TECHNICAL MEMORANDUM

Reservoir Stormwater Runoff Diversion Structures

TM-R-4

TO: Ed Brauner, City of Santa Rosa
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FROM: Andy Hauge, HBA
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DATE: 18 September 1995

INTRODUCTION

There are ten candidate reservoirs under consideration for the project. Each of the reservoirs will, in addition to receiving pumped storage of reclaimed water, trap stormwater runoff from its surrounding watershed. Trapping natural runoff will have at least two consequences: (1) reduce the active storage volume for reclaimed water, and (2) decrease the natural flow in the creek below the dam. The first consequence directly impacts the usefulness of the reservoir for its intended purpose (i.e., temporary reclaimed water storage) and would require that more agricultural acreage be provided to dispose of collected runoff. The second consequence involves potential environmental impacts downstream of the dam (which, if the percentage of runoff trapped is significant, may not be acceptable to the regulatory agencies).

It is anticipated that controlled releases from the reservoir, which could release sufficient water from the reservoir to make up for the net inflow into the reservoir from stormwater (and which could be used to partially mimic the natural creek flows), may not be acceptable to the regulatory agencies or the general public. Therefore, this investigation of runoff diversion structures necessary to accommodate the expected stormwater flows is presented.

This memorandum documents investigation of the impact of trapped stormwater runoff on reservoir storage volume, recommends the need for runoff diversion structures for some of the candidate reservoirs (to divert runoff around the reservoir), and presents the design criteria and details of the proposed facilities.

This memorandum was prepared with hydrology input from Dames & Moore (see Appendix) and consultation with RUST (geotechnical issues) for formulation of the proposed diversion structures.

SUMMARY

A water balance equation of each reservoir must account for inflows (pumped reclaimed water, stormwater runoff, springs) and outflows (releases to irrigation, evaporation, leakage to groundwater, seepage through the dam and foundation). Inflow from springs and outflows from seepage through the dam are considered manageable for all of the reservoir sites. Leakage through the floor and walls may be significant for some of the reservoirs due to the presence of lenses of permeable rock. To limit this leakage it will be necessary to blanket portions of the reservoir surface during construction with compacted layers of material having very low permeability. This subject is covered more fully in the geotechnical report prepared by RUST (Interim Report - Geotechnical Assessment of Alternative Reservoir Sites, August 1995). It is assumed that such measures will be employed and, in combination with the natural tendency for reservoirs to partially seal themselves over time, will eventually reduce leakage from the reservoir to an insignificant level.

This leaves stormwater runoff and evaporation to consider. This memorandum concludes that, for some of the reservoirs, the net positive inflow due to the difference between stormwater runoff and evaporation is sufficiently significant to require stormwater runoff diversion structures as part of the reservoir design.

We recommend that the only reservoirs necessary to include stormwater runoff diversion structures are Tolay A, Tolay C, Sears Point and Adobe Road. For the other reservoirs, runoff diversion is considered either not necessary to preserve active reclaimed water storage capacity or would be extremely cost inefficient.

It was assumed for purposes of this memorandum that controlled releases from the reservoir will not be employed to release the equivalent of captured runoff or to mimic natural runoff creekflows downstream of the dam.

Itemized below is a summary of the recommended facilities to be constructed as a means of capturing stormwater runoff and diverting it around the reservoirs. For a more specific itemization of the recommended facilities see the attached Appendix for the detailed calculations and quantity estimates (Tables A-8, B-9, C-8, and D-9A) prepared in support of this memorandum.

A. TOLAY A RESERVOIR

1. Stormwater detention basin; excavated 10 feet deep, over about 6 acres, upstream of reservoir backdam, to capture Tolay Creek flow upstream of reservoir;

2. Stormwater pump station ("TASW") at detention basin; two 25,000 gpm pumps, 400 HP each, vertical turbine (VT) type;

3. Pressure pipeline from pump station; 48" diameter, discharging into gravity flow conduit;

4. Gravity flow conduit; cast-in-place reinforced concrete box conduit, 15,300 feet long, above waterline along east side of reservoir, from near reservoir backdam to Tolay main dam, discharging into Tolay Creek downstream of Tolay dam, also collects watershed runoff drainage from gullies along reservoir.

B. ADOBE ROAD RESERVOIR

1. Stormwater detention basin and dam; in area of existing stock pond, to capture creek flow upstream of reservoir;

2. Runoff collection gravity pipeline; above northeast end of reservoir, discharging into detention basin;

3. Stormwater pump station ("ARSW") at detention basin; two 28,400 gpm pumps, 550 HP each, VT type;

4. Pressure pipeline from pump station; 48" diameter, lifts flow up 150 feet to discharge into gravity pipeline;

5. Gravity flow pipeline; 60" dia RCP, 5,800 feet long, along west side of reservoir, from above pump station to discharge downstream of Adobe Road dam.

C. TOLAY C RESERVOIR

1. Stormwater detention basin; upstream of reservoir backdam to capture Tolay Creek flow upstream of reservoir, excavated 18 feet deep, over about 7 acres;

2. Stormwater pump station ("TASW") at basin; discharging into pressure pipeline, discharging into Tolay Creek downstream of Tolay dam, five 46,500 gpm pumps, 1,000 HP each, VT type;

3. Pressure pipeline; 900 feet long, from pump station to head of gravity flow box conduit at west end of reservoir backdam;

4. Gravity flow, reinforced concrete box conduit; 9,500 feet long, along west side of reservoir from backdam to discharge downstream of Tolay dam.

D. SEARS POINT RESERVOIR

1. Stormwater diversion dam; located upstream of reservoir at Tolay dam site, to capture Tolay Creek flow upstream of reservoir, 30 foot high concrete wall dam and inlet to open channel;

2. Gravity flow rectangular concrete open channel; 25 feet wide x 15 feet deep, 12,650 feet long, along west side of reservoir, from detention basin to Sears Point dam, discharging into Tolay Creek downstream of dam.

RESERVOIR CHARACTERISTICS

The reservoir water surface area, watershed area, and estimated annual stormwater likely to be captured by each of the reservoirs (if diversion structures are not built, other than to divert stormwater around the Tolay A or C backdam) are shown in the attached Table 1. The percentage of total storage capacity (as originally equated to required reclaimed water storage volume), for each reservoir, that would be taken up by stormwater runoff, if not diverted around the reservoir, is also listed in the table. These volumes were determined as outlined below. The main conclusion from Table 1 is that the Tolay A, Sears Point, Lakeville, and Adobe Road reservoirs, in particular, will have a large percentage of their volume consumed by stormwater runoff if structures are not built to divert it around the reservoir.

The recommended reservoir characteristics, assuming that structures are built to divert some percentage of runoff around some of the reservoirs, are presented in Table 2. As can be seen by comparing Tables 1 and 2, the storage efficiency for reclaimed water would be significantly improved if stormwater runoff structures are constructed for the Tolay A, C, Sears Point, and Adobe Road reservoirs. Table 2 also lists the proposed revised gross storage capacity of the reservoirs necessary to obtain the design reclaimed water storage volume (4,000 MG) for the 1 percent project.

DETERMINATION OF NET STORMWATER VOLUME CAPTURED BY THE RESERVOIR

The volume of stormwater runoff that would be captured by the reservoir is based on an isohyetal map of mean annual precipitation provide by the Sonoma County Water Agency, titled "Sonoma County Mean Seasonal Precipitation", revised June 1983. For conservative design it would be prudent to use a number higher than the mean annual precipitation value. It is proposed that the 10-year return period annual precipitation value be used, which (according to the project team hydrologists, Dames & Moore) is about 150 percent of the mean annual value. Therefore, using the above referenced map mean precipitation values, adjusted by the 150 percent factor, the proposed design value of annual precipitation expected on the watershed of each of the candidate reservoirs would be 38 inches per year for the Tolay, Sears Point and Lakeville Hillside reservoirs, 45 inches per year for the Two Rock reservoir, and 52 inches per year for the other west county reservoirs and for the Adobe Road reservoir.

It is further assumed that nearly the entire annual precipitation would impact the total storage capacity of the new reservoir because most of the rainfall is expected to occur during the same months (December through May) when the reservoir is being filled prior to the start of the irrigation season. The full capacity of the reservoir would be needed for reclaimed water storage at the same time that storage capacity would be diminished by rainfall runoff.

Other impacts on the water balance for a given reservoir include groundwater which might enter the reservoir through springs or subsurface flows from rainfall, water which might leave the reservoir through groundwater flow, seepage through the dam and foundation, and evaporation from the reservoir surface. For purposes of this investigation we have assumed that these effects will result in a net decrease of 50 percent of the theoretical stormwater runoff into the reservoir as determined above. The consequence on the storage capacity of each reservoir is presented in Table 1.

CONCLUSION

The data presented in Table 1 takes the above factors into consideration. As seen from Table 1, the four reservoirs for which the captured precipitation volume would be a significant percentage of the total reservoir storage volume are Tolay A, Sears Point, Adobe Road, and Lakeville; with approximately 38 percent, 81 percent and 22 percent, and 20 percent, respectively, of their gross storage volume consumed by net stormwater runoff. This suggests the need for runoff diversion structures for these reservoirs.

For the other candidate reservoirs (Two Rock, Bloomfield, Carroll Road, Valley Ford, and Huntley) the percentage of net stormwater storage would range from 7 percent to 16 percent of the reservoir gross storage capacity.

RECOMMENDATIONS

Based on the above investigation and the numbers presented in Table 1, it is proposed that stormwater runoff be diverted for some reservoirs, resulting in the recommended reservoir characteristics presented in Table 2.

The recommendations regarding how to handle stormwater runoff for each reservoir are summarized as follows:

1. For Bloomfield, and Huntley: the required 4,000 MG of active reclaimed water storage for the 1 percent project, and the minor dead storage, could be obtained without the need for runoff diversion structures or adjustment in the height of the dam.

2. For Two Rock, Carroll Road, and Valley Ford: the required 4,000 MG of active reclaimed water storage for the 1 percent project, and the minor dead storage, could be obtained without the need for runoff diversion structures by raising the dam height a couple of feet.

3. For Tolay A: the 4,000 MG of active storage could be obtained by raising the dam about 8 feet without the need to add runoff diversion structures. However, without diversion, the flow of Tolay Creek would be significantly reduced downstream of the reservoir. Consequently, it is proposed that runoff diversion be provided to collect and divert around the reservoir runoff from the eastern or largest portion of the watershed, along with Tolay Creek flows which would collect upstream of the backdam built

across the creek. In addition, raising the dam height about five feet would be made to obtain the required gross capacity necessary to accommodate the dead storage and the stormwater runoff which would not be diverted.

4. For Tolay C: the 4,000 MG of active storage could be obtained by raising the dam 5 feet, and without the need for runoff diversion structures. The portion of the watershed draining into this reservoir would be about one third of that into Tolay A without diversion structures. It is proposed that Tolay Creek flows will, therefore, not be significantly reduced by not diverting runoff from its more limited watershed. Of course, as with Tolay A reservoir, Tolay C must still include diversion structures to collect and divert Tolay Creek flows which would collect upstream of the backdam built across the creek. The dam height would also be raised two feet to obtain the required gross capacity necessary to accommodate the dead storage and the stormwater runoff which would not be diverted.

5. For Lakeville, Adobe Road, and Sears Point reservoirs: the originally identified storage capacity cannot be achieved by raising the dam because these dams are already proposed at maximum height for their sites.

   a. For Lakeville: diversion structures could be constructed to restore about 200 MG capacity to the reservoir, to increase its storage capacity from 66 percent of the gross storage capacity (if diversion structures are not built) to about 80 percent of that capacity; to a total of about 1200 MG. Considering this modest increase, the cost of diversion structures, and the relatively small capacity of Lakeville in the first place, it is proposed that diversion structures not be constructed.

   b. For Adobe Road: diversion structures are proposed which could restore reclaimed water storage capacity to about 3,400 MG, or 92 percent of the gross storage capacity available at this site.

   c. For Sears Point: very costly diversion structures would be required to divert natural runoff flows around the reservoir because of the substantial watershed above the reservoir, to thereby preserve storage capacity for reclaimed water to about 3,400 MG capacity. It would be necessary to divert Tolay Creek around the reservoir. Because of the substantial size of the watershed upstream of the reservoir a substantial creek flowrate (>3,400 CFS) of runoff could come down Tolay Creek during a 10 year storm event. It would require a substantial diversion channel to carry this flowrate the more than two miles around the Sears Point reservoir to return to the Tolay Creek channel downstream of the main dam.

      There are two options to provide this diversion: construct a concrete lined open channel to redirect Tolay Creek flow along and above the western shoreline of the reservoir, or build a pump station upstream of the reservoir, and a pipeline around the reservoir to discharge downstream of the Sears Point dam. The open diversion channel option is proposed because of its lesser construction and operation costs and its more reliable nature.

      Even so, the runoff diversion channel would add substantial cost to this alternative, would involve substantial impact on the natural setting along the west side of the reservoir, would involve the diversion of over two miles of creek, and still would not result in a reservoir with sufficient capacity for the 1 percent project. These issues should be taken into consideration in further evaluation of the Sears Point reservoir option.

SPECIAL CONSIDERATION FOR TOLAY RESERVOIR CONFIGURATIONS

The two Tolay reservoir configurations "A" and C" both include a backdam in addition to the main dam. The backdam would isolate the reservoir from part of the watershed to preserve current land use of the non-flooded portion of the watershed. Therefore, for both the Tolay "A" and "C" configurations, the portion of the stormwater runoff which would be trapped upstream of the backdam would need to be removed as it accumulates, by pumping either into the reservoir or around the reservoir. It is proposed that this stormwater be diverted around the reservoirs, thereby preserving reservoir capacity for reclaimed water storage. The numbers presented in the Table 1 and Table 2 for the Tolay "A" and "C" reservoirs already assume this portion of watershed runoff will not enter the reservoirs.

IMPACT OF RESERVOIRS ON CREEKFLOWS

Regarding the issue of impact of the reservoir on the natural creek flows, construction of the reservoirs would impact the creek flows for some distance immediately downstream of the dams by intercepting stormwater and groundwater inflow. On the other hand, the nature of earthfilled dams is such that some seepage would continuously pass through the reservoir floor and the dam embankment. Some of this outflow would likely re-enter the creekbed downstream of the dam..

Controlled releases from the reservoir, to make up for the net inflow into the reservoir from stormwater, are potentially subject to RWQCB regulation.

In an attempt to determine the position of the regulatory agencies on this issue, preliminary discussions were held with representatives of the North Coast Regional Water Quality Control Board and the Department of Fish and Game in March, 1995. The primary concern of these agencies seems to be the relative impact of the proposed reservoirs on the watershed as a whole, and on the area immediately downstream of the proposed dams. If the local watershed affected by the reservoir itself is a relatively small portion of the watershed as a whole, then the regulatory agencies may not require runoff diversion or controlled releases. If the portion of the watershed affected is significant, then diversion or releases may be directed.

The Sears Point and Tolay reservoirs would capture a significant portion of the watershed of Tolay Creek, which would likely reduce the natural creekflows downstream of these dams, possibly with resulting potential impact on the native plant and animal communities, riparian habitat, and wetlands along the drainage. It is proposed, therefore, that these reservoirs include stormwater runoff diversion around the reservoirs.

The other reservoirs are all located in much smaller drainages with ephemeral creeks which contribute a low percentage flow to their collective watershed. It is proposed, therefore, that these candidate reservoirs not include stormwater runoff diversion.

SOME CONSEQUENCES OF RECOMMENDED STORMWATER DIVERSION STRUCTURES

A. Tolay A and Tolay C Reservoirs

1. The proposed detention basins to be excavated for the Tolay A and Tolay C reservoirs would be constructed directly in wetland areas upstream of the proposed backdams.

2. Excavation of detention basins for stormwater pump stations could locally depress the water table, with possible impact on local cropland. Tolay C configuration detention basin could especially impact the currently irrigated crops just upstream.

3. The proposed stormwater pump stations upstream of the backdams are sized to handle 10 year return period storm flows as prudent and cost effective design criteria. If much larger flows occurred in the future, the area upstream of the detention basin could be flooded temporarily during storms. The City would need a flood easement or other right from the private property owner for this eventuality to avoid liability for damage to structures or crops. This will be especially true for Tolay C, where a currently active irrigated area could be flooded.

4. If flooding occurs for Tolay A or Tolay C, water could backup in the flat Tolay valley, flood under Stage Gulch Road, and then spill out of Tolay basin northward to a creek which discharges into Petaluma River. Adequacy of the road culverts and the drainage to take these flows will be investigated.

B. Adobe Road

1. The proposed detention basin would be an enlargement and reconstruction of the existing dam and stock pond in the area upstream of the proposed reservoir waterline. This would likely impact some wetland area and riparian habitat in this area.

C. Sears Point

1. The runoff diversion structures would include a small flow diversion dam near the Tolay dam site and construction of an open channel and access road along the west side of the Sears Point reservoir to divert Tolay Creek around the reservoir.

APPENDIX

Detailed calculations were prepared in support of this technical memorandum. Hydrologic analyses of stormwater runoff flowrates, and analyses of pumping and conveyance facilities (pipelines and open channels) were prepared in detail. The Appendix includes the memorandum summarizing these calculations. Because the calculations themselves, and the supporting tables and figures, are lengthy they have not been included herein, but are available from the file for reference.

15 SEPT, 1995

TABLE 1
RESERVOIR SUMMARY TABLE - (WITHOUT STORMWATER RUNOFF DIVERSION)
SANTA ROSA SUBREGIONAL LONG-TERM WASTEWATER PROJECT

DAM	GROSS CAPACITY (MG)	STORAGE (ACRE-FT)	SPILLWAY CREST ELEVATION (FEET)	DAM HEIGHT (FEET (1)	DAM CREST ELEVATION (FEET) (2)	WATER SURFACE AREA (ACRES)	WATERSHED AREA (ACRES) (3)	RATIO: WATERSHED AREA/ WATER SURFACE AREA	CAPTURED RUNOFF VOLUME (MG) (4)(5)	RUNOFF % OF TOTAL STORAGE	DEAD STORAGE (MG) (6)	NET RECLAIMED WATER STORAGE (MG) (4)(7)
TOLAY A	4,500	13,800	240	85	255	800	3,400	4	1,700	38	750	2,050
TOLAY C	4,500	13,800	265	110	280	390	1,300	3	700	16	400	3,400
SEARS POINT	3,800 (8)	11,600	140	115	155	270	6,080	22	3,100	81	200	500
ADOBE ROAD	3,700 (8)	11,300	340	205	355	170	1,050	6	800	22	200	2,700
LAKEVILLE	1,500 (8)	4,600	200	135	215	155	500	3	300	20	200	1,000
TWO ROCK	4,500	13,800	360	225	375	230	700	3	400	9	200	3,900
BLOOMFIELD	4,500	13,800	255	190	270	195	600	3	400	9	100	4,000
CARROLL ROAD	4,500	13,800	250	185	265	235	850	4	600	13	100	3,800
VALLEY FORD	4,500	13,800	155	130	170	260	880	3	600	13	500	3,400
HUNTLEY	4,500	13,800	285	210	300	175	360	2	300	7	100	4,100

1 MEASURED FROM CREEK CHANNEL AT DOWNSTREAM TOE OF DAM.

2 INCLUDES FREEBOARD (DAM CREST ABOVE SPILLWAY CREST) = 15 FEET

3 INCLUDES WATER SURFACE AREA. EXCLUDES WATERSHED AREA UPSTREAM OF BACKDAMS FOR TOLAY A AND C.

4 ASSUMES RUNOFF CAPTURED UPSTREAM OF TOLAY A AND C BACKDAMS IS DIVERTED AROUND RESERVOIR; THEREFORE, THIS VOLUME NOT INCLUDED.

5 ESTIMATED AS 50% OF 10 YEAR RETURN PERIOD ANNUAL PRECIPITATION TO ACCOUNT FOR LOSSES BY PERCOLATION AND EVAPORATION.
10 YEAR PRECIPITATION TAKEN AS 38"/YEAR FOR TA, TC, SP, AND L; 45"/YEAR FOR TR; AND 52"/YEAR FOR AR, B, CR, VF, AND H RESERVOIRS.

6 ESTIMATED FROM RESERVOIR STORAGE CURVE FOR MIN. ACTIVE WATER LEVEL AT APPROX. 20 FT ABOVE RESERVOIR FLOOR.

7 NET RECLAIMED WATER CAPACITY (W/O RUNOFF DIVERSION) = GROSS CAPACITY - DEAD STORAGE - NET CAPTURED RUNOFF

8 MAXIMUM GROSS STORAGE AVAILABLE AT THESE SITES.

15 SEPT, 1995

TABLE 2
RESERVOIR SUMMARY TABLE -(WITH STORMWATER RUNOFF DIVERSION)
SANTA ROSA SUBREGIONAL LONG-TERM WASTEWATER PROJECT

DAM	REVISED GROSS CAPACITY (MG)	STORAGE (7) (ACRE-FT)	SPILLWAY CREST ELEVATION (FEET)	DAM HEIGHT (FEET (1)	DAM CREST ELEVATION (FEET) (2)	WATER SURFACE AREA (ACRES)	WATERSHED AREA (ACRES) (3)	RATIO: WATERSHED AREA/ WATER SURFACE AREA	CAPTURED RUNOFF VOLUME (MG) (4)(5)	DEAD STORAGE (MG) (6)	STORMWATER RUNOFF (% OF GROSS STORAGE CAPACITY)	NET RECLAIMED WATER STORAGE (MG) (4)(7)
TOLAY A	5,600	17,200	245	90	260	600+	3,400	4	850(8)	750	15	4,000
TOLAY C	5,000	15,300	270	115	285	390+	1,300	3	600(8)	400	12	4,000
SEARS POINT	3,800(10)	11,600	140	115	155	270	6,060	22	600(8)	200	16	3,000
ADOBE ROAD	3,700(10)	11,300	340	205	355	170	1,050	6	100(8)	200	3	3,400
LAKEVILLE	1,500(10)	4,600	200	135	215	155	500	3	300(9)	200	20	1,000
TWO ROCK	4,600	14,100	360	225	375	230+	700	3	400(9)	200	9	4,000
BLOOMFIELD	4,500	13,800	255	190	270	195	600	3	400(9)	100	9	4,000
CARROLL ROAD	4,700	14,400	255	195	270	235+	850	4	600(9)	100	13	4,000
VALLEY FORD	5,100	15,600	160	140	175	260+	880	3	600(9)	500	12	4,000
HUNTLEY	4,400	13,500	285	210	300	175	360	2	300(9)	100	7	4,000

1 MEASURED FROM CREEK CHANNEL AT DOWNSTREAM TOE OF DAM.

2 INCLUDES FREEBOARD (DAM CREST ABOVE SPILLWAY CREST) = 15 FEET

3 INCLUDES WATER SURFACE AREA. EXCLUDES WATERSHED AREA UPSTREAM OF BACKDAMS FOR TOLAY A AND C RESERVOIRS.

4 ASSUMES RUNOFF CAPTURED UPSTREAM OF TOLAY A AND C BACKDAMS IS DIVERTED AROUND RESERVOIR; THEREFORE, THIS VOLUME NOT INCLUDED.

5 ESTIMATED AS 50% OF 10 YEAR RETURN PERIOD ANNUAL PRECIPITATION TO ACCOUNT FOR LOSSES BY PERCOLATION AND EVAPORATION.
10 YEAR PRECIPITATION TAKEN AS 38"/YEAR FOR TA, TC, SP, AND L; 45"/YEAR FOR TR; AND 52"/YEAR FOR AR, B, CR, VF, AND H RESERVOIRS.

6 ESTIMATED FROM RESERVOIR STORAGE CURVE FOR MIN. ACTIVE WATER LEVEL AT APPROX. 20 FT ABOVE RESERVOIR FLOOR.

7 GROSS CAPACITY (W/ RUNOFF DIVERSION) = DEAD STORAGE + NET RUNOFF CAPTURED + RECLAIMED WATER STORAGE

8 RUNOFF DIVERSION REQUIRED TO RESTORE ACTIVE STORAGE CAPACITY, BASED ON TECHNICAL MEMORANDUM R-4.

9 RUNOFF DIVERSION WOULD HAVE HIGH COST/BENEFIT RATIO: NOT PROPOSED

10 MAXIMUM GROSS STORAGE AVAILABLE AT THESE SITES.

APPENDIX

APPENDIX

Santa Rosa Subregional Long-Term Wastewater Project
Preliminary Drainage Design For Reservoir Runoff Diversion

TO: Richard Maurer, Project Manager (Parsons ES)

FROM: William Weinstock (Parsons ES)

DATE: 9 July 1995

RE: Santa Rosa Subregional Long-Term Wastewater Project
Preliminary Drainage Design For Reservoir Runoff Diversion (TM-R-4)

SECTION	DESCRIPTION
I	Introduction and purpose of memo
II	Assumptions
III	Calculations and estimates
IV	Conclusions and recommendations
V	Tables and figures

Reference 1: 6/23/95 memo from April Fallon/Dames & Moore to Bill Weinstock/Parsons ES (pertaining to 10-year peak flow rates for all of the Santa Rosa project sites)

Reference 2: 6/27/95 memo from April Fallon/Dames & Moore to Bill Weinstock/Parsons ES (pertaining to 10-year inflow hydrographs to detention basins for the four sites per this memo)

I. INTRODUCTION AND PURPOSE OF MEMO

This memo was prepared in response to a request to produce preliminary engineering design options (with quantity estimates) for the diversion of stormwater runoff away from reservoirs that would not otherwise meet the 4,000 MG minimum reclaimed water storage capacity requirement without the diversion. Four of the ten sites were in this category: Tolay A, Tolay C, Adobe Road, and Sears Point. Of these, Tolay A and Tolay C meet the required storage capacity with the flow diversion. Adobe Road and Sears Point fall short, and therefore need to be combined with another site, including possibly Lakeville, to meet the required reclaimed water storage capacity.

Both gravity flow and pumping options were explored at the four sites. In some cases, it was obvious by inspection that a runoff diversion (gravity flow) channel alternative was not economically feasible. No detailed comparisons were made in these cases. A "runoff diversion channel" is defined for this study as gravity flow channel (open channel, pipe, or box) that collects runoff and diverts it away from the proposed reservoir, either to the natural channel below the reservoir or to a detention basin at the upper end of the reservoir. It was generally determined not to be economically feasible if the diverted runoff would not significantly increase the available reclaimed water storage in the reservoir.

In other cases, it was obvious by inspection that a gravity flow channel would be more cost effective than a pumped discharge pipeline in the same location. No detailed comparisons were made in these cases. A gravity flow channel is defined for this study as a channel (open channel, pipe, or box) that receives pumped runoff from a pressure main. By pumping from the proposed detention basin up to a sufficiently high level, and then allowing the runoff to flow by gravity for distances up to 10,000 feet (instead of pumping) to the natural stream channel below the reservoir, costs of pumping, channel construction, and maintenance are generally reduced.

The number of alternatives was reduced by making the observations discussed in the preceding two paragraphs.

The options that were evaluated as part of this technical memorandum are described as follows:

Tolay A Reservoir Site (Part A of the calculations in Section III)

A detention basin and pump station located upstream of the backdam are required to divert Tolay Creek flow around the reservoir site because the Tolay Creek channel invert at the backdam is at about Elev. 215 (feet above Mean Sea Level) versus Reservoir Water Surface Elev. 240. Stormwater collected upstream of the backdam needs to be pumped (from Elev. 208 to Elev. 273), so the stormwater flow can be conveyed around the reservoir by means of a gravity flow channel for the remainder of the distance. This is necessary in order to intercept the substantial drainage that is tributary to the east side of the reservoir. By inspection, this is the most feasible option, and others are not evaluated in this technical memorandum.

Adobe Road Reservoir Site (Part B of the calculations in Section III)

Gravity flow around the reservoir site is not physically possible due to the rugged terrain and because the natural channel invert at the backdam is at about the same elevation as the Reservoir Water Surface (Elev. 340). It is apparent by inspection that the pumped discharge line should be on the west side of the reservoir to avoid higher elevations (and greater pumping head), air and vacuum valves, and blowoff valves which would be necessary if the discharge line were on the east side.

A gravity flow channel is proposed to pick up a significant stormwater runoff at the north end of the reservoir, and discharge it into the proposed detention basin above the reservoir.

The aforementioned method of conveyance and alignment were the only ones evaluated as part of this technical memorandum.

Tolay C Reservoir Site (Part C of the calculations in Section III):

A detention basin and pump station located upstream of the backdam are required to divert Tolay Creek flow around the reservoir site because the Tolay Creek channel invert at the backdam is at about Elev. 215 (feet above Mean Sea Level) vs. Reservoir Water Surface Elev. 270.

The south side of the reservoir site was selected for the pumped discharge pipeline because of its gentler terrain and more direct route, which translate to less excavation cost and less pipeline cost.

Options for providing runoff diversion channels intercepting local drainage around the perimeter of the reservoir were not explored, because: (1) the east side has very steep terrain, and by inspection, a runoff diversion channel would not divert enough runoff to significantly increase the available reclaimed water storage volume in the reservoir, and (2) a runoff diversion channel on the west side, although not as steep, would also not divert enough runoff to significantly increase the available reclaimed water storage volume in the reservoir.

The aforementioned pumping and alignment option is the most feasible option, and others are not explored in this evaluation.

Sears Point Reservoir Site (Part D of the calculations in Section III):

Both gravity flow and pumping options were explored (one alignment for each).

The gravity flow option (identified herein as Option 1 in Section III) picks up the existing Tolay Creek channel flow upstream of the reservoir, conveys it around the south side of the reservoir in an open channel, and discharges the runoff into the existing channel downstream of the proposed dam. The channel was located on the south side to intercept the substantial local runoff that accumulates on the south side, which is far greater than on the north side. Additionally, the north side appears to have more difficult terrain and is a less direct route. The aforementioned gravity flow alignment is the only one that was evaluated in this technical memorandum.

The pumping option (identified as Option 2 in Section III) includes a pump discharge line on the south side of the reservoir, following a higher and flatter route than the gravity flow option which hugs the shore line. This route requires the use of air & vacuum valves, and blowoff valves, and a large diameter Cement Mortar Lined & Coated Steel Pipe (CML&C SP), the cost of which is partially or completely offset by the excavation cost savings afforded by the higher and flatter route of Option 2.

An alternative of pumping up to a level above the proposed reservoir shore line and depositing the flow into the gravity flow channel around the reservoir (as described in the preceding paragraph) was not evaluated. It appears to be comparable in cost, however, with Option 2.

II. ASSUMPTIONS (COMMON TO ALL FOUR SITES)

TABLE OF CONTENTS

A. General

1. The runoff diversion channels and detention basins/pumping stations for the Adobe Road and Sears Point reservoirs were designed to maximize the useful reservoir storage capacities for reclaimed water by diverting the maximum practical amount of stormwater runoff to a point below the reservoir outlets.

For these two reservoirs, it is not feasible to obtain the required 4,000 MG reclaimed water storage volume. It is assumed that the required annual storage will be obtained by combining the storage of any two reservoirs that have less than the required annual storage.

However, no attempt was made to reduce the volume of any of these three reservoirs to eliminate excess storage (above 4,000 MG) that would be result from adding the capacities of any two of the reservoirs with reclaimed water capacities less than 4,000 MG.

2. For the Adobe Road and Sears Point reservoirs, stormwater detention basin dams were assumed to be designed with 6 feet of freeboard and to be designed with spillways to pass flows in excess of the 10-year storm up to the Probable Maximum Flood (PMF) into the reservoirs. Each of the reclaimed water storage reservoirs likewise would have a spillway to discharge the PMF should such an event occur. For the Tolay A and Tolay C reservoirs, upstream freeboard and spillways for the backdams are not an issue because the upper Tolay Creek watershed would spill over a natural saddle and out of the basin well before reaching the top of the backdam.

3. Hydrology used in detention basin designs was provided by Dames & Moore, and is included in these calculations. A single hydrograph for a 10-year return period, multi-day storm was provided. Only the maximum 24-hour segment of this multi-day hydrograph was used which was deemed to be equivalent to a 10-year return period, 24-hour storm, as specified by Dames & Moore.

B. Runoff Diversion Channels

1. All runoff diversion channels will be designed to convey 10-year peak flows. These include the Tolay A runoff diversion channel, which would serve a total tributary area between 1 and 4 square miles. In accordance with Reference 1 (Sonoma County Water Agency, "Flood Control Design Criteria"), such channels in flood plains should be designed for 25-year storms. However, in this case there are no facilities between the diversion structures and the reservoir itself at risk of damage. Proper measures will be provided to convey overflows to the reservoir by adding channel freeboard and directing overflows in specific locations via graded ravines (with riprap) from the channel to the reservoir.

2. It is assumed that a rectangular concrete open channel (width = 2 x height to 10-year design water surface) is the most economical section in areas of steep side slopes. This requires less excavation and fill than a trapezoidal section of concrete or riprap.

3. It is assumed that reinforce concrete pipe (RCP) up to 96-inch diameter is the most economical gravity flow channel alternative. For equivalent pipelines larger than 96-inch diameter, reinforced concrete box channels are recommended. Where an equivalent open channel has a width greater than 12 feet, a rectangular concrete open channel is recommended. Trapezoidal channels are generally not recommended for benching in side slopes because the typically greater width requirement for trapezoidal channels causes a significant increase in excavation cost.

4. Open channels were designed with Manning "n" = 0.015 and 1.5 feet of freeboard in accordance with Reference 1. Reinforced concrete pipes and boxes were designed with Manning n = 0.013, flowing surcharged with 100-year water surface below ground level.

5. The Quantity Estimate allows for additional concrete volume to account for overflows in side outlets for storm flow return periods up to 100 years, superelevation for curves, and riprap and grading for overflow ravines from the channel to the reservoir.

C. Detention Basins

1. Detention basin tributary areas were derived by scaling from the 1"=500'scale reservoir layout plans and 1:24,000 USGS topographic quadrangle maps. Excavation volumes were calculated using the average end area method.

2. Allowance should be made for debris collection in the reservoirs at trash racks.

3. Excavated detention basins were assumed to have 2.5 Horizontal (H):1 Vertical (V) side slopes (maximum allowable cut or fill slope as recommended by geotechnical consultant), lined with riprap.

Allowance should be made in final design for groundwater seepage into the detention basins.

D. Pump Stations

1. Storm drain pumps are recommended to be vertical turbine pumps, or vertical mixed flow pumps depending on discharge head conditions. Suggested pumps used in this preliminary design are vertical turbine pumps taken from a Fairbanks Morse catalog. Optional pumps that may be considered are Mixed Flow Pumps (per Tables A-6, B-8, C-6 and D-7). The installation includes starter motors, electrical feeder cables and conduit, electrical primary power supply (no secondary power supply), transformer and related equipment, and trash rack.

2. The recommended pump arrangement is two or more duty pumps and one standby, all with the same capacity. An exception to this rule may be the proposed pump station at Sears Point Reservoir, in which the pumps would work more efficiently by having two sets of pumps operating in separate ranges, i.e. one set in the 91' to 120' range, and one set in the 120' to 166' range. This would be feasible only if suitable, efficient pumps could be found to operate in the higher head range.

E. Pump Discharge Piping

1. Pump discharge pipelines are assumed to be Ductile Iron Pipe (DIP) up to 24" diameter, and Cement Mortar Lined & Coated Steel Pipe (CML&C SP) for 30" diameter and larger. A Hazen-Williams "C" of 120 was used in pipe capacity calculations.

2. Air & Vacuum valves, and blowoff valves, will be required for the pumping option for the Sears Point Reservoir. However, they would not be required for the alternative of pumping up to a level above the proposed reservoir maximum water surface, and flowing by gravity around the reservoir. This alternative was not evaluated.

F. Access Roads and Side Slope Excavations For Channels And Piping

1. As recommended by the geotechnical consultant, the maximum cut slope at the four reservoir sites is 2.5H:1V, or 1.5H:1V with a 12' wide bench above the channel when the cut slope above the channel exceeds 10 feet in height. The maximum fill slope is 2.5H:1V. The "runoff diversion channels" (i.e., gravity flow channels that pick up drainage above the proposed reservoir before any pumping occurs), and "gravity flow channels" (i.e., channels that pick up flow deposited from a pump discharge pipeline by means of an open transition structure), shall be placed on the upslope side of the access road in the cut portion to avoid damage to the channel due to sliding, settling, or erosion.

2 Existing gullies will be filled in on the low sides of runoff diversion channels and gravity flow channels except where channel overflow side outlets are necessary to allow drainage of 100-year flows to the reservoir without damage.

3. Runoff diversion channels and gravity flow channels will be the most economical selection of conveyance structure from the candidates of RCP, RC Box, rectangular concrete open channel, trapezoidal concrete open channel, or others. All channels are presumed to be lined in order to minimize size, maintenance cost, and excavation cost --particularly when the channel is benched into a steep side slope.

III. CALCULATION AND ESTIMATES

The calculations and estimates are included in Section V "Tables and Figures." They are crossed referenced. Two references are cited: References 1 and 2 are the hydrology memos transmitted from April Fallon/Dames & Moore to Bill Weinstock/Parsons ES.

IV. CONCLUSIONS AND RECOMMENDATIONS

A. Tolay A Reservoir

1. General

The most practical solution for diversion of watershed runoff sufficient to preserve reservoir storage capacity for wastewater and to preserve significant Tolay Creek flows downstream of the reservoir is to collect the stormwater upstream of the backdam and pump it a distance of 1,500 feet up to Point B (as shown on Figure A-1), from where it can flow a distance of 15,300 feet by gravity around the perimeter of the proposed Tolay A Reservoir to the natural channel below the proposed dam (Point G, as shown on Figure A-1). See 1"=500' scale layout drawing.

A problem inherent with this site is that the storm runoff in excess of the pump station capacity will flood the private farmland above Elev. 218 ft, and conceivably spill out of the valley into a neighboring water course to the northwest and drain to the Petaluma River. The consequences of such flooding and spill would need to be evaluated in final design. The subject pump station was herein designed to handle only a 10-year storm. Any greater runoff would cause some degree of flooding.

For flows in excess of the pump station design capacity, the runoff cannot pass over a spillway in the backdam, as it can at some other sites, because the proposed Tolay A Reservoir maximum water surface elevation, at Elev. 240 ft, is 22 feet higher than Elev. 218 ft which is the maximum allowable water surface in the valley upstream of the backdam.

A possible solution would be to upsize the pump station to handle a 100-year or larger storm. A 100-year storm would generate approximately 40 percent greater intensity, (and similar storage volume increase) than a 10-year storm. This issue would need to be carefully evaluated in final design.

A possible alternative to the aforementioned solution would be to acquire flooding rights to the land above the backdam, allow flows in excess of 10 years to back up in the basin, and possibly spill out via the saddle near Stage Gulch Road to the adjacent basin, and acquire flooding rights to that basin as well. Although this alternative involves some legal issues, it may be more economical than substantially increasing the pump station capacity to handle floods larger than 10 years.

2. Detention Basin

The natural basin above the backdam was found to provide sufficient storage volume to provide only partial attenuation for a 10-year storm. By excavating to approximately 10 feet below the natural stream bottom over an area of approximately 6 Ac (9.6 Ac including side slopes), the peak pumping rate requirement was reduced from about 170 cfs to about 70 cfs. A further depth of excavation would produce little additional benefit because a significant reduction in pumping rate would require very large percentage increases in storage volumes to handle storms of longer than 24 hours duration. The practical minimum peak pumping flow rate (i.e, at the lowest head, and maximum water surface) is probably no lower than 65 cfs. This is shown in Figure A-3C, a graphical solution to selecting minimum pumping rate and detention basin storage capacity, assuming a constant pumping rate. Figure A-3C closely matches the computer generated calculations in Figure A-4B.

One possible problem with excavating the detention basin below the existing stream invert is that the pumping may draw down the water table, thereby affecting adjacent farmland.

3. Pump Station

The selected pumps should be either vertical turbine pumps or mixed flow pumps. Several manufacturers catalogs were consulted. Pump characteristics are fairly similar. For simplicity, at this stage. representative pumps were selected by Fairbanks Morse & Co. To handle a 10-year storm, with up to approximately 140 Ac Ft available storage capacity in the detention basin upstream of the backdam, two 400 HP vertical turbine (single stage) pumps, each pumping up to 25,000 gpm, with one equivalent standby pump and one jockey (i.e., smaller capacity) pump, are recommended.

The pump station needs to be in the stream embankment between Pt. A and Pt. B. The pumps will be mounted on a concrete slab (over a wet well, bottom Elev. 195’), and needs to be above the high water level (Elev. 218 feet). The pumps will be located 10 feet center to center, and can be either covered or open.

4. Gravity Flow Channel

The 15,300-foot long gravity flow channel from the backdam to the Tolay A dam is more practical and economical than a pumped discharge pipeline. A closed conduit gravity flow channel (reinforced concrete pipe or box) would be considerably less expensive than a 48-inch diameter welded steel pressure main and the larger pumping requirement to pump the 50,000 gpm stormwater flow through an additional 15,300-foot long pressure main.

Two types of gravity flow channels were investigated: open channel and buried closed conduit. Due to the considerably higher excavation and fill costs of an open channel benched in steep side slopes above the proposed reservoir, it is apparent that the closed conduit is the most economical alternative. In addition, there are less maintenance costs and liabilities of maintaining a buried closed conduit.

Two types of closed conduits were sized for the gravity flow channel. For such a large size of RCP pipe (114 inches to 144 inches diameter) in a non-urban setting, the hydraulically equivalent reinforced concrete box is probably a more economical alternative than the RCP pipe. For this analysis, RCP was specified for pipes up to 96" diameter, and RC Boxes for larger conduits.

The proposed gravity flow channel is designed to carry the incremental increased volume between the 10-year return period storm event (Q10) and the 100-year return period event (Q100) for a distance less than the total length of the channel, and release the incremental flow to natural drainages into the Tolay A reservoir (i.e., Points C, D, E, and F as shown on the Reference 1 maps). In this way, the channel can be designed for Q10, but allow for higher runoff up to Q100 to overflow the channel in predetermined locations without damaging the channel or causing erosion. Overflow structures and riprap will be required at Points C, D, E, and F.

B. Adobe Road Reservoir

1. General

The most practical solution for stormwater diversion is to collect the stormwater upstream of the proposed reservoir and pump it a distance of 150 feet up to Elevation 400' on the ridge west of the detention basin, from where it can flow a distance of 5,800 feet by gravity around the west perimeter of the proposed Adobe Road Reservoir to the natural channel below the proposed dam (Point F, as shown on the layout map in Reference 1).

A runoff diversion channel is proposed to pick up the significant drainage northeast of the proposed detention basin.

2. Runoff Diversion Channel

Two types of gravity flow channels were investigated: concrete trapezoidal open channel and buried RCP pipe. The excavation quantities are not significantly different in view of overall storm drainage costs. However, 42-inch and 54-inch RCP are recommended because there are less maintenance costs and liabilities of maintaining a buried closed conduit.

The proposed gravity flow channel is designed to carry the incremental increased volume between the 10-year return period storm event (Q10) and the 100-year return period storm event (Q100) for a distance less than the total length of the channel, and release the incremental flow to natural drainages into the Adobe Road reservoir (i.e., Points A, B, and one point at a natural drainage course between Points A and B). In this way, the channel can be designed for Q10, but allow for higher runoff up to Q100 to overflow the channel in predetermined locations without damaging the channel or causing erosion. Overflow structures and riprap will be required at the three points.

3. Detention Basin

The natural basin and stock pond above the reservoir was found to provide sufficient storage volume (190 AF) to provide adequate attenuation for a 10-year storm, but only with the expense of a fairly large pumping station (53,000 gpm peak flow rate, per Table.B-5B).

Using a much larger detention basin, approximately 10 feet below the natural stream bottom over an area of approximately 6 Ac (9.6 Ac including side slopes), the peak pumping rate requirement was reduced from about 170 cfs to about 70 cfs. This is the recommended option.

A wider area of excavation (up to 403 Ac per Table B-3), within the same 50-ft pump height range as the proposed scheme, would reduce the pumping requirement to only the minimum flow rate necessary to empty the basin in a reasonable time. However, this amount of storage volume is clearly not practicable, even with the additional excavation. Due to the steepness of the terrain, the additional excavation is not practical with the limitation of 2.5H:1V allowable cut slopes (as indicated by the geotechnical consultant).

4. Pump Station

The selected pumps should be either vertical turbine pumps or mixed flow pumps. Several manufacturers catalogs were consulted. Pump characteristics are fairly similar. For simplicity, at this stage. representative pumps were selected by Fairbanks Morse & Co. To handle a 10-year storm, with up to approximately 190 Ac Ft available storage capacity in the proposed detention basin upstream of the reservoir (Table B-5B), two 550 HP vertical turbine (single stage) pumps, each pumping up to 28,400 gpm, with one equivalent standby pump and one jockey pump, are recommended.

The pump station needs to be in the west stream embankment above Pt. E. The pumps will be mounted on a concrete slab (over a wet well, bottom Elev. 322’, Table B-4), and need to be above the high water level at approximately Elev. 370 (Tables B-4 & B-5B. The pumps will be located approximately 10 feet center to center, and can be either covered or open.

5. Gravity Flow Channel

The 5,800-foot long gravity flow channel from the detention basin to the Adobe Road dam is more practical and economical than a pumped discharge pipeline. A closed conduit gravity flow channel (reinforced concrete pipe or box) would be considerably less expensive than a 48-inch diameter welded steel pressure main and the larger pumping requirement to pump the 53,000 gpm stormwater flow through an additional 5,800-ft long pressure main. A 60-inch RCP gravity flow pipeline will adequately convey the 10-year design flow of 53,000 gpm (118.5 cfs, Table B-7).

C. Tolay C Reservoir

1. General

The most practical solution for stormwater diversion is to collect the stormwater upstream of the backdam and pump it a distance of 900 feet around the west end of the proposed backdam, from where it can flow a distance of 9,500 feet by gravity around the west side of the proposed Tolay C Reservoir to the natural channel below the proposed dam (Point A1, as shown on Figure A-1).

A problem inherent with this site is that the storm runoff in excess of the pump station capacity will flood the private farmland above Elev. 218 ft, and conceivably spill out of the valley into a neighboring water course to the northwest and drain to the Petaluma River. The consequences of such flooding and spill would need to be evaluated in final design. The subject pump station was herein designed to handle only a 10-year storm. Any greater runoff would cause some degree of flooding.

For flows in excess of the pump station design capacity, the runoff cannot pass over a spillway in the backdam, as it can at some other sites, because the proposed Tolay A Reservoir maximum water surface elevation, at Elev. 240 ft, is 22 feet higher than Elev. 218 ft which is the maximum allowable water surface in the valley upstream of the backdam.

A possible solution would be to upsize the pump station to handle a 100-year or larger storm. A 100-year storm would generate approximately 40 percent greater intensity (and similar storage volume increase) than a 10-year storm. This issue would need to be carefully evaluated in final design.

A possible alternative to the aforementioned solution would be to acquire flooding rights to the land above the backdam, allow flows in excess of 10 years to back up in the basin, and possibly spill out via the saddle near Stage Gulch Road to the adjacent basin, and acquire flooding rights to that basin as well. Although this alternative involves some legal issues, it may be more economical than substantially increasing the pump station capacity to handle floods larger than 10 years.

2. Detention Basin

The natural basin above the backdam was found to provide sufficient storage volume to provide only partial attenuation for a 10-year storm. By excavating from 10 feet to approximately 20 feet below the natural stream bottom over an area of approximately 7 Ac (12 Ac including side slopes), the peak pumping rate requirement was reduced from about 637 cfs (Table C-4A) to about 437 cfs (Table C-4B). This calculation assumed a constant outflow rate, and was further modified in Table C-4C to calculate an excavation depth of about 18 feet and a peak pumping rate of about 508 cfs.

Unlike the Tolay A reservoir in which further depth of excavation would produce little additional benefit, a further depth of excavation at Tolay C could theoretically reduce the peak pumping rate to as low as about 250 cfs (as indicated in Table C-1). However, this is not possible due to (1) the lack of possible storage volume, and (2) the undesirability of lowering the natural streambed significantly more than proposed (18 feet). Space for the detention basin is limited due to the proximity of the farm a few hundred feet upstream of the proposed backdam.

One possible problem with excavating the detention basin below the existing stream invert is that the pumping may draw down the water table, thereby affecting adjacent farmland.

3. Pump Station

The selected pumps should be either vertical turbine pumps or mixed flow pumps. Several manufacturers catalogs were consulted. Pump characteristics are fairly similar. For simplicity, at this stage. representative pumps by Fairbanks Morse & Co. were selected. To handle a 10 year storm, with up to approximately 250 Ac Ft available storage capacity in the proposed detention basin upstream of the backdam, five 1,000 HP vertical turbine (single stage) pumps, each pumping up to 46,500 gpm, with one equivalent standby pump and one jockey (i.e., smaller capacity) pump, are recommended.

The pump station needs to be in the southwest stream embankment above Pt. A. The pumps will be mounted on a concrete slab (over a wet well, Elev. 185'), and need to be above the high water level (Elev. 218 feet). They will be located approximately 10 feet center to center, and can be either covered or open.

4. Gravity Flow Channel

The 9,500-foot long proposed gravity flow channel from the backdam to the Tolay C dam is more practical and economical than a pumped discharge pipeline. A closed conduit gravity flow channel (reinforced concrete pipe or box) would be considerably less expensive than a 102-inch diameter welded steel pressure main and the larger pumping requirement to pump the 228,000 gpm stormwater flow through an additional 9,500-ft long pressure main.

Only one type of gravity flow channel is proposed, i.e. reinforced concrete box due.to the considerably higher excavation and fill costs of an open channel benched in steep side slopes above the proposed reservoir. In addition, there are less maintenance costs and liabilities of maintaining a buried closed conduit.

Two types of closed conduits were sized for the gravity flow channel. For such a large size of RCP pipe (102 inches) in a non-urban setting, the hydraulically equivalent reinforced concrete box is probably a more economical alternative than the RCP. For this analysis, RCP was specified for pipes up to 96" diameter, and RC Boxes for larger conduits.

The proposed gravity flow channel is designed to carry only the 10-year flow. However, if it is determined that higher than the 10-year flow is needed to be pumped (as per the preceding discussion (in Section 1 "General", 4th paragraph), then the conduit would have to be upsized accordingly.

It will not be necessary to capture hillside runoff into the channel because the tributary runoff as shown on the Figure C-1 is insignificant. It can be allowed to pass over the channel along existing drainage patterns, and flow into the reservoir unimpeded, except that erosion control measures to protect the gravity flow channel access road will be required.

D. Sears Point Reservoir

1. General

Two options were evaluated to divert Tolay Creek around the proposed reservoir.

Option 1 collects the 10-year 3,878 cfs runoff at Point A (as shown on Table D-1 and Figure D-1) and conveys it in a Runoff Diversion Channel (gravity flow) around the west side of the proposed reservoir. The channel flow increases as runoff is picked up from natural streams along its course to a 10-year 4,315 cfs flow at Point E. A relatively low dam (approximately 30 feet) would be required to create the detention basin to intercept stormwater flows in Tolay Creek and serve as an inlet to the gravity flow channel to discharge downstream of the main dam.

Option 2 collects the 10-year 3,878 cfs peak runoff at Point A, attenuates it to 360 cfs (Table D-5C) in a detention basin with 880 AF storage volume (Table D-5C). The resultant flow is then pumped by means of 6 vertical turbine pumps up to 27,000 gpm at 91' TDH through 9,950 feet of 84-inch CML&C SP pressure main around the west side of the reservoir to the natural channel below the proposed dam (Point E). See 1"=500' scale layout drawing. A relatively high dam (approximately 90 feet) would be required to create the detention basin of sufficient volume to attenuate and collect stormwater flows and allow the pump station time to discharge the volume to downstream of the main dam.

The route of the pressure main in Option 2 is higher up on the ridge than the Runoff Diversion Channel in Option 1 (see 1"=500' scale layout map), taking advantage of gentler terrain in an effort to reduce excavation costs.

Option 1 is recommended.

2. Option 1: Runoff Diversion Channel (Recommended)

Due to the relatively large flow rate and flat slope, the 12,650-ft long gravity flow channel must be an open flow channel. A rectangular concrete open channel is recommended to minimize the considerable excavation requirement for the channel. It is to be benched in the basin side slopes averaging 2.5H:1V. Its size is fairly constant, varying from 25'W x 13.5'H to 25'W x 14'H. This channel appears to be less expensive than the combined features of Option

2, which includes a detention basin, pump station, and pumping discharge pipeline in place of the runoff diversion channel. However, a cost comparison may be needed to verify this assumption.

3. Option 2: Detention Basin

The natural basin above the reservoir was found to provide sufficient storage volume to provide only partial attenuation for a 10-year storm (without backflooding into Tolay Valley). The practical minimum peak pumping flow rate (i.e, at the lowest head, and maximum water surface) of approximately 360 cfs (as derived from Table D-3) was essentially obtained with Option 2.

Providing additional excavation in the detention basin to increase storage capacity could possibly lower the required 81-ft detention basin operating height range to more reasonable limits. (For the purpose of this study, a 50-ft desirable maximum has been proposed). However substantial additional excavation for this purpose is not practical because the relatively steep terrain upstream of the proposed backdam would not allow deep cuts using a maximum design cut slope of 2.5H:1V.

4. Option 2: Pump Station And Pumping Discharge Pipeline

The selected pumps should be either vertical turbine pumps or mixed flow pumps (see Table D-7). Several manufacturers catalogs were consulted. Pump characteristics are fairly similar. For simplicity, at this stage. representative pumps were selected by Fairbanks Morse & Co. To handle a 10-year storm, with up to approximately 890 Ac Ft available storage capacity in the proposed detention basin upstream of the reservoir, six 750 HP vertical turbine (single stage) pumps, each pumping up to 27,000 gpm, with one equivalent standby pump and one jockey pump, are recommended.

The pump station needs to be in the southwest stream embankment above Pt. A. The pump motors will be mounted on a concrete slab operating floor over a wet well (bottom Elev. 137’, Table D-4), and need to be above the high water level (Elev. 219 feet, per Tables D-4 and D-5C). The pumps will be located at approximately 10 feet center to center, and can be either covered or open.

The proposed Option 2 pump station height of approximately 81 feet from bottom of wet well to high water level exceeds a desirable maximum of 50 feet, as previously mentioned. Due to the space requirements of the pump station to house 7 large pumps (approximately at 10-ft centers) and a jockey pump, and the high vertical dimensions, this pump station will be very expensive. Limiting the vertical height to 50 feet (per Table D-5A), a more practical limit, resulted in a peak pumping rate of 1,015 cfs (455,000 gpm). This pumping rate is excessive and not practical, and therefore, this alternative to Option 2 was not selected.

The proposed pumping discharge pipeline is a 9,950-ft long 84-inch CML&C SP pipeline from the detention basin above the reservoir, around the southwest perimeter of the reservoir, to the existing natural channel below the dam.

One alternative to Option 2 that was not evaluated was to pump up to a much lower elevation (190’ vs. 295’ for Option 2), and discharge into a 9,000-ft length of gravity flow channel along the alignment of Option 1 instead of continuing the pressure pipeline along the proposed higher, flatter route of Option 2 (see 1”=500’ layout plan). This alternative would replace approximately 9,000 feet of 84-inch CML&C SP pumping discharge pipeline with approximately 9,000 feet of 144-inch RCP or its equivalent of gravity flow channel (approximately sized). This alternative may be more economical, and could be explored in final design. However, it was not evaluated for this analysis because Option 2 does not appear to be economically comparable to Option 1, with or without this alternative.

5. Option 2: Gravity Flow Channel

The proposed Option 2, 12,650-foot long gravity flow channel (60-inch RCP), is more practical and economical than the alternative of extending a larger 84-inch CML&C SP pumped discharge pressure main by 2,250 feet along the same alignment. The relatively small size for the gravity flow channel is made possible by the relatively steep slope of 0.013 above the discharge point near the proposed Sears Point dam.

> Note: Section V, tables and figures, and references 1 and 2 are not included herein, but are available from the file.

By [signature] Date 7/06/95 Checked _____ Date ______

TABLE A-8 QUANTITY ESTIMATE
TOLAY A RESERVOIR

ITEM NO.	DESCRIPTION	QUAN.	UNIT	REMARKS/REFERENCES
A. GENERAL				
B. RUNOFF DIVERSION CHANNEL (NONE)				
C. DETENTION BASIN				
1	MISC CLEARING & GRADING IN NATURAL DETENTION BASIN	10	Ac	TABLE A-3A
2	EXCAVATION BELOW NATURAL CHANNEL BOTTOM	74	CY	TABLE A-3A
D. PUMP STATION				
1	400 HP VERTICAL TURBINE PUMPS (SINGLE STAGE), Q=25,000 GPM, 500 RPM*	3	EA	TABLE A-6, FIGURE A-3
2	JOCKEY PUMP, SUBMERSIBLE SEWAGE TYPE	1	EA	FIGURE A-3
3	CONC. PUMP STATION INTAKE BAY WITH FLOATING TRASH RACK	1	LS	FIGURE A-3
4	PUMP STARTER MOTORS	1	LS	FIGURE A-3
5	ELECTRICAL FEEDER CABLES AND CONDUIT	1	LS	
6	TRANSFORMER AND RELATED EQUIPMENT	1	LS	
E. PUMPING DISCHARGE PIPELINE				
1	48-INCH CML&C SP PUMPING DISCHARGE PIPELINE (PT A TO PT B)	1,500	LF	TABLE A-5
2	EXCAVATION FOR PUMPING DISCH PIPELINE, 6' AVE COVER (TYP SECTION)	3,900	CY	900' x 70.1SF/27 (FIGURE B-2)
3	ADD'L EXCAV FOR PUMPING DISCH PIPELINE THROUGH RIDGES	780	CY	20% x PREVIOUS ITEM
4	FILL FOR PUMPING DISCH PIPELINE, 6' AVE COVER (TYP SECTION)	4,300	CY	900' x 77.1SF/27 (FIGURE B-2)
5	ADD'L FILL FOR PUMPING DISCH PIPELINE IN NAT STREAM CROSSINGS	860	CY	20% x PREVIOUS ITEM
6	TRANSITION STRUCTURE FROM PUMP DISCH LINE TO GRAV FLOW CHAN	1	EA	1"=500' SCALE LAYOUT PLAN
F. GRAVITY FLOW CHANNEL (DOWNSTREAM OF PUMPING DISCHARGE PIPELINE)				
1	8'-0"W x 9'-6"H RC BOX , 6' AVE. COVER (PT B TO PT C)	3,500	LF	TABLE A-7, LAYOUT PLAN
2	8'-5"W x 10'-0"H RC BOX , 6' AVE. COVER (PT C TO PT D)	3,250	LF	TABLE A-7, LAYOUT PLAN
3	8'-10"W x 10'-6"H RC BOX , 6' AVE. COVER (PT D TO PT E)	1,950	LF	TABLE A-7, LAYOUT PLAN
4	9'-7"W x 11'-6"H RC BOX, 6' AVE. COVER (PT E TO PT F)	1,600	LF	TABLE A-7, LAYOUT PLAN
5	10'-0"W x 12'-0"H RC BOX, 6' AVE. COVER (PT F TO PT G)	5,100	LF	TABLE A-7, LAYOUT PLAN
6	EXCAVATION FOR PIPELINE & ACCESS RD (TYP SECTION)	96,000	CY	FIGURE A-3
7	ADD'L EXCAV FOR GRAV FLOW PIPELINE THROUGH RIDGES	19,200	CY	20% x PREVIOUS ITEM
8	FILL FOR PIPELINE & ACCESS RD (TYP SECTION)	105,000	CY	FIGURE A-3
9	ADD'L FILL FOR NATURAL STREAM CROSSINGS OF GRAV FLOW CHANNEL	21,000	CY	20% x PREVIOUS ITEM
10	GROUTED RIPRFAP AT OUTLET FROM PUMP DISCH PIPE TO EXIST CHAN	50	CY	15'W x 30'L x 3'/27

* Includes standby pump

SANTA ROSA PROJECT

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TABLE B-9 QUANTITY ESTIMATE
ADOBE ROAD RESERVOIR

ITEM NO.	DESCRIPTION	QUAN.	UNIT	REMARKS/REFERENCES
A. GENERAL				
B. RUNOFF DIVERSION CHANNEL				
1	42-INCH RCP GRAV. FLOW PIPELINE, 6' AVE. COVER (PT. A TO PT B)	1,000	LF	TABLE B-2
2	54-INCH RCP GRAV. FLOW PIPELINE, 6' AVE. COVER (PT. B TO PT C)	1,200	LF	TABLE B-2
3	EXCAVATION FOR PIPELINE & ACCESS RD (TYP SECTION)	5,712	CY	FIGURE B-3, P. 1 OF 2
4	ADD'L EXCAV FOR GRAV FLOW PIPELINE THROUGH RIDGES	1,142	CY	20% x PREVIOUS ITEM
5	FILL FOR PIPELINE & ACCESS RD (TYP SECTION)	6,282	CY	FIGURE B-3, P. 1 OF 2
6	ADD'L FILL FOR NATURAL STREAM CROSSINGS OF GRAV. FLOW CHANNEL	1,256	CY	20% x PREVIOUS ITEM
7	NATURAL STREAM CHANNEL INLETS TO GRAV. FLOW PIPELINE	3	EA	1"=500' SCALE LAYOUT PLAN
9	6' HIGH CHAIN LINK FENCING FOR PREVIOUS ITEM	90	LF	1"=500' SCALE LAYOUT PLAN
10	Q100 OVERFLOW OUTLETS FROM RCP TO RESERVOIR	3	EA	1"=500' SCALE LAYOUT PLAN
11	RIPRAP FOR Q100 OVERFLOW OUTLETS FROM RCP TO RES., 3 LOC'NS	17	CY	5'W x 20'L x 1.5' H x 3 LOCATIONS
C. DETENTION BASIN				
1	MISC CLEARING & GRADING IN NATURAL DETENTION BASIN	3	Ac	TABLE B-4
D. PUMP STATION				
1	550 HP VERTICAL TURBINE PUMP (SINGLE STAGE), Q=28,400 GPM, 880 RPM*	3	EA	TABLE B-7, FIGURE B-3
2	JOCKEY PUMP, SUBMERSIBLE SEWAGE TYPE	1	EA	FIGURE B-3
3	CONC. PUMP STATION INTAKE BAY WITH FLOATING TRASH RACK	1	LS	FIGURE B-3
4	PUMP STARTER MOTORS	1	LS	FIGURE B-3
5	ELECTFICAL FEEDER CABLES AND,CONDUIT	1	LS	
6	TRANSFORMER AND RELATED EQUIPMENT	1	LS	
E. PUMPING DISCHARGE PIPELINE				
1	48-INCH CML&C SP PUMPING DISCHARGE PIPELINE	150	LF	TABLE B-6, LAYOUT PLAN
2	EXCAVATION FOR PUMPING DISCH PIPELINE, 6' AVE COVER (TYP SECTION)	400	CY	150' x 70.1SF/27 (FIGURE B-2)
3	ADD'L EXCAV FOR PUMPING DISCH PIPELINE THROUGH RIDGES	80	CY	20% x PREVIOUS ITEM
4	FILL FOR PUMPING DISCH PIPELINE, 6' AVE COVER (TYP SECTION)	430	CY	150' x 77.1SF/27 (FIGURE B-2)
5	ADD'L FILL FOR PUMPING DISCH PIPELINE IN NAT STREAM CROSSINGS	86	CY	20% x PREVIOUS ITEM
7	TRANSITION STRUCTURE FROM PUMP DISCH LINE TO GRAV FLOW LINE	1	EA	1"=500' SCALE LAYOUT PLAN
F. GRAVITY FLOW CHANNEL (DOWNSTREAM OF PUMPING DISCHARGE PIPELINE)				
1	60-INCH RCP GRAV FLOW PIPELINE, 6' AVE COVER (PT E TO PT F)	5,800	LF	TABLE B-7, LAYOUT PLAN
2	EXCAVATION FOR GRAV FLOW CHAN, 6' AVE COVER (TYP SECTION)	20,900	CY	5,800' x 97.1SF/27 (FIGURE B-2)
3	ADD'L EXCAV FOR GRAV FLOW CHAN THROUGH RIDGES	4,180	CY	20% x PREVIOUS ITEM
4	FILL FOR GRAV FLOW CHAN, 6' AVE COVER (TYP SECTION)	23,000	CY	5,800' x 106.8SF/27 (FIGURE B-2)
5	ADD'L FILL FOR GRAV FLOW CHAN IN NAT STREAM CROSSINGS	4,600	CY	20% x PREVIOUS ITEM
6	GROUTED RIPRAP AT OUTLET FROM GRAV FLOW CHAN TO EXIST CHAN	50	CY	15'W x 30'L x 3' H/27

* Includes standby pump

TABLE C-8 QUANTITY ESTIMATE
TOLAY C RESERVOIR

ITEM NO.	DESCRIPTION	QUAN.	UNIT	REMARKS/REFERENCES
A. GENERAL				
B. RUNOFF DIVERSION CHANNEL (NONE)				
C. DETENTION BASIN				
1	MISC CLEARING & GRADING IN NATURAL DETENTION BASIN	13	Ac	TABLE C-3B
2	EXCAVATION BELOW NATURAL CHANNEL BOTTOM	275	CY	TABLE C-3B
D. PUMP STATION				
1	1,000 HP VERTICAL TURBINE PUMP (SINGLE STAGE), Q=46,500 GPM, 580 RPM*	6	EA	TABLE C-6, FIGURE C-3
2	JOCKEY PUMP, SUBMERSIBLE SEWAGE TYPE	1	EA	FIGURE C-3
3	CONC. PUMP STATION INTAKE BAY WITH FLOATING TRASH RACK	1	LS	FIGURE C-3
4	PUMP STARTER MOTORS	1	LS	FIGURE C-3
5	ELECTRICAL FEEDER CABLES AND CONDUIT	1	LS	
6	TRANSFORMER AND RELATED EQUIPMENT	1	LS	
E. PUMPING DISCHARGE PIPELINE				
1	102-INCH CML&C SP PUMPING DISCHARGE PIPELINE (PT A TO PT A1)	900	LF	TABLE C-5
2	EXCAVATION FOR PUMPING DISCH PIPELINE, 6' AVE COVER (TYP SECTION)	4,800	CY	900' x 143 SF/27 (FIGURE C-2)
3	ADD'L EXCAV FOR PUMPING DISCH PIPELINE THROUGH RIDGES	960	CY	20% x PREVIOUS ITEM
4	FILL FOR PUMPING DISCH PIPELINE, 6' AVE COVER (TYP SECTION)	5,300	CY	900' x 157.3 SF/27 (FIGURE C-2)
5	ADD'L FILL FOR PUMPING DISCH PIPELINE IN NAT STREAM CROSSINGS	1,060	CY	20% x PREVIOUS ITEM
6	TRANSITION STRUCTURE FROM PUMP DISCH LINE TO GRAV FLOW CHAN	1	EA	1"=500' SCALE LAYOUT PLAN
F. GRAVITY FLOW CHANNEL (DOWNSTREAM OF PUMPING DISCHARGE PIPELINE)				
1	7'-1"W x 8'-6"H RC BOX, 6' AVE. COVER (PT A TO PT A1)	9,500	LF	TABLE C-7, LAYOUT PLAN
6	EXCAVATION FOR PIPELINE & ACCESS RD (TYP SECTION)	51,000	CY	9,500' x 143 SF/27 (FIGURE C-2)
7	ADD'L EXCAV FOR GRAV FLOW PIPELINE THROUGH RIDGES	10,200	CY	20% x PREVIOUS ITEM
8	FILL FOR PIPELINE & ACCESS RD (TYP SECTION)	56,000	CY	9,500' x 157.3 SF/27 (FIGURE C-2)
9	ADD'L FILL FOR NATURAL STREAM CROSSINGS OF GRAV FLOW CHANNEL	11,200	CY	20% x PREVIOUS ITEM
10	GROUTED RIPRFAP AT OUTLET FROM PUMP DISCH PIPE TO EXIST CHAN	50	CY	15'W x 30'L x 3'/27

*Includes standby pump

By [signature] Date 7/06/95 Checked _____ Date _____

TABLE D-9A QUANTITY ESTIMATE
SEARS POINT RESERVOIR, OPTION 1

ITEM NO.	DESCRIPTION	QUAN.	UNIT	REMARKS/REFERENCES
A. GENERAL				
B. RUNOFF DIVERSION CHANNEL				
1	25'W x 13.5'H RECT CONC OPEN CHAN (PTS A TO C, Q=3,972 TO 4,033 CFS)	6,900	LF	TABLE D-2 & LAYOUT PLAN
2	25'W x 14.0'H RECT CONC OPEN CHAN (PTS C TO END, Q=4,140 TO 4,315 CFS)	5,750	LF	TABLE D-2 & LAYOUT PLAN
3	EXCAVATION FOR OPEN CHANNEL (TYP SECTION)	108,000	CY	12,650' x 230 SF/27 (FIGURE D-2)
4	ADD'L EXCAV FOR OPEN CHANNEL THROUGH RIDGES	21,600	CY	20% x PREVIOUS ITEM
5	FILL FOR OPEN CHANNEL (TYP SECTION)	119,000	CY	12,650' x 253 SF/27 (FIGURE D-2)
6	ADD'L FILL FOR OPEN CHANNEL IN NAT STREAM CROSSINGS	23,800	CY	20% x PREVIOUS ITEM
7	GROUTED RIPRAP AT OUTLET FROM OPEN CHANNEL TO EXIST CHAN	50	CY	15'W x 30'L x 3' H/27
C. DETENTION BASIN (NONE)				
D. PUMP STATION (NONE)				
E. PUMPING DISCHARGE PIPELINE (NONE)				