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Water Resources Program

OPEN-FILE TECHNICAL REPORT

WASHINGTON STATE
DEPARTMENT OF
ECOLOGY

DAWN LAKE DAM
HYDROLOGIC ANALYSIS

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Dam Safety Section
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This Open File Technical Report presents the results of a hydrologic investigation by the Water Resources Program, Dam Safety Section, of the Department of Ecology. It is intended as a working document and has received internal review. This report may also be circulated to other agencies and to the Public.

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DAWN LAKE DAM HYDROLOGIC ANALYSIS

INTRODUCTION

In accordance with RCW 43.21A.064(2), the Dam Safety Section (DSS) conducted a periodic inspection of the Dawn Lake Dam project on October 6, 1993. As part of the inspection, the DSS performed a hydrologic analysis to determine the adequacy of the project's spillway. This report summarizes that analysis.

GENERAL INFORMATION

Dawn Lake Dam is located 4½ miles south of the town of Port Angeles, in Clallam County (Figures 1 and 2). The facility is operated by Glenn Self and the Lake Dawn Water Users Association. Ownership of the dam was not clear at the time of this writing. The dam is either wholly or partially owned by the U.S. National Park Service or by Mr. Self. The ownership issue will be resolved by the Park Service early in 1994, when the Bureau of Land Management completes a survey of the dam area. The primary purpose of Dawn Lake Dam is for recreation and as an amenity to home owners surrounding the lake. The lake is mainly filled by springs and from a small creek located at the west end of the lake.

Dawn Lake was formed by construction of an earthfill dam at the east end of a topographic saddle between Mt. Angeles and "The Foothills". The original dam at Dawn Lake was a timber crib structure constructed sometime prior to 1950. In February 1950, this dam failed, causing extensive flooding and damage along lower Ennis Creek. The present earthfill dam was then constructed in mid-1950 to replace the failed structure.

The dam has a height of 17 feet, a crest width of 23 feet and a crest length of 100 feet. The crest elevation of the dam varies from 1823.0[a] feet at the left (north) end to 1821.5 feet at the right end. Figure 3 shows the existing dam crest profile. The spillway for this facility consists of a 24-inch diameter drop-inlet spillway through the right end of the dam. The riser is composed of a 24-inch diameter concrete pipe encased in concrete. The crest of the spillway is covered by a wood platform which prevents debris from entering the spillway. A 24-inch diameter concrete pipe is connected to the base of the riser, and conducts flow through the embankment to the downstream creek channel. A 10-inch gate valve is also connected to the

[a]All elevations are referenced to an assumed spillway crest elevation of 1820.0 feet.

base of the riser, which serves as the low level outlet. Outlet discharges pass through the spillway conduit.

The normal maximum lake level is about 1820.3 feet. According to Mr. Self, the lake generally stays within a few inches of this elevation year-round. During extreme rainfall events, however, the lake level can rise several more inches. The Lake Dawn Water Users open the outlet valve during extreme storms in order to maintain a lower lake level. The maximum reservoir storage capacity at the dam crest (elevation 1821.5 feet) is estimated to be 53 acre-feet, which represents a flood storage capacity of about 13 acre-feet between normal pool and top of dam.

CLIMATIC AND HYDROLOGIC CHARACTERISTICS OF THE BASIN

Based on 42 years of record at the Port Angeles Weather Station[1], and on isopluvial maps of Washington State prepared by the U.S. Weather Bureau[2], the mean annual precipitation for the Dawn Lake basin averages about 55 inches. The seasonal distribution is such that about 80% of the annual precipitation falls between October and March. Snow occurs in small amounts during most winters, but snowmelt is normally only a minor contributor to floods. Large flood events are generally produced by large rainfall events which occur in the period of October through March.

RECORDED STORMS AT NEARBY WEATHER STATIONS

Historically, the greatest 24 hour precipitation amounts observed in the Dawn Lake region have generally occurred between November and March[3]. The greatest 24 hour depth measured at a nearby weather station was 5.60 inches at Lake Sutherland in January 1935. Other notable 24 hour amounts at nearby stations include 4.81 inches at Elwha Ranger Station in November 1955, 4.56 inches at Lake Sutherland in November 1955, and 3.80 inches at Port Angeles in January 1986.

Notable 72-hour precipitation totals in the region include 9.57 inches at Lake Sutherland in January 1935, 6.52 inches at Elwha Ranger Station in November 1955 and 4.30 inches at Port Angeles in January 1986.

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DOWNSTREAM HAZARD POTENTIAL

A major consideration in the assessment of spillway adequacy is the selection of an appropriate inflow flood for evaluating the response of the reservoir and spillway(s). It is standard practice in the engineering community to select the magnitude of the Inflow Design Flood (IDF) dependent upon the level and type of development in the valley downstream from the dam. As the potential for loss of life and/or property damage resulting from a dam failure increases, the design criteria become increasingly more stringent.

Based on a dam breach analysis described later in this report, the consequences of a failure of Dawn Dam would include the potential for loss of life and property damage at five residences, damage to the sewage treatment plant, loss of two county roads, and the loss of the use of the facility. This corresponds to a downstream hazard classification of 1C, High downstream hazard potential.

SELECTION OF DESIGN STORMS

The DSS has recently adopted design storm selection criteria[4] which has an 8 Step format. Design storms range from a minimum of a 500 year event (Step 1) to Probable Maximum Precipitation (PMP, Step 8). Based on the potential for damage in the event of a flood induced dam failure, it was determined that the Dawn Lake Dam and spillway should be capable of accommodating an IDF as generated by a storm event corresponding to Step 4 of the 8 Step criteria. Such an event has about a 1% chance of being exceeded in the lifespan of the facility (assumed to be 100 years). The checklist in Appendix C shows the design step selection process.

The storm type considered for generating floods to assess spillway adequacy was a long duration, 72 hour event, which is characterized by relatively moderate intensities. This type of storm produces a flood having a sustained flood peak and a large runoff volume. This storm is critical with respect to flood generation because the basin is small, and a relatively large storage volume is available in the Dawn Lake. The selected Step 4 design storm has a 2 hour depth of 1.4 inches, a 6 hour depth of 3.5 inches, a 24 hour depth of 8.8 inches, and 72 hour depth of 12.5 inches. By comparison, the 24 hour Probable Maximum Precipitation (PMP) is estimated to be 14 inches, based on HMR-57[5].

Estimates of the precipitation amounts were made using data contained in NOAA Atlas II[6] and analyses of extreme storms in the region[7]. The temporal distribution of the design storm (hyetograph) was developed based on Ecology Report 89-51[8] and is shown in Figure 4.

RAINFALL RUNOFF MODEL

A rainfall-runoff computer model was used to assess the adequacy of the Dawn Lake Dam and spillway. The model selected for this study was the U.S. Army Corps of Engineers HEC-1 program[9]. HEC-1 is a single event model capable of simulating direct runoff from the land surface, channel routing in the creeks, as well as reservoir elevations and discharges. Inputs to the HEC-1 program include precipitation, land cover, soil types, and hydraulic characteristics of the reservoir. Each of these parameters is described in detail in the following sections.

A major limitation with HEC-1 is that it cannot simulate subsurface discharge to creeks or reservoirs. All precipitation that infiltrates is assumed lost from the system. This limitation is more significant for the simulation of long duration storms, such as the 72-hour storm, which have low rainfall intensities relative to the infiltration capacity of the soil. A modeling scheme was developed for use with the 72-hour storm that approximates a subsurface flow component for the infiltrated precipitation. This scheme is described in detail later in the report.

Drainage Basin - The watershed boundaries (Figure 2) were determined from aerial photographs and the Port Angeles and Mount Angeles 1:24000 scale USGS topographic maps. The contributing area for the Dawn Lake watershed was 280 acres, including the lake. For purposes of runoff modeling, the watershed was divided into two subbasins: the watershed surrounding the lake and the lake itself.

Basin Description - Dawn Lake is situated in a topographic saddle between Mt Angeles to the south and "The Foothills" to the north. The topography in the lower part of the basin adjacent to the lake consists of mild to moderate slopes. The upper portion of the watershed consists of the steep lower slopes of Mount Angeles and The Foothills. The basin elevation ranges from about 1820 feet at the lake to 2650 feet along the crest of The Foothills. The average elevation in the basin is about 2100 feet. The basin is heavily forested, with the exception of the residential area surrounding the lake.

Soil Types - According to soil survey maps for Clallam County prepared by the U.S. Soil Conservation Service[10] (SCS), the basin soils consist of gravelly clay loams associated with the Louella series. These soils were formed in residuum and colluvium derived from basalt and flow breccia. These soils have moderate permeability. Bedrock underlies these soils at depths greater than 60 inches. The SCS lists the permeability of these soils to be 0.6 to 2.0 inches/hour, and classifies them as Hydrologic Soil Group B. By comparison, Musgrave[11] determined that typical minimum infiltration rates for SCS Type B soils range from 0.15 to 0.30 inches/hour. Based on this information, a uniform infiltration rate of 0.40 inches per hour was used throughout the basin.

For storms typically experienced in the basin, the hydrologic response of the basin soils is generally subsurface, with little or no surface runoff. The soil moisture conditions antecedent to the beginning of the storm were assumed to be typical of mid-winter, when the reservoir is at maximum capacity and basin soils are saturated from numerous preceeding winter storms. Thus, soils were assumed to be at field capacity and no soil moisture deficit was present.

Based on the information listed above, a uniform infiltration rate of 0.40 in/hr was used for the upper soil stratum, and a deep percolation rate of 0.10 inches per hour was assumed for the bedrock/till stratum.

Snowpack Data - Snow occurs in most winters in the basin, especially on the upper slopes of the basin. In order to determine the snowpack conditions which would likely be in place during a late winter storm, snow data were examined from stations that were climatically similar to the Dawn Lake watershed. Based on this information, a 5-year snow water content of 2.8 inches was assumed to be present during the January design storm event.

RUNOFF MODELING APPROACH

The long duration, large volume design storm contains relatively low precipitation intensities, and therefore produces a relatively small percentage of surface runoff. The majority of the precipitation is infiltrated into the soil column. The runoff is thus dominated by shallow subsurface flow called interflow. Interflow is a complex flow mechanism composed of both unsaturated and saturated flow through the soil[12]. The infiltrated precipitation first travels vertically through the unsaturated zone of the soil column to a layer of lower permeability, such as glacial till or bedrock, where a zone of saturation forms. Flow then moves laterally according to the slope of the impervious layer until it intersects the reservoir or reemerges as a seepage face near the creek or reservoir. The HEC-1 program was not designed to handle interflow directly. However, a two step approach was developed for use in this study to approximate an interflow runoff response.

In the first step, the surface flow hydrograph was computed using the uniform loss rate equation. The surface runoff was routed to the reservoir using synthetic unit hydrographs with parameters estimated by using methods developed by the Soil Conservation Service[13] (Figure 5).

The second step simulates the interflow component. This step simulates the longer travel time for the flow to reach the reservoir. The precipitation minus the surface runoff was assumed to be available for interflow. A deep percolation rate of 0.10 in/hr was used to simulate the transfer of water to deep ground water. This moisture was assumed to be lost from the system.

The SCS unit hydrograph was used to simulate the subsurface lag time for this flow to travel to the reservoir. The soil/bedrock configuration in the Dawn Lake basin is similar hydrologically to the soil and glacial till profile described and modeled by Dincola[14] (USGS 89-4052). Based on work by Barker, 1992[15], the interflow response for the basin was initially estimated to have a time of concentration (T) of 6 hours. However, after calibrating the model to match water surface elevation at the lake during the the January 18-19, 1986 storm (which did not overtop the dam) the interflow lag was lengthened to 12 hours.

INFLOW DESIGN FLOOD

The runoff modeling approach described above was used to compute the flood hydrograph as generated by the 72 hour design storm. The total inflow hydrograph (surface, interflow and precipitation on the reservoir) is shown on Figure 6. This hydrograph produced 9 inches (211 acre-feet) of total runoff volume, with a peak flow of about 168 cubic feet per second. This flood is the Inflow Design Flood, and is the standard against which the hydrological/hydraulic adequacy of Dawn Lake Dam is to be measured.

FLOOD ROUTING THROUGH RESERVOIR AND SPILLWAY

To determine the response of the reservoir to floods, flood routing procedures were used to determine the maximum reservoir elevation and spillway discharge. Reservoir routing of the IDF was performed for two spillway configurations. Case 1 was for the existing dam and spillway configuration. Case 2 assumed that a 25 foot wide overflow spillway was added, with a crest elevation of 1820.5 feet, and the dam crest and parking lot area were raised to elevation 1822.5 feet.

Spillway Adequacy - Case 1: Existing Spillway - To assess the adequacy of the existing spillway, a rating curve was developed relating reservoir outflow to elevation (Figure 7). The spillway capacity is severely restricted by the deck covering the spillway inlet. The rating curve included flow from the low level outlet, which is normally opened during floods. The maximum discharge capacity of the spillway with the reservoir at the low point on the dam crest (elevation 1821.5 feet) was estimated to be 17 cfs. A reservoir elevation volume curve (Figure 8) was estimated based on the normal surface area and an estimate of the surface area based on photographs with the reservoir drawn down. At high reservoir pool levels (above 1821.5 feet), the right end of the dam and the adjacent parking lot would be overtopped, sending excess flow down the abutment contact. For initial runs the dam was assumed not to fail.

The lake level was set at elevation 1820.5 feet at the beginning of the storm, 0.5 feet above the spillway crest. The IDF hydrograph was then routed through the reservoir. The flood routing revealed that the IDF greatly exceeded the capacity of the existing spillway, and would overtop the dam by 0.6 feet. Such a depth of overtopping would likely result in an erosive failure of the earthen embankment. Appendix B provides a listing of the HEC-1 input and output for Case 1.

Based on the foregoing, the existing spillway capacity at Dawn Lake Dam is inadequate. In fact, further analysis showed that the existing facility can only handle about 30% of the IDF.

Spillway Adequacy - Case 2: Emergency Spillway Added - For Case 2, it was assumed that an emergency spillway was added with an invert elevation of 1820.5 feet, and the dam crest and parking lot area were raised to elevation 1822.5 feet. The spillway could be constructed through the Klahanie Club parking lot and discharge into an adjacent drainage course. (Alternatively, a concrete chute with a narrower section could be constructed over the dam). This spillway would increase the total spillway capacity to 240 cfs.

The IDF was routed through the reservoir with the above assumptions (Figure 9). The flood routing showed that the modified facility could safely handle the IDF with 0.8 feet of freeboard remaining on the dam. This freeboard would provide a factor of safety in the event of partial blockage of either spillway by debris.

Based on this analysis, the configuration listed in Case 2 would meet DSS standards for spillway adequacy. A summary of the reservoir routing analyses for both cases 1 and 2 is shown in Table 1.

TABLE 1
DAWN LAKE DAM
IDF ROUTING SUMMARY - CASES 1 AND 2

MODEL DESCRIPTION	PEAK INFLOW (cfs)	RUNOFF DEPTH (in)	RUNOFF VOLUME (Acre-feet)	PEAK RESERVOIR ELEVATION	PEAK OUTFLOW (cfs)	FREEBOARD ON DAM (ft)
IDF Case 1 - Existing Spillway	168	9.0	210	1822.1[a]	160	Overtops dam by 0.6 ft[b]
IDF Case 2 - Emerg. Spillway	168	9.0	210	1821.8[c]	130	0.8 feet

[a] Dam Crest Elevation = 1821.5 feet
[b] Includes 140 cfs over top of dam
[c] Dam crest Elevation = 1822.5 feet

DAM BREAK FLOOD ANALYSIS

The flood routing analysis demonstrated that the existing project configuration could not accommodate the IDF. Overtopping of the dam and erosive breaching of the embankment would likely occur during the IDF. This section describes the flooding that would occur downstream from the dam under this situation.

The dam breach was simulated using the methodology developed by the National Weather Service and contained in the HEC-1 program. Input data necessary for the computation of the dam breach included the physical dimensions of the breach and the estimated time for erosional development of the breach. These parameters were estimated based on the data from historical dam failures and presented in an article by MacDonald and Monopolis[16]. The shape of the dam breach was assumed to be trapezoidal, with a bottom width of 25 feet and side slopes of 0.5H:IV. The base elevation of the breach was assumed to be at 1822.0 feet. The time for the failure to fully develop was taken to be 24 minutes, which is a representative value for a dam of this size and reservoir volume.

The dam breach was simulated for both a "sunny day" failure, and during the IDF, under existing conditions. The sunny day scenario assumed that the lake level was 0.5 feet above the spillway, and that failure was by internal erosion and piping. This scenario would present the worst consequences to downstream residents, because there would be minimal flow in Ennis Creek prior to arrival of the dam break flood. Thus, the flood would hit without warning.

The IDF scenario assumed that the dam would fail by overtopping during the flood. Failure during the IDF would result in higher overall flood levels than the sunny day scenarios, but the threat to life may not be as severe because the antecedent flood would have already inundated most structures, and the area would likely have been evacuated.

The dam break analysis revealed that the peak discharge from a failure of Dawn Lake Dam for the "sunny day" scenario would be about 2160 cfs. Failure of the dam during the IDF would produce a peak discharge of about 2680 cfs. These discharges are about four and five times larger, respectively, than the 100-year flood along lower Ennis Creek.

The dam break flood was then routed downstream using the HEC-1 program. The floodplain below Dawn Lake is somewhat complicated by the presence of two large roadfills which would tend to attenuate the floods. The first roadfill is for the Hurricane Ridge Road, located some 400 feet downstream from dawn Lake Dam. This roadfill is about 37 feet high and has a 2 foot diameter concrete culvert at the creek level. Since the culvert capacity is severely limited, flows in excess of the pipe's capacity would fill the valley between the road and the dam, and would overtop the road. Based on an old topographic map of the site provided by the U.S. National Park service, the valley could store about 15 acre-feet before overtopping the road. The grade of the Hurricane Ridge Road is such that overtopping would occur away from the main embankment section. Because of the broad crest width of the road and the location of the overtopping, it is unlikely that this road would fail. Thus, Hurricane Ridge Road was modeled as a storage impoundment with an overtoppable crest.

Between Hurricane Ridge Road and U.S. Highway 101, the creek passes through a deeply incised, steeply sloped v-shaped valley. This valley is heavily forested and uninhabited. This reach as modeled using Muskingum routing with a K of 0.42 and a travel time (x) of 0.8 hours.

In the case of the dam break during the IDF, the IDF was also modeled for Ennis Creek and the discharge hydrograph was added to the dam break flood.

The second road fill along Ennis Creek is U.S. Highway 101, located 5.4 miles downstream from the Ridge Road. This roadfill is a 50 foot high embankment with an 8 foot by 10 foot rectangular concrete box culvert at the base. Based on topographic maps provided by the City of Port Angeles, the maximum storage capacity upstream from the road is 170 acre-feet. The maximum discharge capacity of the box culvert is about 2700 cfs. All computer runs indicated that the combination of storage capacity and discharge capacity was sufficient to prevent the roadfill from overtopping. Thus, the U.S. 101 roadfill was assumed not to fail.

Downstream from the roadfill, the floods were routed through the populated area along Ennis Creek using the Muskingum-Cunge routing technique. This is a diffusion routing technique which accounts for the physical properties of the stream channel and the hydraulics of the breach hydrograph. Cross sections were determined from 1" = 200' scale, 5-foot contour interval topographic maps provided by the City of Port Angeles.

The analysis showed that the dam break floods would spread across the lower Ennis Creek valley below U.S. 101. Under the "sunny day" scenario, a total of three houses would be inundated. Under the IDF, a total of five houses would be inundated. A detailed inundation map of the populated area for both cases is provided in Figure 11.

Downstream from the residential area, the dam break floods would partially inundate the sewage treatment plant, then would flood the ITT Rayonier parking lot upstream from an old railroad bridge. Beyond the railroad, the flood would likely cause some damage at the ITT mill before dumping into the Straits of Juan de Fuca.

A summary of the dam breach routing analysis is shown in Table 2.

TABLE 2
DAM BREACH AND FLOOD ROUTING SUMMARY

LOCATION	PEAK DISCHARGE (cfs)		PEAK FLOOD ELEVATION (ft)		MAXIMUM FLOOD DEPTH (ft)		TIME OF BREACH PEAK
	Sunny Day	IDF	Sunny Day	IDF	Sunny Day	IDF	(minutes from start of failure)
Dawn Lake Dam	2160	2680	1820.5	1822.0	--	--	24
Hurricane Ridge Rd	2080	2470	1801.9	1802.0	1.9	2.0	30
U.S. 101							
• upstream	1710	3640	143.5	160.2	13.5	30.2	76
• downstream	1100	2010	--	--	--	--	88
Cross Section 3 Lower Ennis Creek Rd	1090	2000	90.3	91.6	10.3	11.6	92
Cross Section 7 End residential area	1080	1980	63.1	64.0	9.1	10.0	96

Figures 10 and 11 provide inundation maps of the downstream area based on the preceding analysis.

CONCLUSIONS

In summary, the flood routing analysis revealed that in its existing condition, Dawn Lake Dam cannot safely accommodate the IDF. In fact, the analysis indicated that the facility can only handle a flood generated by about 30% of the IDF. Furthermore, even if the reservoir was completely drained and the outlet locked open, the facility could only handle about 50% of the IDF. If a major storm and resultant flood were to occur, the dam would be overtopped and failure would likely result. The dam break analysis indicated that catastrophic flooding would occur downstream from the dam along lower Ennis Creek, possibly leading to loss of lives. Thus, it was concluded that the dam and spillway need to be modified to safely pass the IDF.

RECOMMENDATIONS

As a result of this analysis and field inspection, the following remedial work is needed to ensure Dawn Lake Dam meets Dam Safety Section standards for flood capacity.

1. Construct an emergency spillway to prevent the dam from overtopping during the IDF.

   One spillway option would be to construct an open channel through the parking lot on the south abutment. The spillway would need a base width of 25 feet with 2H:1V side slopes and an invert elevation of 1820.5 feet, 0.5 feet above the current spillway. The dam crest will have to be raised about one foot to elevation 1822.5 feet. The spillway would extend through the parking lot and discharge into a ravine which ties into the main creek above Hurricane Ridge Road. The spillway could be grass lined, provided concrete cutoff walls were constructed across the channel at several locationsto prevent headword erosion.

   Other spillway options are possible and would include:

   a. Construct a concrete chute with a narrower cross section over the dam embankment.

   b. Construct a new, large diameter culvert spillway with a concrete drop-inlet entrance structure.

   c. Construct berms and raising the dam to prevent overtopping by forcing excess floodwater through the parking lot area.

2. A video inspection of the existing spillway discharge conduit revealed it to be in poor condition with numerous cracks and leaks along the concrete pipe. This pipe either needs to be replaced, or repaired by inserting a smaller pipe into the existing pipe, and grouting the space between the pipes with concrete.

3. Remove the wood decking on top of the spillway riser to increase discharge capacity. The decking could be replaced with an open-mesh steel grating with a surface area 3-5 times the inlet opening.

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APPENDIX A

FIGURES

APPENDIX B

HEC-1 OUTPUT FILE FOR CASE 1

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*                                       *
*  FLOOD HYDROGRAPH PACKAGE  (HEC-1)    *
*             MAY  1991                 *
*           VERSION 4.0.1E              *
*                                       *
* RUN DATE  12/08/93  TIME  14:02:59    *
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*                                     *
*   U.S. ARMY CORPS OF ENGINEERS      *
*   HYDROLOGIC ENGINEERING CENTER     *
*         609 SECOND STREET           *
*      DAVIS, CALIFORNIA 95616        *
*          (916) 551-1748             *
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X     X  X        X     X         XX
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THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

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LINE        ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1         ID   FILE DAWNIDFA.DAT  DAWN LAKE DAM  IDF STUDY
  2         ID                  72 HOUR INTENSITY STORM
  3         ID                  24 HR DEPTH = 8.7 IN.
  4         ID                  72 HR DEPTH = 12.5 IN
  5         ID                  RUN TO DETERMINE COMBINED SURFACE AND INTERFLOW
  6         ID             ***** Reservoir full - Existing Spillway Configuration **
  7         ID                **** RAINFALL + SNOWMELT ****
  8         ID
  9         ID       No DAM BREACH - model Calibrated 0.10 deep perc, 12 hr int lag
 10         ID
 11         IT       4 01JAN99    1200    1260
 12         IO       1

 13         KK     100  RUNOFF FROM BASIN
 14         KM          COMPUTED RUNOFF FROM WATERSHED AND LAKE
 15         KO       3
 16         BA   0.428
 17         IN      12 01JAN99    1200
            *  IDF INFLOW HYDROGRAPH ABOVE DAWN LAKE
 18         QI       0       0       0       0       0       0       0       0       0       0
 19         QI       0       0       0       0       0       0       0       0       0       0
 20         QI       0       0       0       0       0       0       0       0       0       0
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 31         QI       0       0       0       0       0       0       0       0       0       0
 32         QI       1       1       1       1       1       1       1       1       1       1
 33         QI       1       1       1       1       1       2       2       2       2       2
 34         QI       2       2       2       3       3       3       3       3       3       3
 35         QI       4       4       4       4       4       5       5       5       5       5
 36         QI       6       6       6       6       6       7       7       7       8       8
 37         QI       8       8       9       9       9       9      10      10      10      11
 38         QI      11      11      12      12      12      13      13      13      14      14
 39         QI      14      15      15      16      16      17      17      18      18      19
 40         QI      19      22      23      28      31      35      41      44      51      57
 41         QI      62      70      74      88      99     118     142     163     159     151
 42         QI     138     118     105      94      90      87      85      83      81      79
 43         QI      78      76      74      73      72      71      69      68      68      67
 44         QI      66      65      65      64      63      63      63      62      62      62
 45         QI      61      61      61      61      61      61      61      61      61      61
 46         QI      61      61      61      61      61      61      61      61      61      61
 47         QI      61      61      61      61      61      62      62      62      62      62
 48         QI      62      62      62      62      62      62      62      62      61      61
 49         QI      61      61      61      61      61      61      60      60      60      60
 50         QI      59      59      59      59      58      58      57      57      57      56
 51         QI      56      55      55      54      54      53      53      52      52      51
 52         QI      50      50      49      49      48      47      47      46      45      44
 53         QI      44      43      42      42      41      40      39      39      38      37
```

```
LINE           ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

 54            QI      36      35      35      34      33      33      32      31      30      30
 55            QI      29      28      28      27      26      26      25      24      24      23
 56            QI      23      22      22      21      20      20      19      19      18      18
 57            QI      17      17      16      16      15      15      15      14      14      13
 58            QI      13      13      12      12      12      11      11      11      10      10
 59            QI      10      10       9       9       9       9       8       8       8       8

 60            KK     200     ROUTE FLOOD THROUGH DAWN LAKE  Reservoir Full
 61            KM             Existing Spillway Configuration
 62            KO       3
 63            RS       1    ELEV  1820.5
 64            SV       0       2      16      40    44.2    48.4    52.9    57.5    62.2
 65            SQ       0       0       0       0       6    15.0      17      19      21
 66            SE    1808    1810    1816    1820  1820.5    1821  1821.5    1822  1822.5
 67            ST  1821.5      50     2.6     1.5
 68            SW      50     180     220
 69            SE  1821.5    1822  1822.0
               * SB  1808      25     0.5     0.4  1822.0

 70            KK     250    ROUTE FLOOD THROUGH HURRICANE RIDGE ROAD FILL AND CANYON
 71            KO       3
 72            RS       1    ELEV  1765.0
 73            SV       0     0.5       1     5.5    10.5    11.8    13.0    15.0
 74            SQ       0       5      43      62      72      76      78      80
 75            SE    1763    1765    1773    1788    1798    1800    1801    1802
 76            ST    1800      50     2.6     1.5
 77            SW      50     175     350     450     550
*** WARNING *** ZZ-CARD MISSING
 78            SE    1800  1800.5  1801.0  1801.5    1802
 79            ZZ
```

```
*****************************************                          ***************************************
*                                       *                          *                                     *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                          *   U.S. ARMY CORPS OF ENGINEERS      *
*              MAY   1991               *                          *   HYDROLOGIC ENGINEERING CENTER     *
*           VERSION 4.0.1E              *                          *         609 SECOND STREET           *
*                                       *                          *      DAVIS, CALIFORNIA 95616        *
*  RUN DATE  12/08/93  TIME  14:02:59   *                          *          (916) 551-1748             *
*                                       *                          *                                     *
*****************************************                          ***************************************




                   FILE DAWNIDFA.DAT  DAWN LAKE DAM  IDF STUDY
                                72 HOUR INTENSITY STORM
                                24 HR DEPTH = 8.7 IN.
                                72 HR DEPTH = 12.5 IN
                                RUN TO DETERMINE COMBINED SURFACE AND INTERFLOW
                          ***** Reservoir full - Existing Spillway Configuration **
                             **** RAINFALL + SNOWMELT ****

                       No DAM BREACH - model Calibrated 0.10 deep perc, 12 hr int lag


 12 IO          OUTPUT CONTROL VARIABLES
                      IPRNT           1  PRINT CONTROL
                      IPLOT           0  PLOT CONTROL
                      QSCAL          0.  HYDROGRAPH PLOT SCALE

   IT           HYDROGRAPH TIME DATA
                       NMIN           4  MINUTES IN COMPUTATION INTERVAL
                      IDATE      1JAN99  STARTING DATE
                      ITIME        1200  STARTING TIME
                         NQ        1260  NUMBER OF HYDROGRAPH ORDINATES
                     NDDATE      4JAN99  ENDING DATE
                     NDTIME        2356  ENDING TIME
                      ICENT          19  CENTURY MARK

                COMPUTATION INTERVAL    0.07 HOURS
                     TOTAL TIME BASE   83.93 HOURS

         ENGLISH UNITS
              DRAINAGE AREA          SQUARE MILES
              PRECIPITATION DEPTH    INCHES
              LENGTH, ELEVATION      FEET
              FLOW                   CUBIC FEET PER SECOND
              STORAGE VOLUME         ACRE-FEET
              SURFACE AREA           ACRES
              TEMPERATURE            DEGREES FAHRENHEIT


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


          **************
          *            *
 13 KK    *      100   *       RUNOFF FROM BASIN
          *            *
```

```
              **************
                                    COMPUTED RUNOFF FROM WATERSHED AND LAKE

  15 KO          OUTPUT CONTROL VARIABLES
                       IPRNT           3  PRINT CONTROL
                       IPLOT           0  PLOT CONTROL
                       QSCAL          0.  HYDROGRAPH PLOT SCALE

  17 IN          TIME DATA FOR INPUT TIME SERIES
                       JXMIN          12  TIME INTERVAL IN MINUTES
                      JXDATE      1JAN99  STARTING DATE
                      JXTIME        1200  STARTING TIME

                SUBBASIN RUNOFF DATA

  16 BA          SUBBASIN CHARACTERISTICS
                       TAREA        0.43  SUBBASIN AREA

                                                                     ***

      ***              ***              ***              ***              ***

                            HYDROGRAPH AT STATION       100

 PEAK FLOW     TIME                             MAXIMUM AVERAGE FLOW
   (CFS)       (HR)                    6-HR         24-HR        72-HR       83.93-HR
     163.     47.40        (CFS)        93.           68.          29.            25.
                        (INCHES)      2.031         5.868        7.629          7.629
                         (AC-FT)        46.          134.         174.           174.

                           CUMULATIVE AREA =      0.43 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

              **************
              *            *
  60 KK       *      200   *          ROUTE FLOOD THROUGH DAWN LAKE  Reservoir Full
              *            *
              **************
                                       Existing Spillway Configuration

  62 KO          OUTPUT CONTROL VARIABLES
                       IPRNT           3  PRINT CONTROL
                       IPLOT           0  PLOT CONTROL
                       QSCAL          0.  HYDROGRAPH PLOT SCALE

                HYDROGRAPH ROUTING DATA

  63 RS          STORAGE ROUTING
                       NSTPS           1  NUMBER OF SUBREACHES
                        ITYP        ELEV  TYPE OF INITIAL CONDITION
                      RSVRIC     1820.50  INITIAL CONDITION
                           X        0.00 WORKING R AND D COEFFICIENT

  64 SV            STORAGE         0.0       2.0      16.0      40.0      44.2      48.4      52.9      57.5      62.2
```

```
 65 SQ          DISCHARGE          0.         0.         0.         0.         6.        15.        17.        19.        21.

 66 SE          ELEVATION    1808.00    1810.00    1816.00    1820.00    1820.50    1821.00    1821.50    1822.00    1822.50

 67 ST          TOP OF DAM
                      TOPEL    1821.50  ELEVATION AT TOP OF DAM
                     DAMWID      50.00  DAM WIDTH
                       COQD       2.60  WEIR COEFFICIENT
                       EXPD       1.50  EXPONENT OF HEAD

    SW          DAM WIDTH      50.00     180.00     220.00
    SE          ELEVATION    1821.50    1822.00    1822.00

                                                                      ***

     ***              ***              ***              ***              ***

                           HYDROGRAPH AT STATION      200

PEAK OUTFLOW IS      148. AT TIME  47.87 HOURS


 PEAK FLOW     TIME                              MAXIMUM AVERAGE FLOW
   (CFS)       (HR)                      6-HR         24-HR        72-HR      83.93-HR
     148.     47.87         (CFS)          89.          66.          28.          24.
                         (INCHES)        1.932        5.706        7.210        7.349
                          (AC-FT)          44.         130.         165.         168.

PEAK STORAGE   TIME                            MAXIMUM AVERAGE STORAGE
  (AC-FT)      (HR)                      6-HR         24-HR        72-HR      83.93-HR
       58.    47.87                        57.          56.          49.          48.

 PEAK STAGE    TIME                              MAXIMUM AVERAGE STAGE
   (FEET)      (HR)                      6-HR         24-HR        72-HR      83.93-HR
  1822.05     47.87                    1821.90      1821.82      1820.99      1820.88

                          CUMULATIVE AREA =     0.43 SQ MI



*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


              **************
              *            *
 70 KK        *      250   *           ROUTE FLOOD THROUGH HURRICANE RIDGE ROAD FILL AND CANYON
              *            *
              **************

 71 KO          OUTPUT CONTROL VARIABLES
                      IPRNT          3  PRINT CONTROL
                      IPLOT          0  PLOT CONTROL
                      QSCAL         0.  HYDROGRAPH PLOT SCALE

                HYDROGRAPH ROUTING DATA

 72 RS          STORAGE ROUTING
                      NSTPS          1  NUMBER OF SUBREACHES
                       ITYP       ELEV  TYPE OF INITIAL CONDITION
```

	RSVRIC	1765.00 INITIAL CONDITION							
	X	0.00 WORKING R AND D COEFFICIENT							
73 SV	STORAGE	0.0	0.5	1.0	5.5	10.5	11.8	13.0	15.0
74 SQ	DISCHARGE	0.	5.	43.	62.	72.	76.	78.	80.
75 SE	ELEVATION	1763.00	1765.00	1773.00	1788.00	1798.00	1800.00	1801.00	1802.00

76 ST	TOP OF DAM		
	TOPEL	1800.00	ELEVATION AT TOP OF DAM
	DAMWID	50.00	DAM WIDTH
	COQD	2.60	WEIR COEFFICIENT
	EXPD	1.50	EXPONENT OF HEAD

SW	DAM WIDTH	50.00	175.00	350.00	450.00	550.00
SE	ELEVATION	1800.00	1800.50	1801.00	1801.50	1802.00

***

*** *** *** *** ***

HYDROGRAPH AT STATION 250

PEAK OUTFLOW IS 75. AT TIME 50.73 HOURS

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	83.93-HR
(CFS)	(HR)					
75.	50.67	(CFS)	73.	65.	28.	24.
		(INCHES)	1.586	5.633	7.190	7.341
		(AC-FT)	36.	129.	164.	168.

PEAK STORAGE	TIME	MAXIMUM AVERAGE STORAGE			
(AC-FT)	(HR)	6-HR	24-HR	72-HR	83.93-HR
12.	50.67	11.	7.	3.	2.

PEAK STAGE	TIME	MAXIMUM AVERAGE STAGE			
(FEET)	(HR)	6-HR	24-HR	72-HR	83.93-HR
1799.59	50.73	1798.32	1790.98	1773.96	1772.61

CUMULATIVE AREA = 0.43 SQ MI

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
HYDROGRAPH AT	100	163.	47.40	93.	68.	29.	0.43		
ROUTED TO	200	148.	47.87	89.	66.	28.	0.43	1822.05	47.87
ROUTED TO	250	75.	50.67	73.	65.	28.	0.43	1799.59	50.73

SUMMARY OF DAM OVERTOPPING/BREACH ANALYSIS FOR STATION 200
(PEAKS SHOWN ARE FOR INTERNAL TIME STEP USED DURING BREACH FORMATION)

PLAN 1 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1820.50	1821.50	1821.50
STORAGE	44.	53.	53.
OUTFLOW	6.	17.	17.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	1822.05	0.55	58.	148.	33.60	47.87	0.00

SUMMARY OF DAM OVERTOPPING/BREACH ANALYSIS FOR STATION 250
(PEAKS SHOWN ARE FOR INTERNAL TIME STEP USED DURING BREACH FORMATION)

PLAN 1 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1765.00	1800.00	1800.00
STORAGE	1.	12.	12.
OUTFLOW	5.	76.	76.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	1799.59	0.00	12.	75.	0.00	50.73	0.00

*** NORMAL END OF HEC-1 ***

APPENDIX C

DESIGN STEP WORKSHEET

WORKSHEET
DAM SAFETY GUIDELINES

SELECTION OF DESIGN/PERFORMANCE GOALS FOR CRITICAL PROJECT ELEMENTS

PROJECT NAME: Dawn Lake Dam

DAM NAME: Same

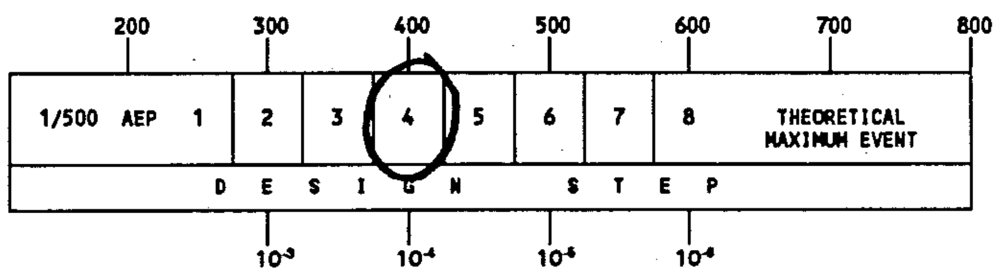
CONSEQUENCES EVALUATED FOR FAILURE OF Dam

AT RESERVOIR LEVEL OF Overtopping

SUMMARY SHEET

		CONSEQUENCE RATING POINTS
I.	CAPITAL VALUE OF PROJECT	60
II.	POPULATION AT RISK	126
III.	DOWNSTREAM PROPERTY AT RISK	77
	BASE POINTS	150
	CUMULATIVE CONSEQUENCE RATING POINTS . . .	413

CUMULATIVE CONSEQUENCE RATING POINTS



DESIGN/PERFORMANCE GOAL - ANNUAL EXCEEDANCE PROBABILITY

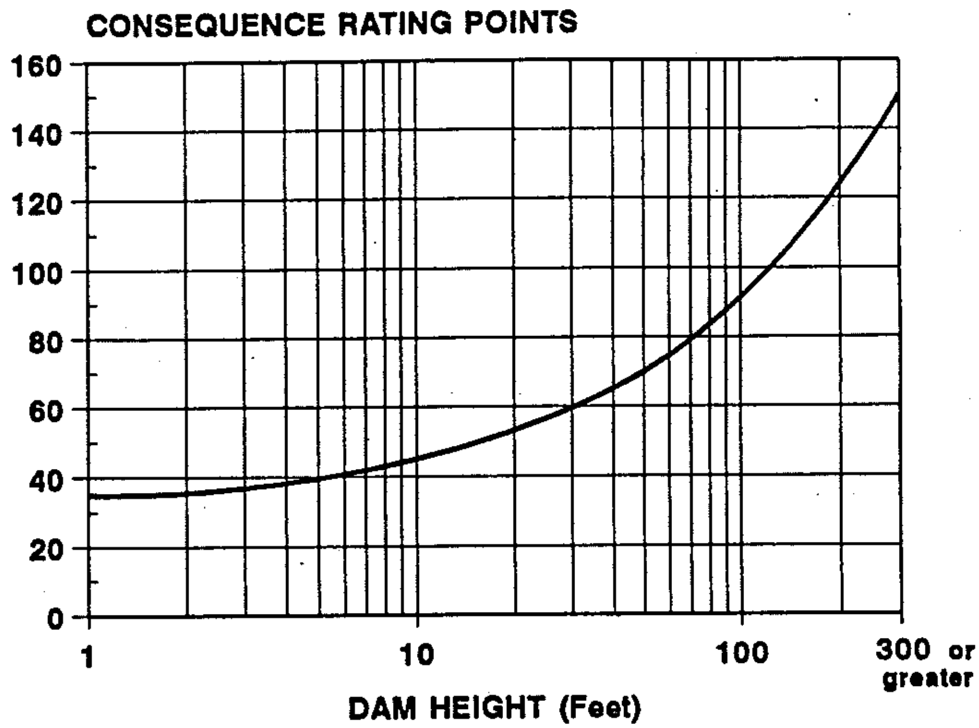
DESIGN STEP NUMBER 4

PROJECT ENGINEER Douglas L Johnson **DATE** 11/20/93

I. CAPITAL VALUE OF PROJECT

A. DAM HEIGHT INDEX

	Dam Height (feet)	Consequence Rating Points
Maximum Dam Height	17	50



B. VALUE OF RESERVOIR CONTENTS/PROJECT BENEFITS

Mandatory Consideration for Some Projects		Points Per Item	Consequence Rating Points
1.	Public Water Supply Storage	25 - 75	–
Discretionary Considerations			
2.	Irrigation Water Supply Storage	10 - 75	______
3.	Industrial Water Supply Storage	10 - 75	______
4.	Hydropower Generation Facilities	10 - 75	______
5.	Mining or Manufacturing Process Water	10 - 75	______
6.	Aesthetics, Recreation or Wildlife Habitat	10 - 25	10
7.	Other ______________________		______

Describe: ____

____

____

____

____

____

____

____

____

____

Assignment of consequence rating points to dams which provide a community with a limited resource, such as a public water supply, is mandatory.

Assignment of consequence rating points to dams which provide benefits primarily to the owner, is at the discretion of the owner and/or project engineer.

A wide range of consequence rating points are possible for the various project benefits. Selection of an appropriate value should be based on the size and importance of the project benefit under consideration relative to the broad range of projects of that type. In addition, a larger or smaller value may be selected depending on the owner's and/or project engineer's perceived need for conservatism in protecting project benefits.

SUBSECTION I - SUBTOTAL OF CONSEQUENCE RATING POINTS 60

II. POPULATION AT RISK

A. CATASTROPHIC POTENTIAL INDEX

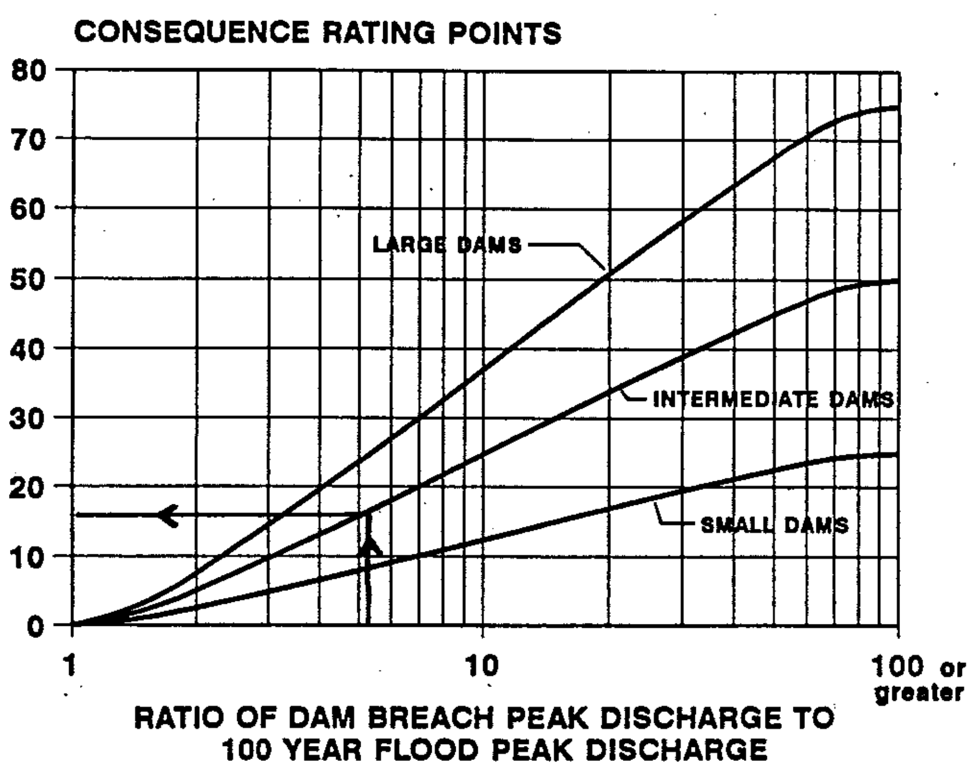
1. Estimated Dam Breach Peak Discharge at Dam Site due to Failure of Critical Project Element ____2700____ cfs

2. Estimated 100 year Flood Peak Discharge ____500____ cfs

   Taken on a Natural Watercourse at First Location Downstream of the Dam Where There is a Potential for Loss of Life or

   If There is No Downstream Development, It is Taken on the Natural Watercourse at a Point 1 Mile Downstream of Dam

	Index	Consequence Rating Points
3. Ratio of Dam Breach Peak Discharge to 100 Year Flood Peak Discharge	5.3	16

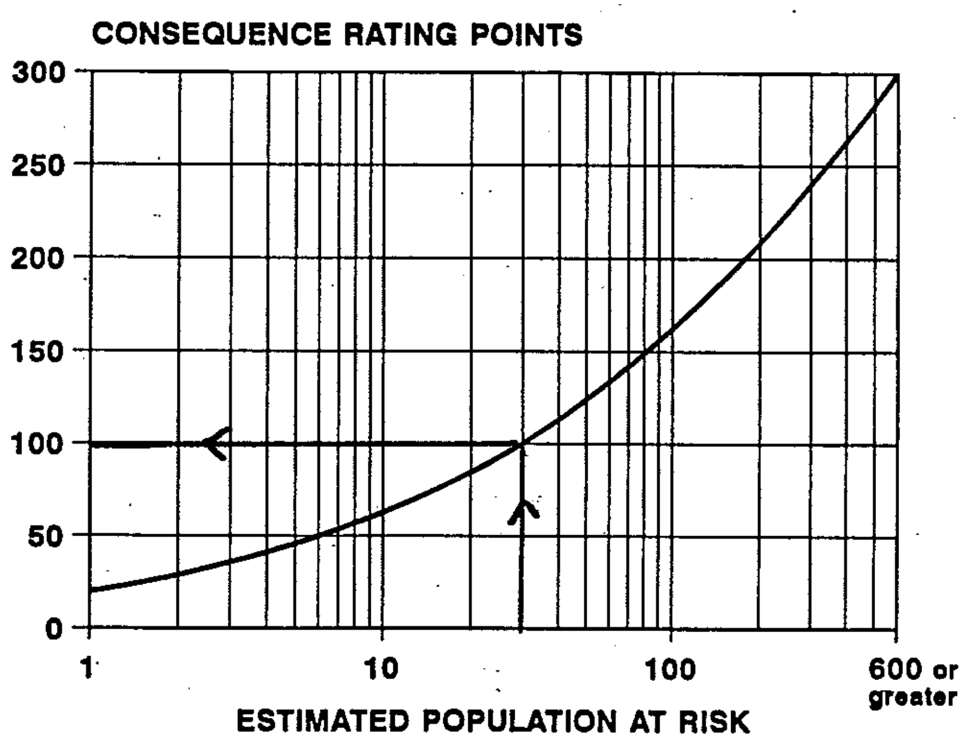


II. POPULATION AT RISK - Continued

B. POPULATION AT RISK INDEX

		No. of Persons	Consequence Rating Points
1.	Estimated Current Population at Risk (PAR)	15	
2.	Increase in Population Due to Development	15	
3.	TOTAL - Future Population at Risk	30	100

Describe: 5 homes @ 3 persons each



II. POPULATION AT RISK - Continued

C. ADEQUACY OF WARNING

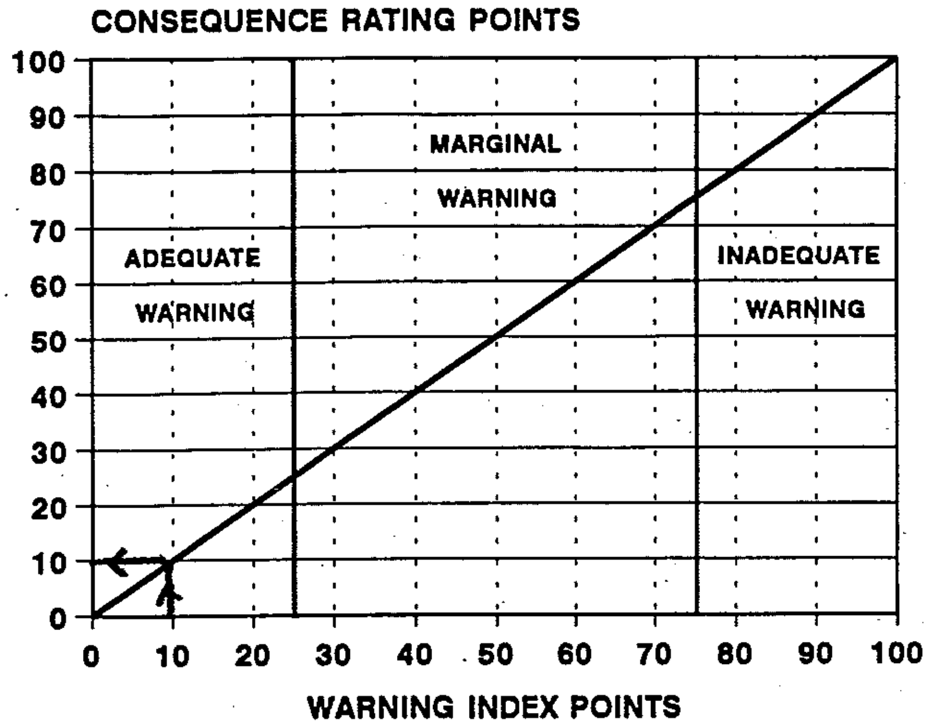
To be used when there is Population at Risk

FACTOR	ADEQUATE WARNING	MARGINAL WARNING	INADEQUATE WARNING
ADVANCED WARNING TIME	More than 30 minutes *0 Warning Index Points*	More Than 10 Minutes but Less Than 30 Minutes *25 Warning Index Points*	Less Than 10 Minutes *50 Warning Index Points*
LIKELIHOOD OF DANGEROUS SITUATION TO BE OBSERVED AND NOTIFICATION GIVEN TO GENERAL PUBLIC	Dam Owner Resides near Dam Site, or Designated Responsible Party Has Reasonably Short Access Time to Dam Site and has Duty of Initiating Warning *0 Warning Index Points*	Designated Responsible Party not Located near Dam Site, but Dam Site is Visible to General Public. There is Reasonably Good Vehicular Access near Dam Site and Intermittent Vehicular Traffic. *15 Warning Index Points*	No Designated Responsible Party near Dam Site. Dam in Remote Location. Poor Vehicular Access to Dam Site. *30 Warning Index Points*
DOWNSTREAM VALLEY SETTING AND EASE OF EVACUATION	Valleys with Good Access to High Ground and Good Roadway Systems for Escape Routes *0 Warning Index Points*	Valleys with Limited Access to High Ground and Limited Roadway Systems *10 Warning Index Points*	Narrow Confining Valley with Roadways near the Stream Bank or Along Valley Floor and Poor Access to High Ground *20 Warning Index Points*

	Item	Warning Index Points	Consequence Rating Points
1.	Advanced Warning Time	0	
2.	Likelihood of Dangerous Situations to be Observed and Notification Give to Public	0	
3.	Downstream Valley Setting and Ease of Evacuation	10	
	TOTAL WARNING INDEX POINTS	10	

WARNING RATED AS Adequate 10

II. POPULATION AT RISK - Continued



Describe: ____

____

____

____

____

____

____

____

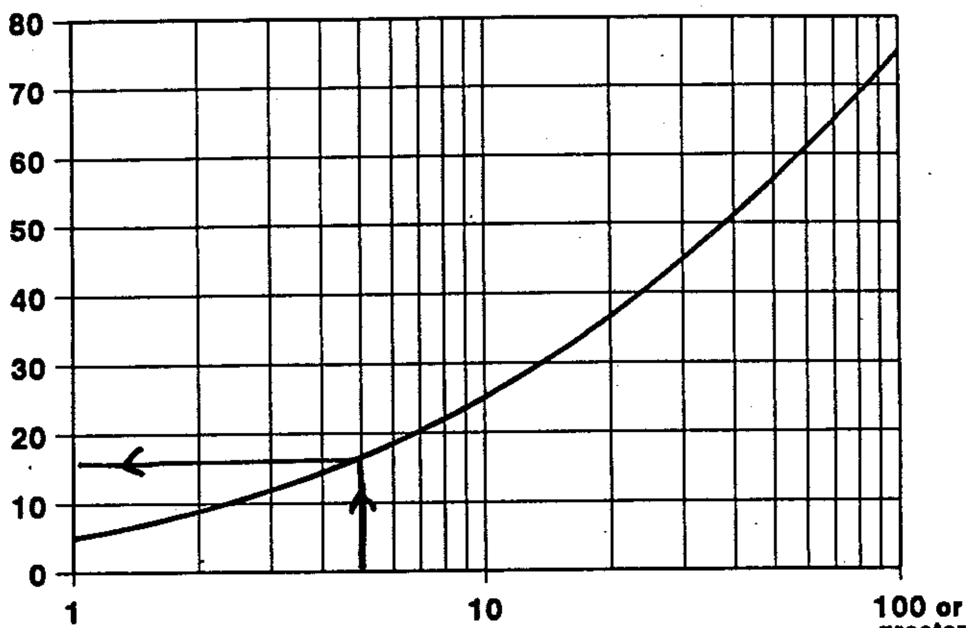
____

____

SUBSECTION II - SUBTOTAL OF CONSEQUENCE RATING POINTS 126

III. DOWNSTREAM PROPERTY AT RISK

A. RESIDENTIAL UNITS	No. of Items	Consequence Rating Points
1. Equivalent Single Family Dwelling Units	5	17



B. LIFELINE FACILITIES	Points Per Item	No. of Items	Consequence Rating Points
1. Transportation Links - Bridges and Stream Crossings			
a. Freeways/interstate highways Railway main lines	25		
b. State highways	10		
c. Other public roads Railway spur lines	2 - 5	2	10

III. DOWNSTREAM PROPERTY AT RISK - Continued

			Points Per Item	No. of Items	Consequence Rating Points
2.	Water Supply Systems				
	a.	Storage Reservoirs (Downstream)	10 - 75		
	b.	Treatment Facilities	10 - 25		
	c.	Delivery Systems	5 - 25		
3.	Domestic Waste Treatment Systems				
	a.	Treatment Facilities Port Angeles Treatment Plant	5 - 25	1	15
4.	Electric Power Facilities				
	a.	Electric power plant or Appurtenant works	5 - 75		
5.	Emergency Response Facilities				
	a.	Hospitals, Police, Fire, Paramedical Units	10 - 75		

C. OTHER IMPORTANT FACILITIES

		Points Per Item	No. of Items	Consequence Rating Points
1.	Public Buildings, Schools, Libraries	10 - 75		
2.	Fish Hatcheries	5 - 25		
3.	Industrial, Commercial and Agricultural Developments	5 - 75		25
4.	Other Facilities or Considerations ITT Rayonier Mill & Parking			

A wide range of consequence rating points are possible for the damages that could occur to property and lifeline facilities. Selection of an appropriate value should be based on the size and importance of the features under consideration relative to the broad range of features of that type. In addition, a larger or smaller value may be selected depending on the owner's and/or project engineer's perceived need for the protection against property damages.

III. DOWNSTREAM PROPERTY AT RISK - Continued

		Points Per Item	No. of Items	Consequence Rating Points
D.	**ENVIRONMENTAL DEGRADATION**			
1.	Deleterious contents in proposed reservoir			
a.	Release of reservoir contents will result in long term environmental degradation	10 - 75	____	________
b.	Release of reservoir contents will result in temporary, minor environmental degradation	5 - 20	1	10
2.	Damage to downstream facilities could result in release of deleterious materials stored on-site			
a.	Release of deleterious materials will result in long term environmental degradation	10 - 75	____	________
b.	Release of deleterious materials will result in temporary, minor environmental degradation	5 - 20	____	________

Description of damages to property, lifeline facilities, and environmental degradation: Siltation & Erosion of Creek

SUBSECTION III - SUBTOTAL OF CONSEQUENCE RATING POINTS 77

GENERAL NOTES AND COMMENTS:

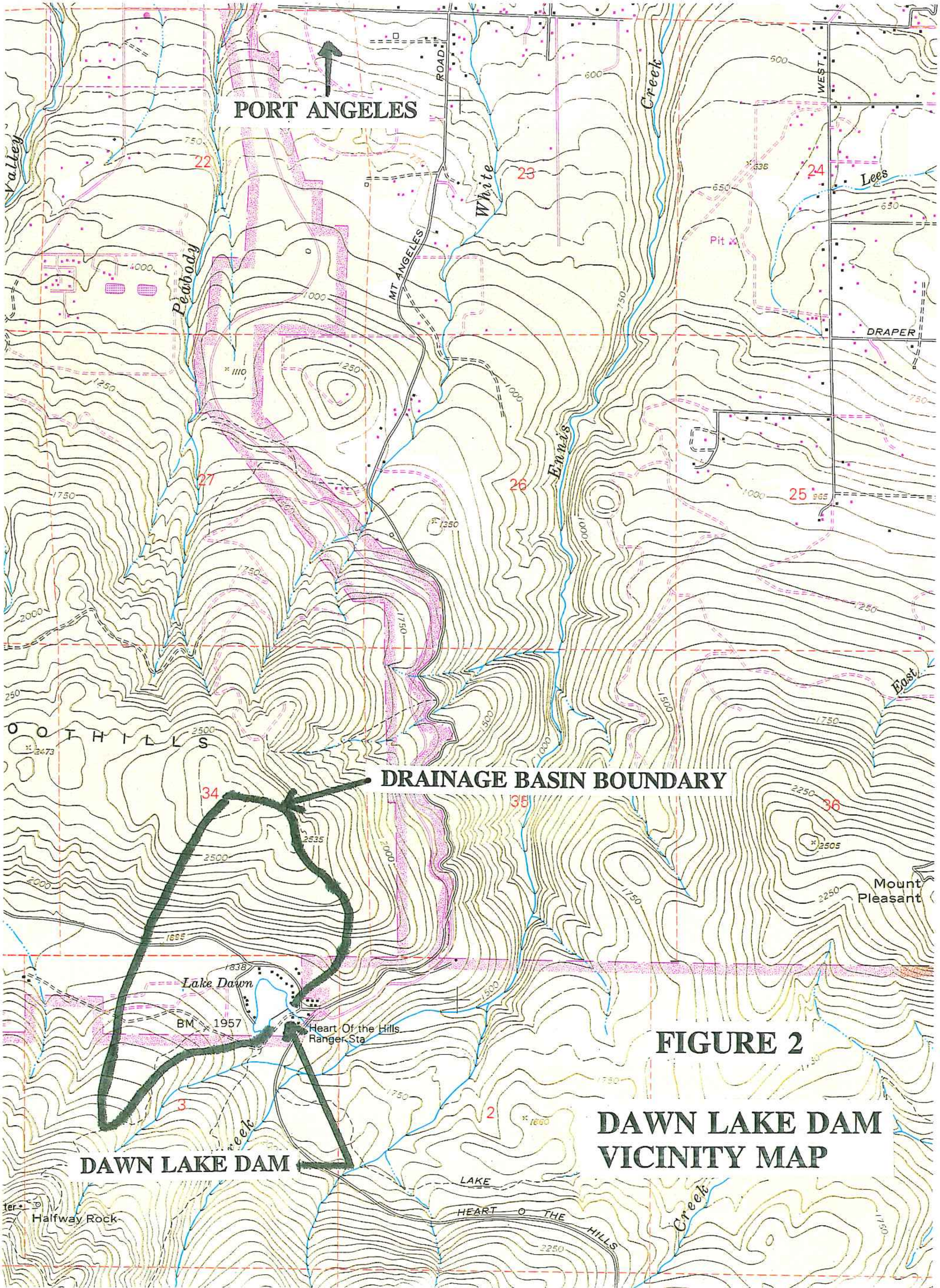


FIGURE 2

DAWN LAKE DAM VICINITY MAP

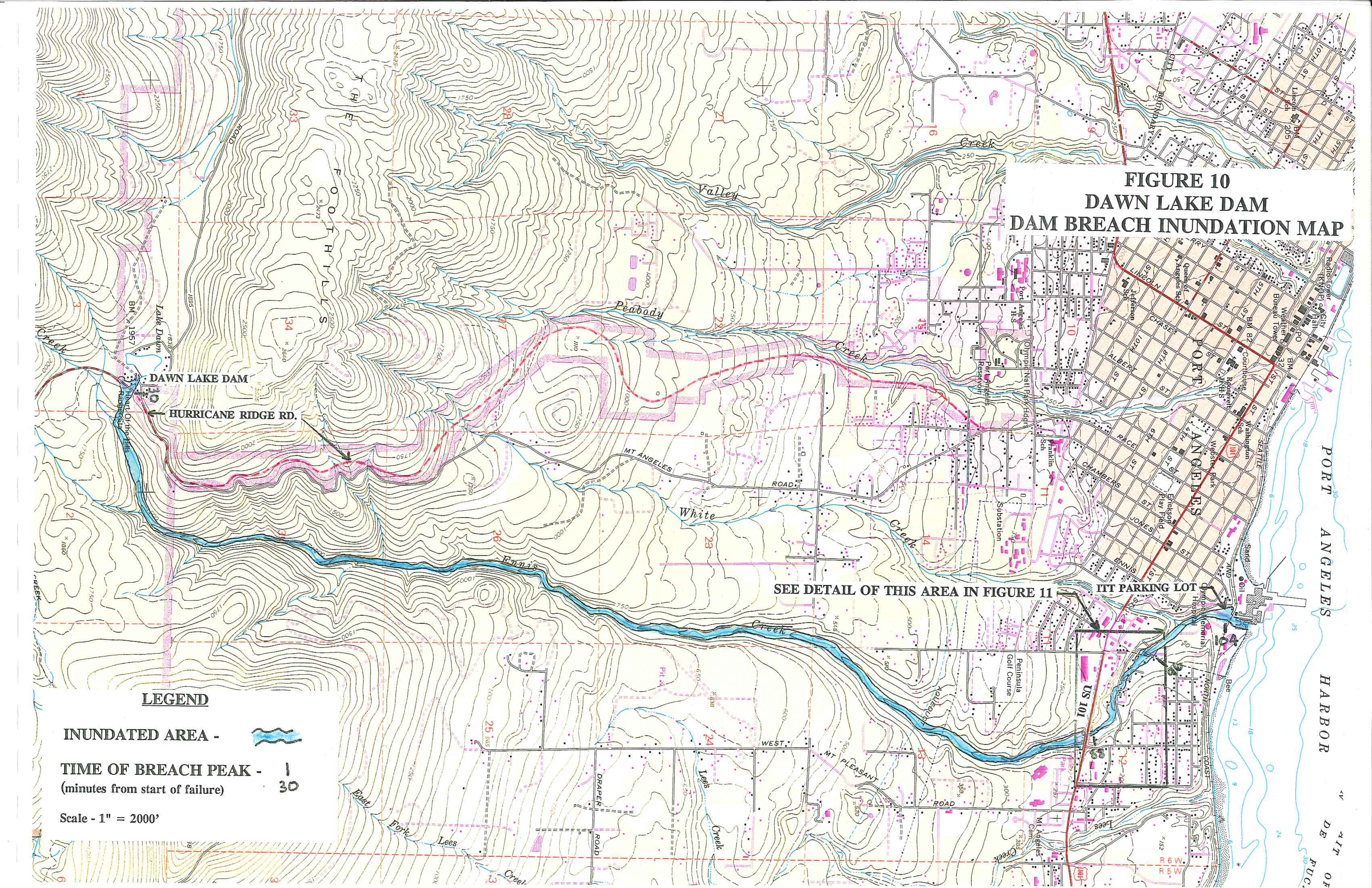
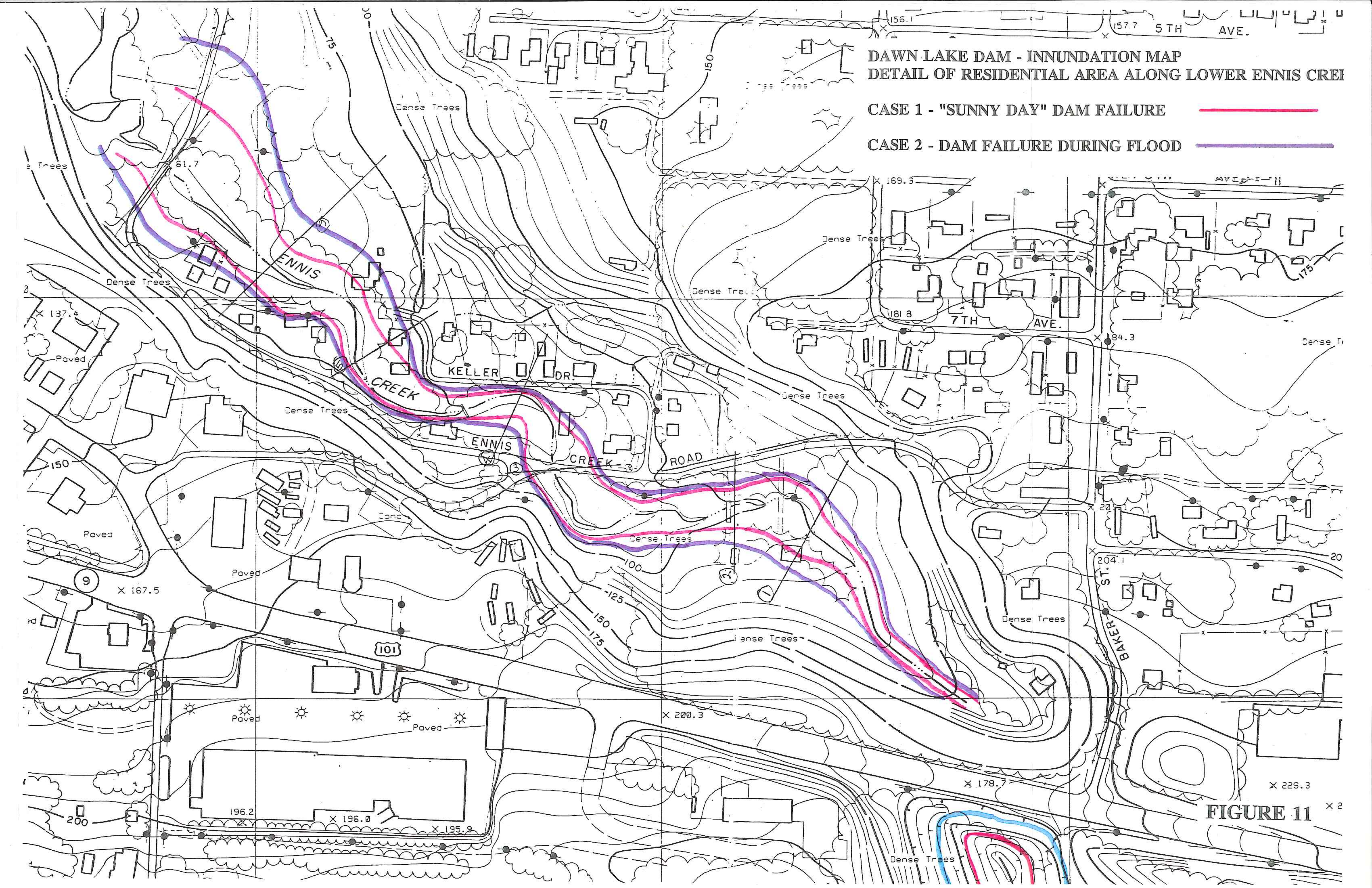


FIGURE 10
DAWN LAKE DAM
DAM BREACH INUNDATION MAP
DAWN LAKE DAM
HURRICANE RIDGE RD.
SEE DETAIL OF THIS AREA IN FIGURE 11
ITT PARKING LOT
LEGEND
INUNDATED AREA -
TIME OF BREACH PEAK -
(minutes from start of failure)
Scale - 1" = 2000'
PORT ANGELES
PORT ANGELES HARBOR
Peabody Creek
Valley Creek
White Creek
Ennis Creek
Lees Creek
East Fork Lees Creek
MT ANGELES ROAD
WEST MT PLEASANT ROAD
US 101
THE FOOTHILLS
Peninsula Golf Course



DAWN LAKE DAM - INNUNDATION MAP
DETAIL OF RESIDENTIAL AREA ALONG LOWER ENNIS CREE

FIGURE 11