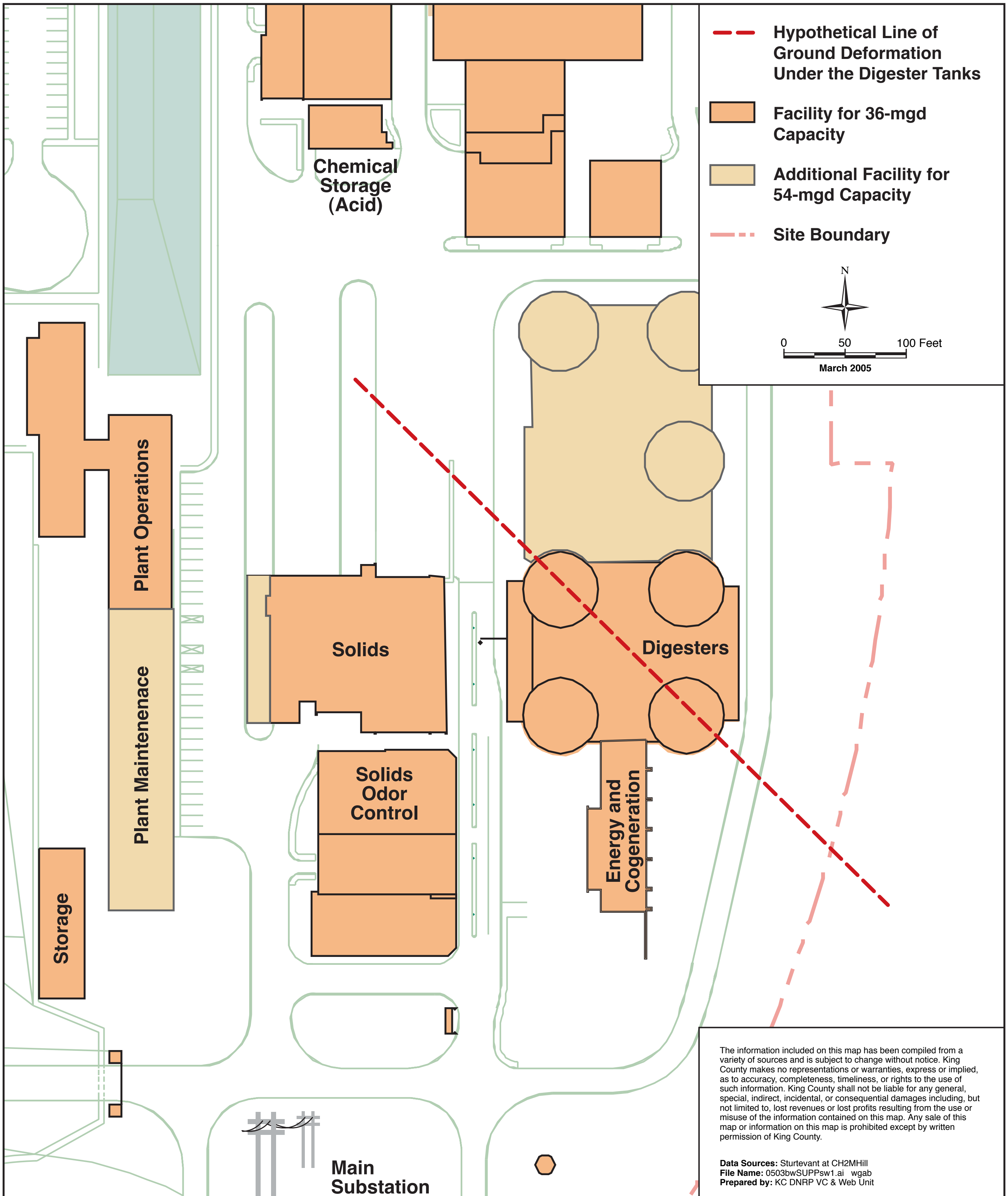
2. Under this worst-case scenario it is assumed that all damaged tanks would be full at the time of the seismic event resulting in up to 4.0 MG of contents being released to the ground surface. In this analysis all the contents are treated as fluids, with a viscosity equivalent to that of water.
3. Stormwater canals on the project site would maintain their integrity and not release large flows of stored stormwater. The canals will lie largely below the local grade and are situated several hundred feet east of the down-sloping, western portion of the project site. Although likely to suffer damage due to the earthquake scenario, canals would not develop any major cracks or breaches that would allow stored stormwater to rapidly escape.
4. The digester tank underdrain system would be disrupted due to the localized ground deformation and cease to provide subsurface drainage. None of the belowground wastewater solids seeping from the cracked tanks would be conveyed from beneath the site via the damaged underdrain system.
5. Under the worst case scenario, the hypothetical earthquake would occur during the month of August, which is the period of least flow in Little Bear Creek and minimum dilution potential. A breach during August would, therefore, result in the greatest water quality impact, in Little Bear Creek.

2. Flood Effects of the Escaping Wastewater Solids The computer model, FLDWAV, was used to develop the initial hydrograph representing the wastewater solids escaping from earthquake-induced cracks in the digester tanks (refer to Attachment 1). This FLDWAV hydrograph was then input into the XP-SWMM (XP-Software, 2004) model, which was used to simulate the flow the escaped contents as they flow across the plant site toward Little Bear Creek.

Methodology

Attachment 2 shows the model schematic for this analysis. This figure presents a pictorial representation of the hydraulic elements and flow paths used to simulate the routing of the wastewater solids following release from the digester tanks.

The FLDWAV analysis produced a hydrograph of escaping water from a <u>single</u> digester tank. Since Scenario C: surface water release involves the simultaneous escape of wastewater solids from <u>four</u> digester tanks, the outflow hydrograph from FLDWAV was input as a point inflow at two locations in the XP-SWMM model (nodes "E Digester" and "W Digester" in Attachment 2). This FLDWAV hydrograph was doubled at each of the two locations because two digester tanks are located at each of the hydrograph input nodes (for a total of four tanks, representing the worst-case scenario). The computations were performed using a 1-second time step. The use of a small time step was necessary due to the extremely short time it takes for the hydrograph to peak (less than 1 minute). A constant baseflow of 8 cfs, representing summer low flow conditions, was added to the flow hydrograph (node "U988") at Little Bear Creek.



Data Sources: Sturtevant at CH2MHill
File Name: 0503bwSUPPsw1.ai wgab
Prepared by: KC DNRP VC & Web Unit

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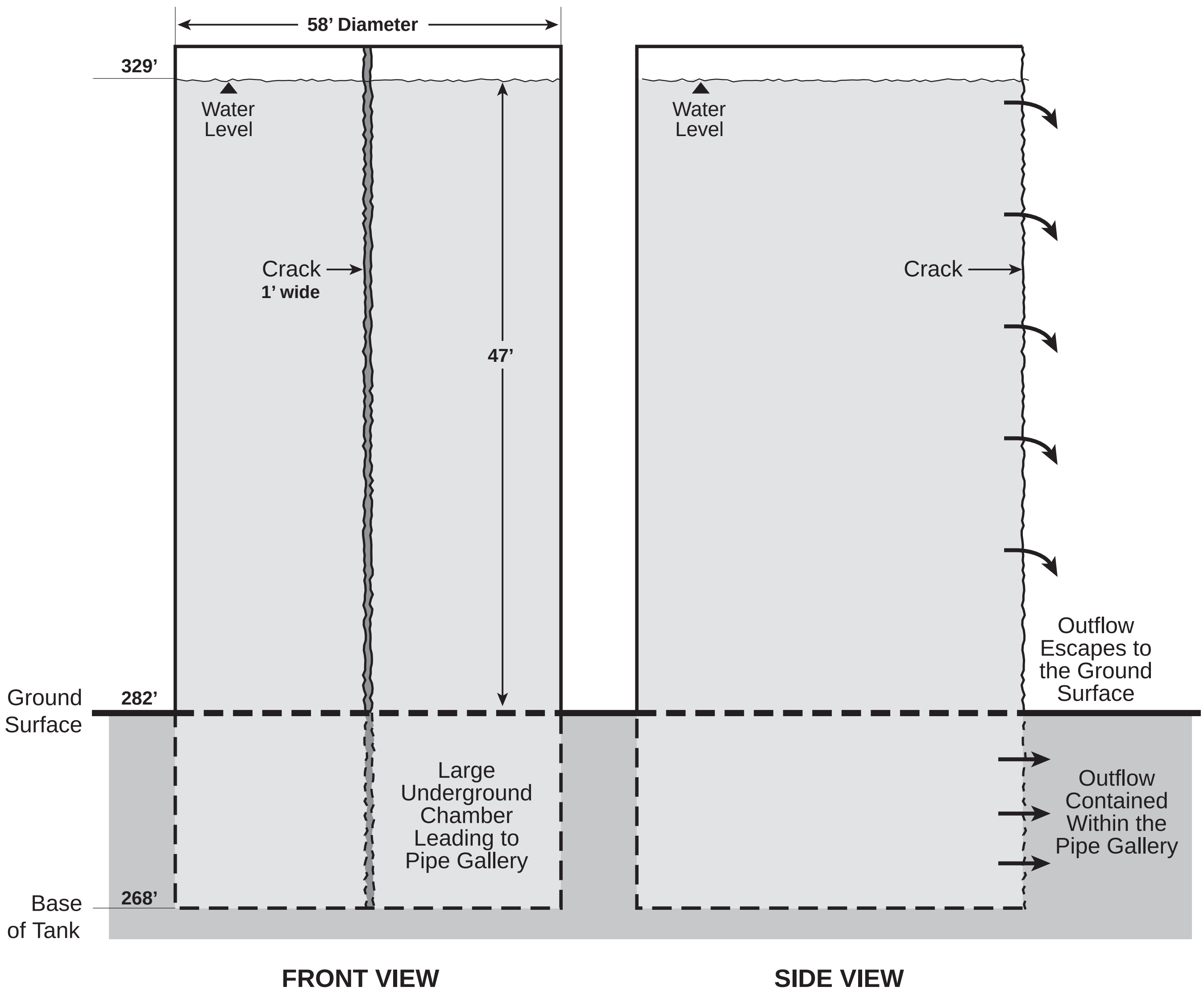
Figure SW-1

Hypothetical Line of Ground Deformation Under the Digester Tanks

BRIGHTWATER SUPPLEMENTAL EIS



Data Sources: Sturtevant at CH2MHill
File Name: 0412bwSUPPsw2.ai wgab
Prepared by: KC DNRP VC & Web Unit

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Figure SW-2

Modeled Crack in Concrete Digester Tanks

BRIGHTWATER SUPPLEMENTAL EIS

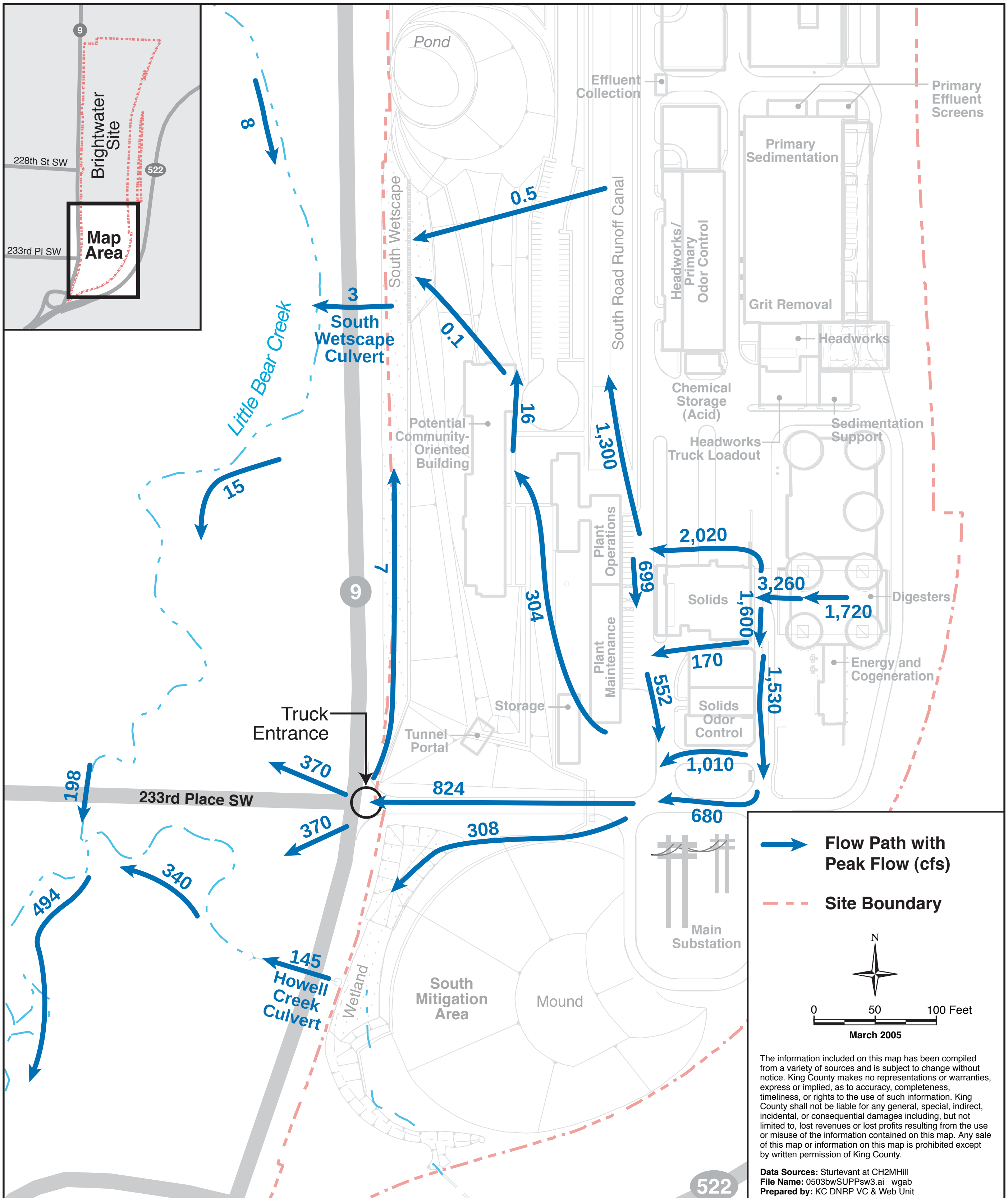

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Figure SW-3

Flow Paths of Discharge from Cracked Digester Tanks

BRIGHTWATER SUPPLEMENTAL EIS

Results

Table SW-1 illustrates the surface flow impacts due to the escaping wastewater solids from the damaged digester tanks.

TABLE SW-1
Selected Results from the XP-SWMM Analysis

	XP-SWMM Model Location[a]	Peak Flow (cfs-rounded)	Time to Peak (minutes)	Time to Reach Minimal Flow[b](minutes)
Digester Tanks	FLDWAV Output	3,520	1	45
Building 700	D2	3,260	1	45
Intersection of SR 9 and 233rd Place SE	S6.2, S7	740	4	70
Howell Creek Culvert	S5.3.2	145	7	30
South Wetscape Culvert	N6.2	3	10	5,360 (4 days)
Little Bear Creek Downstream of 233rd Place SE	5557	500	9	56
Little Bear Creek at County Line	226	200	50	170
Little Bear Creek at Sammamish River	226[c]	200	80	200

[a]Refer to Attachment 2.

[b]The flow associated with the wastewater solids escaping from the digester tanks either ceases entirely or falls below 1 percent of the peak flow of that location.

[c]The most downstream model point is approximately 1.6 miles upstream of the Sammamish River. The time to peak was lagged (delayed) 30 minutes to account for travel time between the most downstream model point and the confluence of Little Bear Creek at the Sammamish River.

The wastewater solids would spread out rapidly across the southern portion of the project site, as shown in Figure SW-3. The flows would travel west from the digesters following the site topography to Highway 9 and eventually Little Bear Creek.

While still on the treatment plant site, the flow would split, portions of it heading north and south. Discharge from this north flow path would enter Little Bear Creek via a culvert located under SR-9 midway between 228th Street SE and 233rd Place SE.

Flow from the south flow path enters Little Bear Creek both upstream and downstream of the 233rd Place Bridge, the latter portion via Howell Creek. Howell Creek would also convey the wastewater solids reaching the South Mitigation Area.

Figure SW-4 shows effect of attenuation within the site on the peak flow of wastewater solids through the Brightwater plant site. As flow travels through the project site, peak flow is significantly reduced from a peak of approximately 3,600 cfs flowing out of the digesters to approximately 730 cfs being discharged from the plant site. The unevenness of the terrain of the flow paths and the storage in the depressional area would tend to slow down and disperse the flow, greatly reducing the flow peak. Flow attenuation of this magnitude is normal for a short duration high magnitude hydrograph such as the hydrograph predicted for a cracked tank, which produces a high peak flow but a relatively low total volume. If fewer than four tanks developed cracks, or if the cracks in each of the tanks did not develop simultaneously, considerably lower peak flows would result.

On the west side of the project site, the flows would leave the site via culverts under SR-9 at the South Wetscape and Howell Creek (Figure SW-3). Peak discharge through the South Wetscape culvert is predicted to be approximately 3 cfs, while peak flow through the Howell Creek culvert would be 145 cfs. The combined peak flow reaching Little Bear Creek would be approximately 740 cfs (Figure SW-5). The wastewater solids leaving the project site would peak approximately 4 minutes after the damage occurred and be largely finished in less than 1.5 hours.

FIGURE SW-4
Peak Flow Attenuation through the Brightwater Plant Site

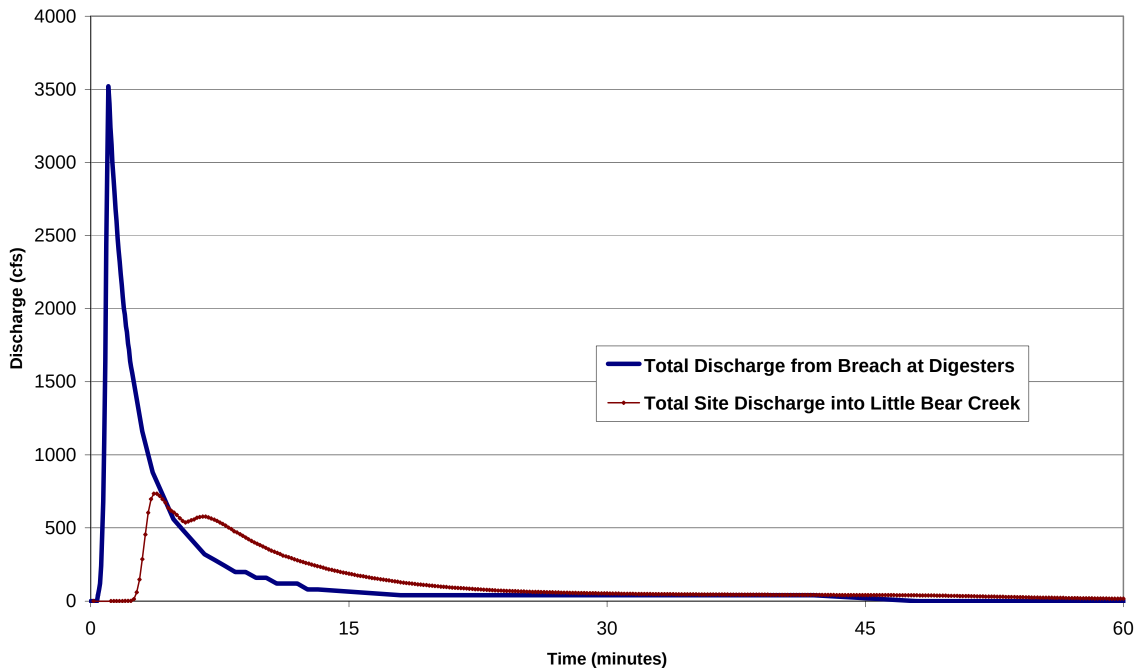
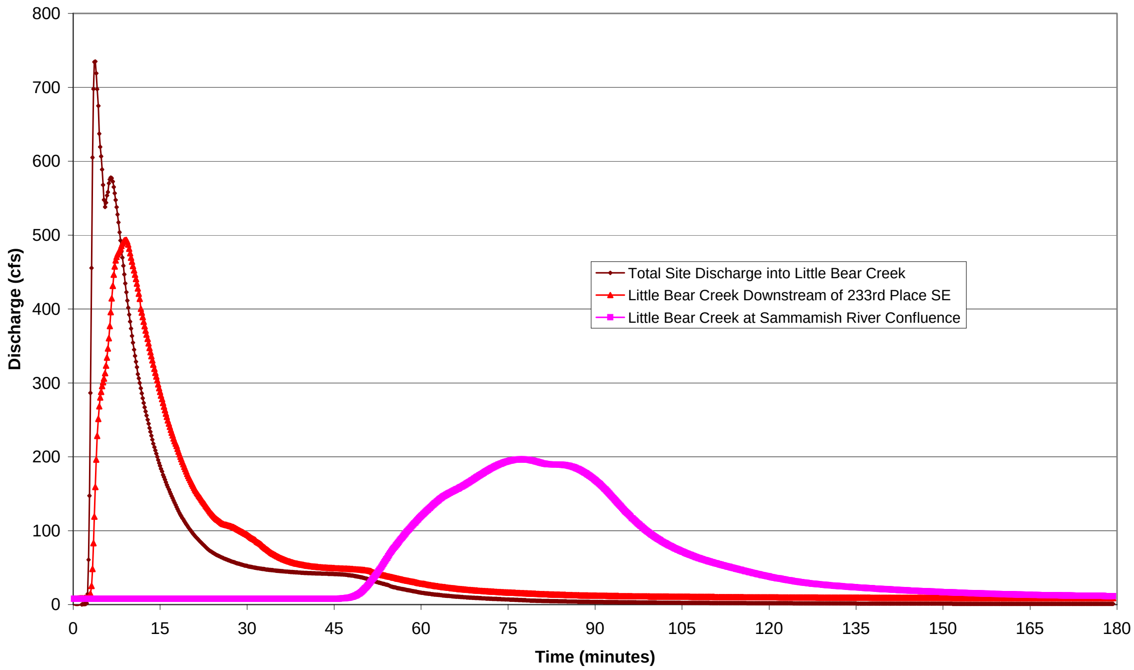


FIGURE SW-5
Peak Flow Attenuation in Little Bear Creek



The largest quantity of flow would cross the surface of SR-9 at the intersection with 233rd Place SE. Peak flow at 233rd Place SE is predicted to be approximately 740 cfs. The maximum depth of flow on SR-9 is predicted to be approximately 0.5 ft with a flow velocity of 6 feet per second (fps). If smaller volumes of wastewater solids escaped, shallower flooding would result. These peak flow conditions would last for a few minutes, taper off and then cease entirely within an hour.

Figure SW-5 shows that the flow in Little Bear Creek further attenuates as it travels downstream. From approximately 490 cfs, downstream of 233rd Place SE, the peak flow would decline to approximately 200 cfs at the county line. Once, again, these peak creek flows represent a worst-case scenario. Lesser volumes of escaping wastewater solids would result in lower flows in Little Bear Creek. The flows at the mouth of the creek (at the Sammamish River) would return to near-normal in approximately 3 hours.

Discussion

The greatest flood threat outside of the treatment plant site would be flows moving across SR-9 at the intersection with 233rd Place SE. Flows moving across the intersection would pose a hazard to traffic on SR-9, assuming SR-9 has not been significantly damaged during the earthquake. East of SR-9 flood damage might occur as the flow proceeds to Little Bear Creek. The lower portion of Howell Creek and its associated wetland could suffer erosion damage due to escaping wastewater solids. In addition, considerable quantities of sediment could be eroded from the project site, with much of it depositing in Little Bear Creek upstream and downstream of the 233rd Place Bridge.

Despite the considerable degree of flow attenuation , the peak flow in Little Bear Creek downstream of 233rd Place SE (around 500 cfs) would still be substantially higher than the natural flow in the creek during the month of August, which averages a little more than 7 cfs. For comparison, the natural flood flows in the creek, immediately downstream of the project site, are estimated to be 379 cfs for the 2-year event (the flow with a 50% chance of being equaled or exceeded each year) and 580 cfs for the 10-year event (King County, 2003). Scenario C would result in peak creek flows on the order of the 5-year flood event. The high creek flow would further attenuate as it traveled the lower 3 miles of Little Bear Creek through the City of Woodinville, declining to approximately 200 cfs at the creek's confluence with the Sammamish River. High flow conditions (greater than 100 cfs) in Little Bear Creek downstream of 233rd Place SE would persist for a relatively short time: from 30 to 90 minutes, depending upon location. Staff from the City of Woodinville report that high flows in Little Bear Creek are generally confined within the stream channel (Monzaki, personal communication, 2004). This is further supported by the flood insurance rate maps (FIRM maps) produced for Little Bear Creek (Federal Emergency Management Agency, 1995 and 1999; refer to Attachment 3). These FIRM maps show that the flood flows in Little Bear Creek are generally confined to areas near the creek and result in a very limited floodplain width. City staff report that high flows in Little Bear Creek generally cause little property damage. It is concluded that even the worst-case scenario would result in relatively minor flood-related damage along the creek downstream of Howell Creek.

In the extremely unlikely case that the hypothetical seismic event occurred simultaneously with a flood event on Little Bear Creek, flood damages along the creek would be aggravated by the inflow of wastewater solids from the treatment plant site. However, overall flood damages along Little Bear Creek would be expected to remain relatively limited.

3. Water Quality Effects

Methods

The escaping wastewater solids would negatively impact the water quality in Little Bear Creek. Table SW-2 shows the water quality parameters that were evaluated for this scenario. The water quality data for Little Bear Creek represents the average of the data collected from the creek at 228th Street SE for the years 1993 through 2003 (Snohomish County, 2004). For the temperature and dissolved parameters, only, the concentrations were calculated as the averages of the values for May through September (Dry Season column) and October through April (Wet Season column). King County provided the water quality data for biological oxygen demand (BOD_5) (Burkey, personal communication, 2004). The quality of the wastewater solids inside the digester tanks was obtained from design data developed for the Brightwater Project (Scott Vandenberg, personal communication, 2004). The water quality impacts to Little Bear Creek were calculated using a simple mass balance equation, which mathematically "mixes" the constituents in the creek with the escaped wastewater solids flowing into the creek.

$C_{LBC\ mixed} = ((Q_{LBC} \times C_{LBC}) + (Q_{Dig} \times C_{Dig})) / (Q_{LBC} \times Q_{Dig})$ where

$C_{LBC\ mixed}$ is the concentration of the parameter in the creek downstream of the wastewater solids inflow
Q_{LBC} is the flow in Little Bear Creek upstream of the wastewater solids inflow
Q_{Dig} is the wastewater solids inflow to the creek
C_{LBC} is the parameter concentration in Little Bear Creek upstream of the wastewater solids inflow
C_{Dig} is the parameter concentration of the wastewater solids inflow to the creek

TABLE SW-2.
Water Quality Data

Parameter	Wastewater Solids[1]	Little Bear Creek - Dry Season[2]	Little Bear Creek - Wet Season[2]
Temperature (°C)	35	12.4	7.1
pH (units)	7	7.2	7.2
Dissolved Oxygen (mg/L)	0	10.4	11.6
BOD_5 (mg/l)[3]	4,125	1	1
Total Suspended Solids (mg/L)	36,000	7	7
Ammonia-N (mg/L)	1,500	0.03	0.03
Nitrate-N (mg/L)	0	0.94	0.94
Total Phosphorus (mg/L)	863	0.05	0.05
Hydrogen Sulfide (mg/L)	50	0	0
Fecal Coliforms (#/100 ml)	10,000,000	434	434

Sources:
[1]Brightwater Design Project
[2]Skohomish County Monitoring Data
[3]King County Monitoring Data

All of the parameters were treated conservatively, that is, they were assumed to remain stable and not degrade naturally. Since the time of travel in Little Bear Creek between the treatment plant site and the mouth of the creek at the Sammamish River is only a few hours, this is considered a reasonable assumption for the time period immediately following the earthquake.

Over time, transformation would occur to most of these parameters, making the assumption of simple dilution effects less accurate and overly conservative. For example, the suspended solids in the water held by the South Wetscape would tend to settle, greatly reducing their concentration. The hydrogen sulfide and ammonia would tend to oxidize to far less toxic forms due to bacterial action. Natural die-off of fecal coliforms would reduce their numbers. The analysis in this section ignores these factors and therefore likely overstates the water quality impacts in Little Bear Creek.

Results

The upstream water quality in Little Bear Creek for Scenario C was taken from the Dry Season column of Table SW-2.

As stated above, large flows of wastewater solids would reach Little Bear Creek within minutes of the hypothetical earthquake. Because of this, the quality of the creek would closely resemble that of the wastewater solids for a brief period of time. This water would have an extremely poor quality. Relative to the creek, the wastewater solids would be very warm. Dissolved oxygen concentration would be at or near zero. The wastewater solids would have extremely high levels of suspended solids, fecal coliforms (bacteria), ammonia, and hydrogen sulfide. There would be very high levels of phosphorus and BOD_5. The latter would tend to depress oxygen levels in the creek and further downstream.

The resultant water quality effects in Little Bear Creek can be seen on Table SW-3. With the exception of pH, all of the parameters with numeric state water quality standards would be exceeded. The concentrations for ammonia and hydrogen sulfide would exceed their respective thresholds for acute toxicity. The acute toxicity level is a concentration above which an aquatic organism is likely to suffer damage or death if exposed for even a short period of time (typically 1 hour). The high concentrations of ammonia and hydrogen sulfide, combined with a very low dissolved oxygen concentration, would result in the death of virtually all fish and most benthic organisms in the entire lower stretch of Little Bear Creek below the treatment plant site. The water quality in the Sammamish River could also be severely impacted, as discussed later in this section.

Although the flow effects of the escaping wastewater solids would be largely dissipated within a few hours, the water quality effects in Little Bear Creek would last for a number of days (refer to Table SW-3). This is because wastewater solids that were trapped and detained within the stormwater facilities on the treatment plant site (specifically the South Road runoff canal) would be slowly released to Little Bear Creek through the South Wetscape. By the end of the first day following the hypothetical earthquake, stream temperature and dissolved oxygen would likely meet state standards (as would pH). However, the remaining parameters would likely be exceeded in the creek until discharge from the South Wetscape ceased around the end of the fourth day.

TABLE SW-3.
Water Quality Effects in Little Bear Creek Downstream of 233rd Place SE

	Units	State Standard[1]	Acute Toxicity Criteria	Chronic Toxicity Criteria	Immediately Following Earthquake	Day 1	Day 2	Day 3	Day 4
Temperature	°C	16			34	13	13	13	13
pH	pH units	6.5 – 8.0			7.0	7.2	7.2	7.2	7.2
Dissolved Oxygen	mg/L	9.5			0.1	10	10	10	10
Suspended Solids	mg/L	5[2]			35,500	1,800	1,400	930	474
Fecal Coliforms	#/100 ml	50			9,890,000	500,000	380,000	250,000	130,000
Ammonia-N	mg/L		22[1]		1,480	75	60	40	20
Hydrogen Sulfide	mg/L		0.002[3]		49	3	1	12	0.5

Sources:

[1]Washington Administrative Code 173-2-1A

[2]The State Standard associated with suspended solids is turbidity: 5 NTU. Suspended solids concentrations greater than 20 mg/L are assumed to violate the State Turbidity Standard.

[3]U.S. Environmental Protection Agency (1999)

Shaded cells indicate that this parameter exceeds the applicable water quality standard or criterion.

Under Scenario C, the wastewater solids flow into Little Bear Creek would receive very limited dilution before discharging to the Sammamish River. Depending upon the flow conditions, dilution in the river may only be on the order of 2:1. This would result in somewhat less severe water quality degradation that described for Little Bear Creek, above. However, toxic concentrations of hydrogen sulfide and ammonia would likely persist for a period of a few hours or more at any given location along the river as this pulse of highly degraded water moved downstream. Fish kills and mortality to aquatic invertebrates would likely result. These conditions might extend from the inflow point of Little Bear Creek in Woodinville to the outlet of the river at Lake Washington.

Some solids may be deposited in Sammamish River but it is assumed the majority will flow down to the mouth and Lake Washington. Much of these solids will likely settle in this area and cause adverse impacts to aquatic life potentially within the northern half of Lake Washington. Although the wastewater solids release would occur as a one-time event, any solids that are initially deposited in Little Bear Creek or Sammamish River would be mobilized during the next storm-event, potentially causing additional toxicity to aquatic life. The recovery of Sammamish River ecology after release of wastewater solids in Scenario C would potentially be faster than that of Little Bear Creek due to the river's larger size and its use as a fish migration corridor between Lakes Sammamish and Washington. However, it may still require up to several years for Sammamish River fish communities to return to their previous status.

The methods used in this water quality analysis are approximate. The analysis only takes into account dilution effects. Beyond the first few hours following the earthquake, other natural processes would begin to reduce the concentrations below those shown on Table SW-3. These include volatilization, settling, and biological degradation. Conversely, at least a small portion of the pollutants in the wastewater solids would remain on the ground at or near the project site and along the banks and streamside vegetation of the creek. Their gradual movement into the creek would probably result in elevated levels of suspended solids, phosphorus, nitrogen, and fecal coliforms for a period of weeks or months following the earthquake before the concentrations returned to background levels. Following any releases of untreated wastewater to Little Bear Creek or other surface water body, King County would identify and implement mitigation measures as reasonable and appropriate, such as bank clean up, to reduce the duration of water quality impacts.

4. References

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ATTACHMENT 1

FLDWAV Model Analysis

Brightwater Wastewater Facilities Digester Tank Crack Analysis

PREPARED FOR: Pete Sturtevant/CH2M HILL

PREPARED BY: Joe Plaskett/CH2M HILL

DATE: December 3, 2004

Summary

The National Weather Service FLDWAV model was used to simulate a hypothetical crack scenario for the failure of a digester tank at the King County Brightwater Wastewater Treatment Facility.

The failure of a single 58-foot diameter concrete digester tank resulting from an extreme earthquake causing rapid discharge of fluid from the tank was simulated. The tank was assumed to be full of liquid at the time of failure. The failure mechanism was assumed to begin with a 1-foot wide crack at the base of the tank which propagated vertically to the top of the tank within a time span of one minute. The analysis showed that the peak outflow from the tank crack was 883 cubic feet per second (cfs), and assumes that the crack reaches its full extent one minute after the initial crack formation.

Introduction

The FLDWAV model was used to compute the time-dependent outflow hydrograph from the hypothetical crack of a single digester tank. The crack is the opening formed in the structure as it fails. The model uses a parametric approach to estimate the time-dependent outflow from the crack based on empirical observations from historic dam failures. For a piping failure of the type that would occur in this scenario the model computes flow through a linearly expanding orifice until the top of the orifice is above the water level, at which time the outflow calculation switches to weir flow. The model input consists primarily of the user-specified parameters defining the crack and a description of the fluid reservoir.

Study Criteria

- Dam Crack Model
  - National Weather Service (NWS) FLDWAV model, version dated November 1998, which combines the NWS DAMBRK and DWOPER models.
- Dam Crack Parameters
  - The magnitude of the outflow from a tank crack is primarily dependent upon three variables, the average crack width, the shape of the crack and the time to failure. The crack is always assumed to develop over a finite interval of time (time to failure), and will have a final size determined be the terminal bottom width and side slope of

the crack. These parameters are part of the input data, and are chosen by the modeler. The parameters defining the tank crack scenario were developed based on the input from the structural designers of the digester tank, and are considered to be conservative.

- Time to failure: The time to failure is the time from the beginning of crack formation until it reaches its maximum size. Based on the hypothetical seismic event, a value of one minute was chosen.
- Crack width: Based on the input from the structural designers of the digester tank, the crack width of one foot for the concrete tank was also chosen.
- Crack height: The height of the crack was chosen to be the height of the tank above ground level. Liquid in that portion of the tank below ground was assumed not to spill onto the ground but instead would remain at the site. This is the worst case scenario.
- Crack side slopes: The crack side slopes (z:1, horizontal : vertical) for concrete structures are typically assumed to be vertical. For the crack occurring in the digester tank a value of 0.0 was therefore chosen.

Results

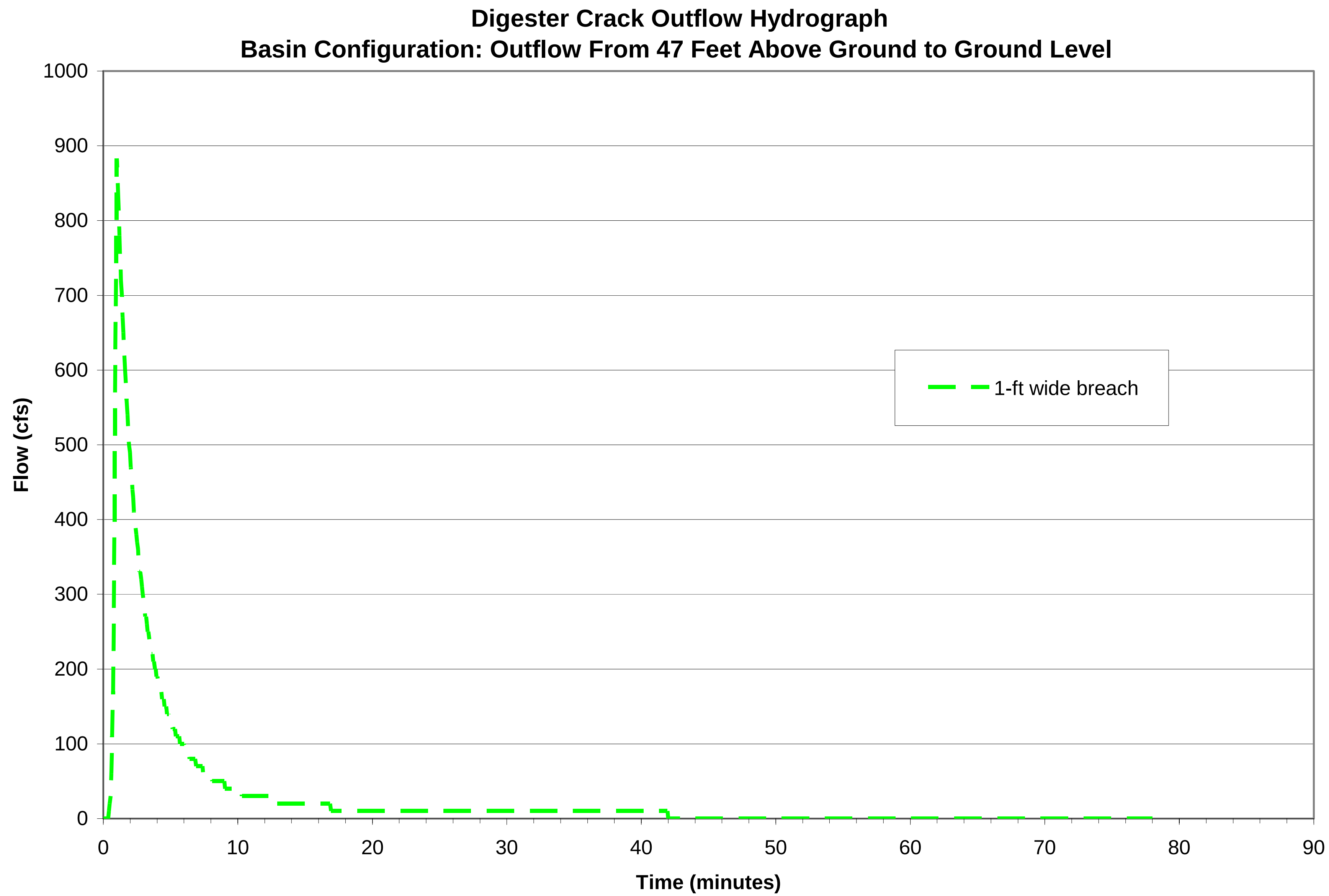
Table 1 summarizes the parameters used to model the digester tank failure scenario and the resulting flow from the crack.

TABLE 1

Brightwater Digester Tank Crack Parameters and Crack Outflow

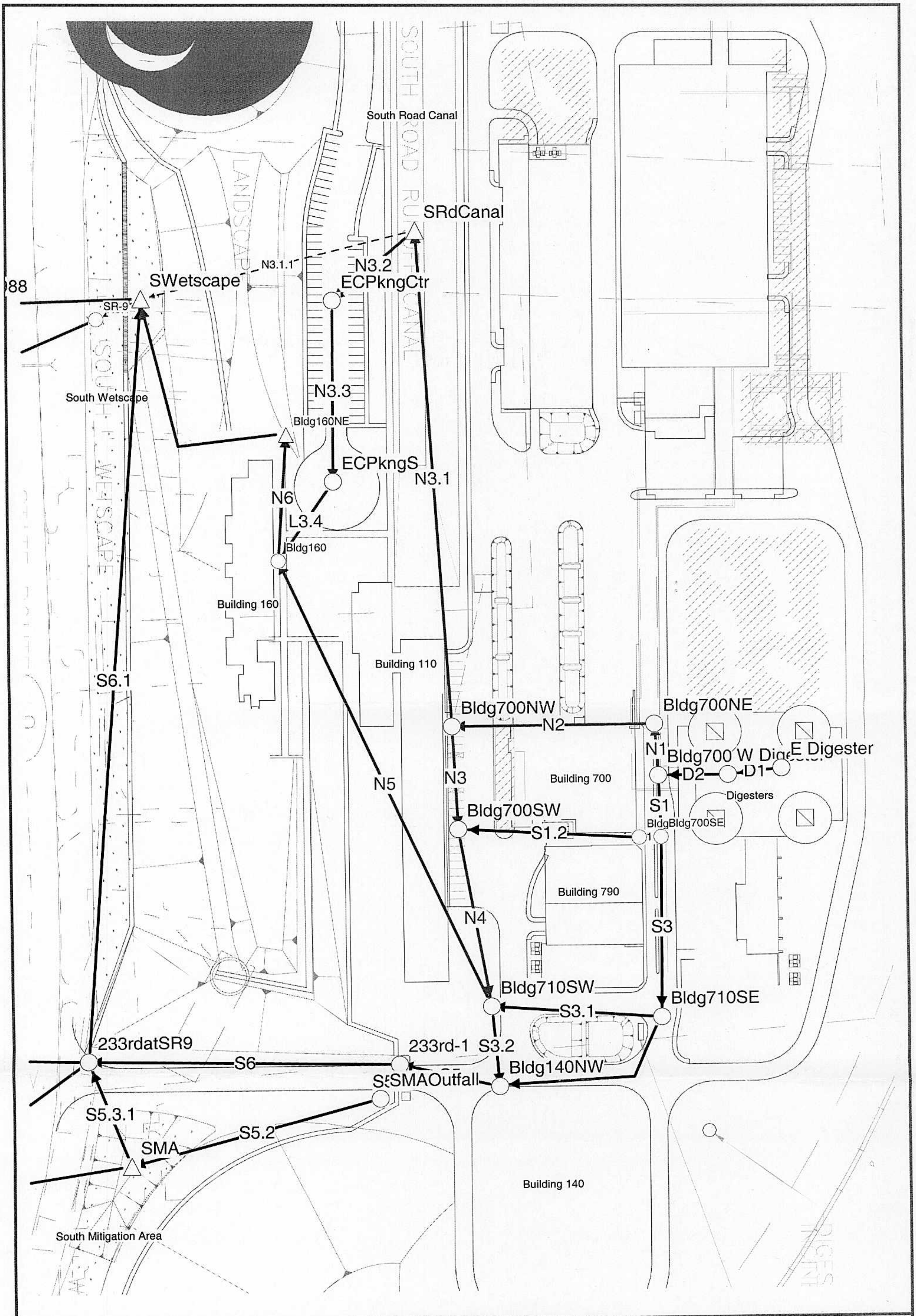
Location/ Crack Scenario	**Crack Formation Time** (min:sec)	**Crack Height (H)** **(ft)**	**Crack Width** **(ft)**	**Crack Side Slopes**	**Tank Liquid Volume at Failure** **(MG)**	**Maximum Crack Flow (cfs)**
Digester Tank/1-ft Vertical Crack	1:00	47	1	0.0:1	1.2	883

Figure 1 shows the outflow hydrograph resulting from the tank crack. As can be seen, the fluid in the tank is released extremely rapidly. Output from the model indicates that the water level in the tank would drop 15 feet during the first minute after formation of the crack. Peak flow from the tank was calculated to be about 880 cfs.

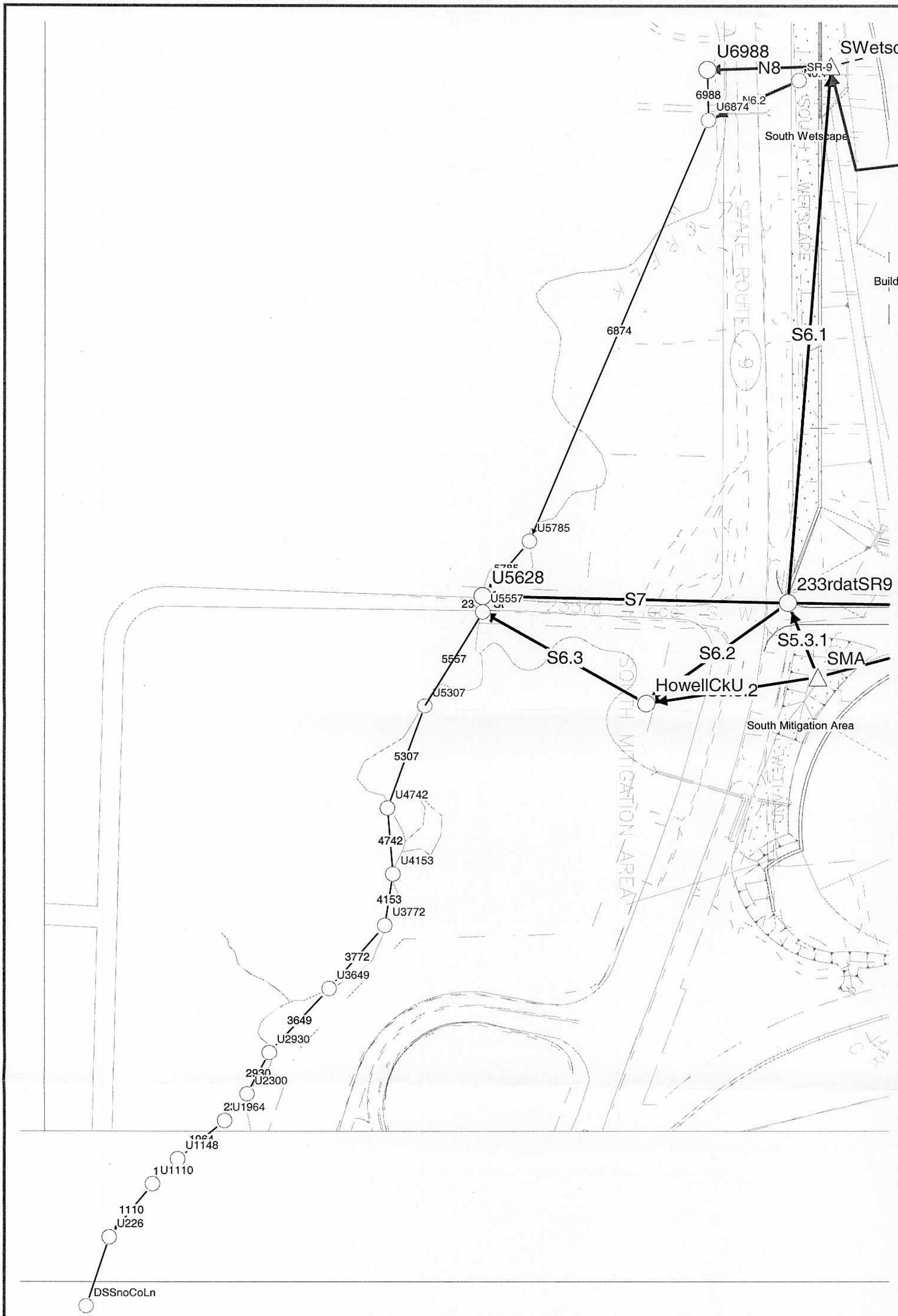

Digester Crack Outflow Hydrograph
Basin Configuration: Outflow From 47 Feet Above Ground to Ground Level
Flow (cfs)
1000
900
800
700
600
500
400
300
200
100
0
1-ft wide breach
0
10
20
30
40
50
60
70
80
90
Time (minutes)

ATTACHMENT 2

XP-SWMM Model Schematics



SWMM Version 9.12 Copyright (c) XP Software	Untitled Licenced To: CH2M Hill [42-900-1144]	12/21/04 Page 1/1



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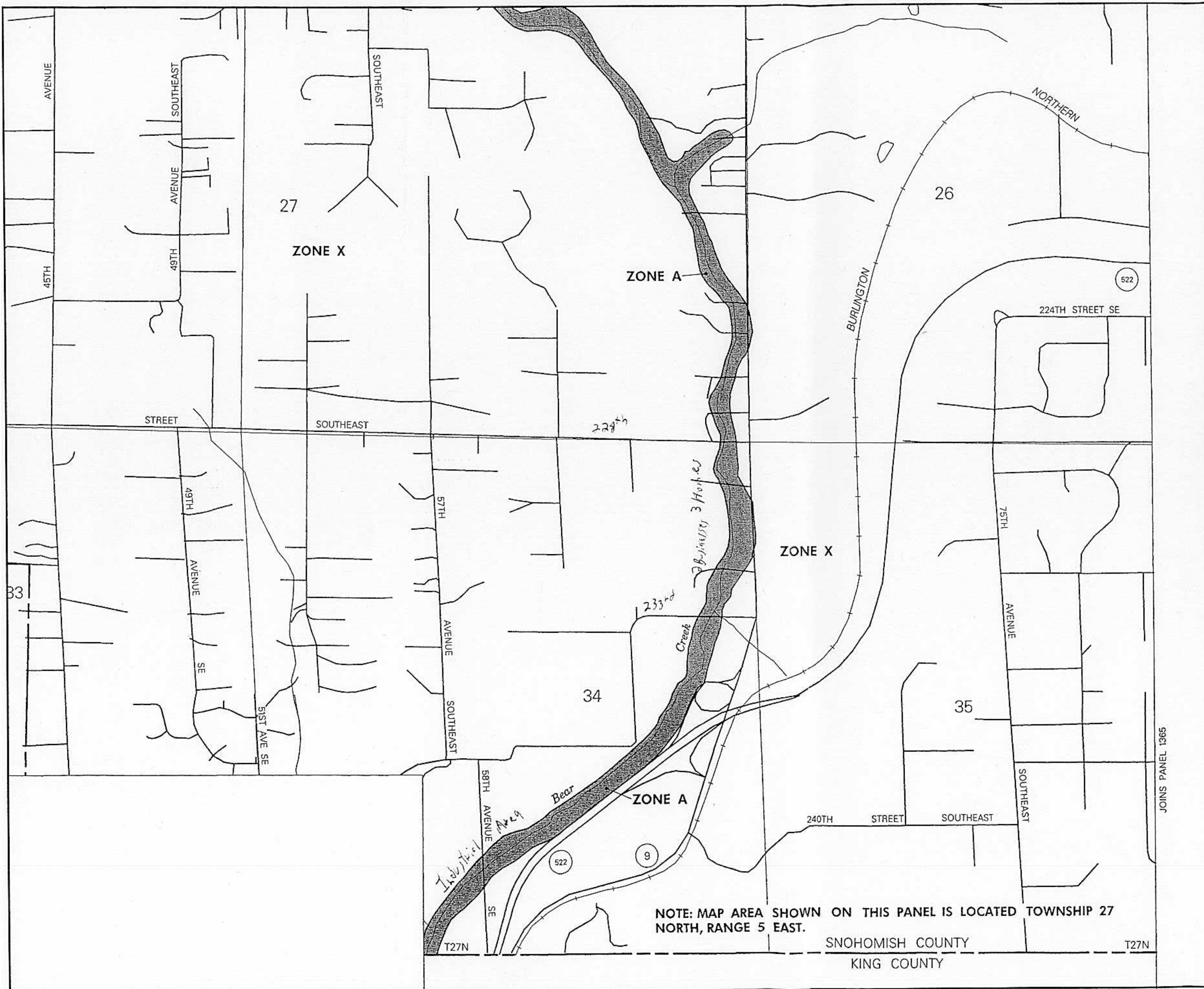
ATTACHMENT 3

FEMA Flood Insurance Rate Maps for Lower Little Bear Creek



NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP

SNOHOMISH COUNTY, WASHINGTON AND INCORPORATED AREAS

PANEL 1345 OF 1575
(SEE MAP INDEX FOR PANELS NOT PRINTED)

CONTAINS:

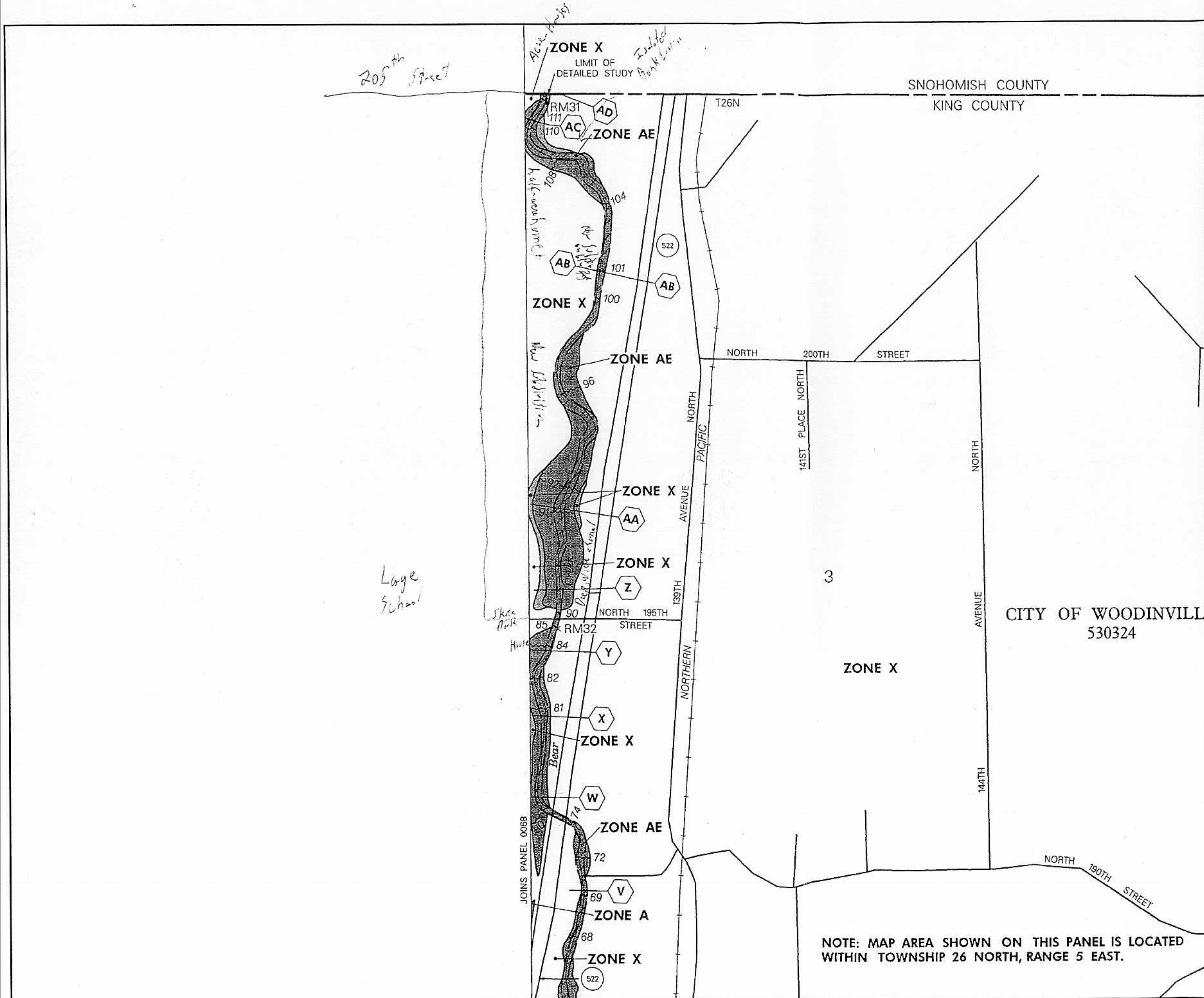
COMMUNITY	NUMBER	PANEL	SUFFIX
BOTHELL, CITY OF	530075	1345	E
SNOHOMISH COUNTY, UNINCORPORATED AREAS	535534	1345	E

MAP NUMBER
53061C1345 E

EFFECTIVE DATE:
NOVEMBER 8, 1999

Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov



APPROXIMATE SCALE IN FEET

500 0 500

NATIONAL FLOOD INSURANCE PROGRAM

FIRM

FLOOD INSURANCE RATE MAP

KING COUNTY, WASHINGTON AND INCORPORATED AREAS

PANEL 69 OF 1725

(SEE MAP INDEX FOR PANELS NOT PRINTED)

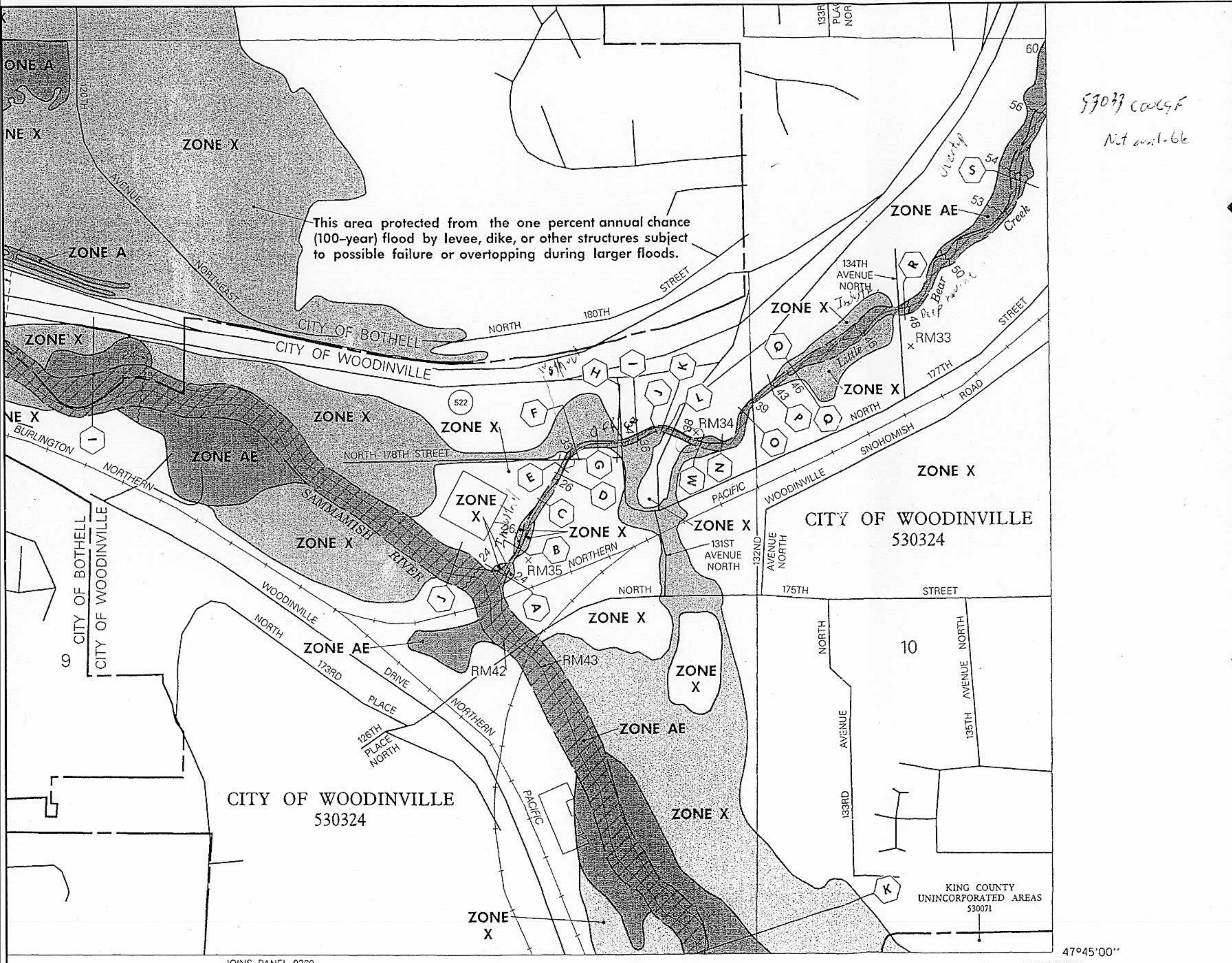
CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
KING COUNTY, UNINCORPORATED AREAS	530071	0069	F
WOODINVILLE, CITY OF	530324	0069	F

MAP NUMBER 53033C0069 F

MAP REVISED: MAY 16, 1995

Federal Emergency Management Agency



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APPROXIMATE SCALE IN FEET

500 0 500

NATIONAL FLOOD INSURANCE PROGRAM

FIRM

FLOOD INSURANCE RATE MAP

KING COUNTY, WASHINGTON AND INCORPORATED AREAS

PANEL 68 OF 1725

(SEE MAP INDEX FOR PANELS NOT PRINTED)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
BOTHELL, CITY OF	530075	0068	G
WOODINVILLE, CITY OF	530324	0068	G
KING COUNTY, UNINCORPORATED AREAS	530071	0068	G

MAP NUMBER
53033C0068 G

MAP REVISED:
NOVEMBER 8, 1999

Federal Emergency Management Agency