CITY OF LITCHFIELD PARK

LITCHFIELD ROAD AND NEOLIN AVE

DRAINAGE IMPROVEMENTS

Outfalling to the RID Overchute

ASL

CONSULTING ENGINEERS

Quality Beyond Expectation

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CITY OF LITCHFIELD PARK
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I. INTRODUCTION

This project is located within the City of Litchfield Park, Arizona and will tie into the RID Overchute that was recently constructed by the Flood Control District of Maricopa County (FCDMC) just south of the City of Litchfield Park. The goals of the project are to eliminate some of the flooding within the City during storms and to minimize the transport of stormwater on the surfaces of Litchfield Road, Wigwam Boulevard and through the intersection of Litchfield Road and Indian School Bypass.

II. BACKGROUND

This project is part of the ongoing effort by Litchfield Park to address flooding within the city limits. For several years the City has been working with the Flood Control District of Maricopa County (FCD) to eliminate offsite storm runoff from entering the City. With the completion of the Colter Channel, the Dysart Channel, and the R.I.D. Overchute and the proposed construction of the Camelback Road improvements, the offsite storm flows which have historically contributed to flooding within the city limits have been mitigated.

The City began to address the problems of flooding from storm flows which develop in the city in 1989 with the completion of a Master Drainage Study. This study tabulated the expected stormwater runoff rates, identified areas prone to flooding and recommended a variety of alternate solutions. In late 1991 the City began the process of eliminating the flooding problems in the Ancora Drive South and Desert Ave. area. By late 1994 Phase III of the Ancora Drain project was complete and it appears from current data that all of the typical flooding (less than the 100 year storm) in this area has been eliminated.

In 1996 while the FCD was planning the R.I.D. Overchute project the City again reviewed the options for the elimination of flood prone areas within the city. The use of new detention basins had previously been rejected since they would impact areas currently used for parks or school playgrounds. Dredging of 'The Lake' at the corner of Litchfield Road and Villa Nueva Drive to provide storm runoff storage capacity has previously been rejected by the City for aesthetic and operational reasons. A letter report was prepared which indicated that connecting storm drains to the R.I.D. Overchute could be used to eliminate most of the existing flood prone areas within the city. The report did not go into detailed analysis of the drainage conditions or possible solutions, but it was adequate to convince the FCD to install four pipe stub-outs for the future use of Litchfield Park.

In September 1997 ASL Consulting Engineers assisted the City with the preparation of an application to the FCD for funding of drainage work for inclusion into the FCD's 5-year Capital Improvement Program (See Appendix I). As part of the application we reviewed the FEMA maps and noted Zone A floodplains at and around the intersection of Campina and Bird Lanes, the intersection of La Loma Ave. and Fairway Drive and along the north side of the Airline Canal on the Wigwam Resort's golf course. City staff also indicated that known flood prone areas existed at the intersections of Wigwam Blvd. and Litchfield Road, Wigwam Blvd. and Neolin Ave., Neolin Ave. and Cascada Road and along southern Litchfield Road. The 1996 letter report for the R.I.D. project had proposed storm drains to carry the storm runoff to the R.I.D. Overchute, thus eliminating the flooding in all of the areas described above except for the Campina and Bird Lanes area. We revised these proposed storm drain layouts to reduce the pipe sizes and lengths and to incorporate "The Lake" into the drainage system for the FCD application. While the study for the FCD application was preliminary it was adequate for determining basic pipe sizes, alignments, and project cost estimates.

This report will detail the results of a detailed review and study of the storm drains proposed in the FCD application. This study will then be the basis for the design of the storm drain systems when the funding becomes available.

III. EXISTING UTILITIES

The research of existing utilities for this study was limited to a review of the utility maps obtained from Litchfield Park Service Company (water and sewer), Southwest Gas Company, Arizona Public Service Company and U.S. West. The utility line locations from these maps were placed onto a plan of the City and the map was then used to determine possible routes for the storm drain lines. During the design and construction plan preparation phase detailed field surveys and potholing will be required to more accurately locate the utilities within the vicinity of the proposed storm drain routes. The utilities of most concern for the storm drain lines will be the sewer and water lines and any locations where there appears to be limited space because of multiple utility lines. The proposed alignments of the three storm drain lines studied in this report are shown on Exhibit No. 2.

The sewer will be of primary concern since both the storm drain and the sewer are gravity flow systems and therefore will have a limited horizontal zone in which they can be constructed. The location of water lines is important because of the Arizona Department of Environmental Quality (ADEQ) requirements for adequate horizontal and vertical separation for health reasons. However, of the two utility lines the sewer will be most critical since horizontal or vertical relocations and concrete encasement of the water have become common methods for meeting the ADEQ separation requirements. The remaining utilities do not pose any problem when relocating them to install the storm drain with the exception of the additional cost for each relocation.

For the Neolin Ave. storm drain there are four locations where possible conflicts with the sewer occur. These locations are at the intersection of Wigwam Blvd., the intersection of Sagebrush St., and as the storm drain line enters 'The Lake'. These four possible conflicts will all be with the vertical location of the sewer and storm drain as they cross each other. There will be at least six locations where the water line will have to be vertically relocated for the storm drain to be installed without violating ADEQ standards. It appears that there will be adequate room horizontally to install the storm drain along the proposed alignment. The one horizontal exception is along a portion of the sidewalk/cart path between 'The Lake and the end of Neolin Ave., where a waterline may need to be horizontally relocated .

The storm drain in Fairway Dr. from La Loma Ave. to Litchfield Rd. will require one vertical relocation of a water line. The storm drain will be located to miss the existing sewer that is located at the intersection of Fairway Dr. and Litchfield Rd. Just south of Fairway Dr. the storm drain in Litchfield Rd will cross the Airline Canal underground pipe. If there is a vertical conflict at this location we will recommend that the Airline Canal pipe be relocated using a siphon.

From Fairway Dr. to the RID overchute there will be as many as ten locations where a vertical waterline relocation will be required, depending on the final storm drain alignment. There will be as many as five locations where the storm drain will cross the sewer. Miscellaneous other utility relocations will also be required if the vertical alignment conflicts with the storm drain. Selecting an alternate route for the northern portion of the Litchfield Rd. storm drain has been ruled out because of the need to collect flows along Litchfield Rd. and the high number of utility lines in Wigwam Blvd.

The lake outlet storm drain will have to cross three water lines and one sewer before reaching the RID overchute. Alternate alignments for this storm drain will reduce the number of miscellaneous utilities which cross the storm drain but will not decrease the number of water or sewer crossings.

IV. HYDROLOGY

Hydrologic calculations were not completed as a part of this report. Since the hydrology for the study area was completed in both 1989 and 1997 it was not necessary to recalculate the runoff data. The reports which were used for the hydrologic data are as follows:

> City of Litchfield Park, Master Drainage Study, by Willdan and Associates, March 1989 (MD study)
>
> RID Overchute Project, Flood Control District of Maricopa County, by Stantech Consulting, July 1997 (FCD study)

Although both of the reports used similar drainage divides to determine how the water was routed through the city, there are differences between the two reports. The FCD study used two drainage sub-areas (See Exhibit No. 1)and the MD study used fifteen drainage sub-areas (See Figure No. 1)for the contributing area of this project. The FCD study routed all of the runoff to one outfall point while the MD study used six different outfall points. The total peak runoff rate from the FCD study is 548 cfs while the total of the six runoff rates from the MD study is 407 cfs (61+80+25+7+100+134), which is about 75% of FCD study total.

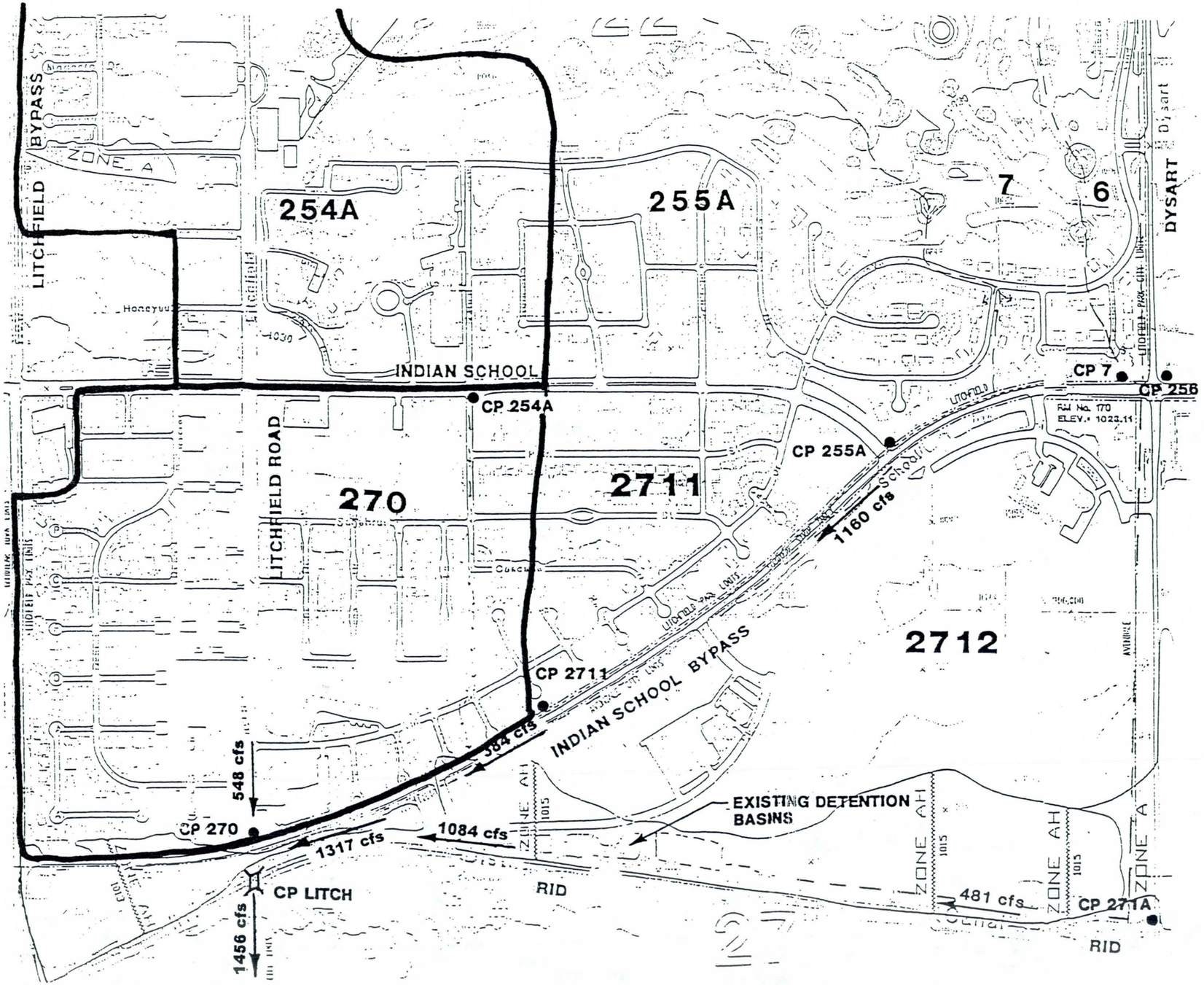
The differences in the reports are not unusual considering the sources and purposes of the studies. The FCD is concerned about major flows from large drainage basins and major drainage facilities. Therefore the FCD uses a 'broad brush' approach when completing hydrologic studies. The MD study was intended to determine the details of how water was routed around the city and what the runoff rates were in various areas so that drainage facilities could be designed to collect the runoff. It is common for runoff rates from detailed studies to be less than those developed in 'broad brush' studies since greater details about slope, routing ,travel length and drainage subarea limits can be incorporated into a study which covers a smaller area.

Therefore, we will use the values listed in the MD study, since they were prepared for the purpose of designing a drainage system within the City. The storm runoff values to be used for this study are listed in Table No. 1. Runoff will also continue to exit the city via the existing Ancora storm drain and the Indian School Bypass storm drain.

TABLE NO. 1

Drainage Basin Name	100-yr Peak Runoff (cfs)	How the value will be used in the Hydraulic Analysis
Basin K	26	Direct Input to Litchfield Rd. Storm Drain
Basin J	18	Direct Input to Litchfield Rd. Storm Drain
Basin F-2	52	Direct Input to Litchfield Rd. Storm Drain
Basin F-1	25	Direct Input to Litchfield Rd. Storm Drain
Routed Total	**121**	**Total Flow in Litchfield Rd Storm Drain**
Basin H-1	110	Routing Flows to Wigwam Blvd. and Neolin
Basin C-4	157	Routing Flows to Neolin and Cascada
Basin C-3	164	Routing Flows to 'The Lake'
Basin E (1&2)	39	Direct Input to 'The Lake'
Routed Total	**203 ***	**Total Flow Discharge From 'The Lake'**

* Combination of flows from Basin C-3 and Basin E (1&2)



*** FLOW RATES REFLECT FINAL ITERATION OF MODELS (1997)**

FIGURE 1

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY

HEC-1 MODEL SUMMARY
PROPOSED CONDITIONS
100-YEAR 24-HOUR

R.I.D. OVERCHUTE PROJECT

V. HYDRAULICS AND RUNOFF ROUTING

The hydraulic calculations for this study used the computer model StormCAD for the pipeline design and Manning's equation for the channel and street capacity design. The design storm for this project is the 100-year 24-hour storm. The design standard is from the City Code, Sec. 15-2-3 Storm Drainage, Subsection C "...the 100-year storm shall be carried within the cross-section between right-of-way lines and must not exceed 4 inches above the top of curb." Since detailed data about the area between the back of curb and the right-of-way was not available for this study we have limited the available flow width to be from the back of curb to the back of curb. The depth of flow will be four inches above the curb but only within the limits stated above. During the design and construction plan preparation phase of this project the detailed survey data will be used to verify the street runoff carrying capacity. Since the street will be carrying runoff the hydraulic grade line for the pipes was allowed to be as high as the existing ground line. Discussion of the storm drain capacity is included in the Alternates section.

The storm drain line in Neolin Ave. will begin at the point where Neolin Ave. meets the Wigwam Golf Resort golf course. The runoff for this storm drain is originally generated from the golf course and the residential areas to the north and collects along the north side of the Airline Canal. At the southwest corner of the golf course the Airline Canal transitions to an underground pipe. At that location the runoff overtops the Airline Canal with approximately 20 cfs being collected by the canal/pipe and the remainder (110 cfs) flows to the south of the canal. At this point the runoff needs to be collected and routed to Neolin Ave. The runoff can be collect in a storm drain or in an open channel. Since this is a golf course and pipes are more costly than channels we have assumed that the Wigwam Golf Resort would choose to use a grass lined open channel to route the runoff to Neolin Ave. Appendix II, Sheet 1 contains the calculations and schematics for two shallow channel alternates which were analyzed using Manning's equation. A drop inlet headwall per MAG Standard Detail 501-5 will be used to transition the runoff from the channel to the Neolin Ave. storm drain.

Neolin Ave., north of Wigwam Blvd., currently has capacity to carry 68 cfs with water up to four inches above the top of curb (Appendix II, Sheet 2). Although the slope of the street is 0.62% the capacity of the street is limited because the street has minimal flow area since four inch roll curb and gutter was used instead of six inch vertical curb and gutter. The results of a revised street section analysis, using six inch vertical curb and gutter set at the same top of gutter elevation as the roll curb, indicates that 140 cfs could be carried in the street (Appendix II, Sheet 3). Both of the street sections were used in the alternatives analysis to determine the required pipe sizes.

Neolin Ave. from Wigwam Blvd. south to Sagebrush St. was constructed with six inch vertical curb and gutter. This existing section of Neolin Ave. has good runoff carrying capacity (69 cfs) considering the fact that the slope of the street is only 0.30% (Appendix II, Sheet 4). For the proposed section the street cross slope was reduced from over 2% to approximately 1%. The capacity of the proposed section then increases to 94 cfs (Appendix II, Sheet 5).

Neolin Ave. at Cascada Rd. has the capacity to carry 60 cfs with water up to four inches above the top of curb (Appendix II, Sheet 6). Although the slope of the street is 0.74% the capacity of the street is limited because the street has minimal flow area since four inch roll curb and gutter was used instead of six inch vertical curb and gutter. The cross slopes of the street exceed 2% which also reduces the overall capacity of the street. The revised street section analysis uses six inch vertical curb and gutter set at the same top of gutter elevation as the roll curb and cross slopes of 1-2 %. The analysis indicates that 79 cfs could be carried in the street (Appendix II, Sheet 7). Both of the street sections were used in the alternatives analysis to determine the required pipe sizes.

From the intersection of Neolin Ave. and Cascada Rd. the water will travel down the sidewalk/cart path to 'The Lake'. No calculations were performed for the existing capacity of the path since it's elevation is approximately equivalent to the back yard gates of some of the residences along the path. Therefore, it would be inappropriate to allow large runoff volumes to be carried on the path since they would negatively impact the residences back yards and possibly the residential structure. Appendix II, Sheet 8 shows the typical section and calculations for two different channel sections. Both of the sections can carry 80 cfs and will be set below the existing grade. This channel will probably consist of several different sections which will be designed during the plan preparation phase. Freeboard should be provided on this channel since it will be close to residential structures and will have to curve just before it discharges to the lake.

The description for the outfall from 'The Lake' will be presented with the description for the final section of the Litchfield Rd. system since they will both use the same road for surface flow.

The Litchfield Rd. system will begin at the intersection of La Loma Ave. and Fairway Dr. The runoff from drainage Basins J and K (Exhibit 1) normally exit the City in a westerly direction because Fairway Drive slopes to the west. The storm drain will carry the runoff easterly to Litchfield Road. Since the storm drain will slope in the opposite direction as the street, all of the runoff in this area will have to be carried in the storm drain. Therefore, the capacity of the street to carry water was not needed and no calculations were completed. The existing inlets and storm drains which currently bleed off the ponding water in this area will be left in place to act as emergency overflows for this area.

Litchfield Rd. is one of the major roadways in Litchfield Park, therefore the design for this road will only allow water to pond within sixteen feet of the outside curb line. By limiting the area of ponding it will still be possible for cars to travel the road with minimum impact from water if vehicles are parked against the median. The capacity of Litchfield Rd. north of Wigwam Blvd. is only 8.5 cfs (Appendix II, Sheet 9). There are no options for increasing the capacity of the street since the limiting factor is the allowable ponding width. If a pavement overlay is placed on this section of Litchfield Rd. the cross slope will increase and the runoff carrying capacity of the street will increase. However, the placement of catch basins will be determined using the existing cross slope so that the drainage system will function now and in the future. One of the alternates which will be reviewed is the pipe sizes required if the street is allowed to flood to the top of curb. Under this scenario the street would have about six inches of water at the curb line and the spread would be from 28 ft. to 34.5 ft. While this would require vehicles to travel slower it would not prevent travel on Litchfield Rd. Allowing ponding to the top of curb will increase the street capacity to 52 cfs (Appendix II, Sheet 9).

Litchfield Rd. from Wigwam Blvd. to Oeste Lane appears to have already received several pavement overlays or seal coats. The existing cross slopes of 2.44% and 2.54% are probably the maximum that could be used on this street without replacing the existing median curb. The existing capacity of the street, when the ponding width is limited to sixteen feet, is 15.69 cfs (Appendix II, Sheet 10). Due to the current pavement condition and thickness, this street will probably be reconstructed in the near future (5-10 years). Typically reconstruction of this type of road in Litchfield Park would involve removing some or all of the pavement, replacing only damaged sections of the curb and placing new pavement with a reduced cross slope. The capacity of this section of the street drops to only 6.7 cfs if the road is reconstructed with a 1.5 % cross slope (Appendix II, Sheet 11). Therefore the catch basins will be designed assuming that the cross slope is only 1.5% so that the drainage system will function now and in the future. One of the alternates which will be reviewed is the pipe sizes required if the street is allowed to flood to the top of curb. Under this scenario the street would have six inches of water at the curb line and the spread would be from 29 ft. to 34 ft. While this would require vehicles to travel slower it would not prevent travel on Litchfield Rd. Allowing ponding to the top of curb will increase the street capacity to 39 cfs (Appendix II, Sheet 11).

Litchfield Rd. from Oeste Lane to Indian School Bypass also appears to have received several pavement overlays or seal coats. The section which was surveyed shows existing cross slopes of 1.85% and 0.26% and that the top of curb elevations differ by approximately 3 inches. The existing cross section will only carry 1.1 cfs when the ponding width is limited to nine and one-half feet. Because the cross slope on one side of the street is very shallow, relatively insignificant volumes of runoff will be carried on that side of the street. Allowing

the street to pond to the top of curb will increase the capacity of the street to 39 cfs (Appendix II, Sheet 12). If this street is reconstructed it is advisable to reconstruct the curb as required to match the top of curb grade lines for both sides of the street. Under this alternative the street capacity, when the ponding width is limited to only nine and one-half feet, is 1.6 cfs. The change in the capacity of the street between the existing and proposed cross sections is minor when the ponding width is limited. However, if the street is allowed to pond to the top of curb the reconstructed cross section will be able to carry 65 cfs (Appendix II, Sheet 13). The section of Litchfield Rd. from Villa Nueva Drive to Indian School Bypass may carry runoff from both the Litchfield Road drainage area and/or from 'The Lake' discharge.

The outlet from 'The Lake' will use either a grated inlet or curb opening inlets to collect the runoff and discharge it to the two lake discharge pipes. Calculations for the capacity of the inlets and schematics of the inlets are included on Sheets 14-17 of Appendix II. The storm drain will follow an alignment in the Litchfield Rd. street or behind the back of the east curb line. Routing the storm drain behind the back of curb will limit the amount of construction in the street and therefore reduce the construction cost.

VI. ALTERNATIVES

Neolin Ave. - Alternate - 1

This alternate is based on the assumption that a channel will be constructed on the Wigwam Golf course to route the runoff to the northern end of Neolin Ave.(See Exhibit No. 2). Alternate 1 uses the maximum runoff capacity of the existing street so that the size of the storm drain can be kept to a minimum. However, there is one location where the street has such limited capacity that it will need to be reconstructed as a part of this alternate. The hydraulic calculations summary tables and profiles for this alternate are in Appendix III, Sheets 1-5. Table 2 contains the design flow rates used for this alternate.

TABLE 2
NEOLIN AVE. - ALTERNATE 1

Location Along Neolin Ave.	Design (cfs)	Street (cfs)	Pipe (cfs)	Combined (cfs)
Golf Course - Wigwam Blvd.	110	68	46 - 57	156 - 167
Wigwam Blvd. - Palm St.	134	69	63	132
Palm St. - Sagebrush St.	157	69	75	144
Sagebrush St. - Cascada Rd	164	79*	81	160
Cascada Rd. - 'The Lake'	164	80	86	166

* Street Reconstruction Required

The combined capacity of the proposed system from Wigwam Blvd. to Sagebrush St. is slightly below the design flows. This is not a concern at this time since the street capacity calculations in this report are based on limiting the flow to the width of the existing street. During the final design and plan preparation phase detailed survey data will be available to determine the capacity of the entire street right-of-way. From Sagebrush St. to Cascada Rd. the existing capacity of the street is only 60 cfs. Therefore, this alternate includes the reconstruction of that section of Neolin Ave. which will increase the runoff carrying capacity to at least 79 cfs. This alternate will use 36" storm drain from the golf course to Wigwam Blvd. and 34" x 53" storm drain from Wigwam Blvd. to 'The Lake'.

Neolin Ave. - Alternate 2

This alternate also includes a channel on the Wigwam Golf course to route the runoff to the northern end of Neolin Ave. Alternate 2 however assumes that the street will be reconstructed to create a greater runoff capacity for the street so

that the size of the storm drain can be kept to a minimum or the storm drain can be eliminated. The hydraulic calculations summary tables and profiles for this alternate are in Appendix III, Sheets 6-10. Table 3 contains the design flow rates used for this alternate.

TABLE 3
NEOLIN AVE. - ALTERNATE 2

Location Along Neolin Ave.	Design (cfs)	Street (cfs)	Pipe (cfs)	Combined (cfs)
Golf Course - Wigwam Blvd.	110	140*	0	140
Wigwam Blvd. - Palm St.	134	94*	40	134
Palm St. - Sagebrush St.	157	94*	63	157
Sagebrush St. - Cascada Rd	164	79*	74	153
Cascada Rd. - 'The Lake'	164	80*	85	165

* Street Reconstruction Required

The combined capacity of the proposed system from Wigwam Blvd. to Sagebrush St. is equal to or greater than the design flows. From Sagebrush St. to Cascada Rd. the proposed combined capacity of the street is slightly below the design flow. This is not a concern at this time since the street capacity calculations in this report are based on limiting the flow to the width of the existing street. During the final design and plan preparation phase detailed survey data will be available to determine the capacity of the entire street right-of-way. The storm drain for this alternate uses 30" pipe crossing Wigwam Blvd., 36" pipe from Wigwam Blvd. to Palm Street, and 34" x 53" pipe from Palm Street to 'The Lake".

Litchfield Road - Alternate 1

Because Fairway Dr. slopes to the west the storm drain will have to intercept the entire runoff from the La Loma Ave. and Fairway Dr. concentration point . For Litchfield Rd. this alternate will allow street ponding which will leave a single driving lane open to traffic. The remainder of the runoff will be collected as quickly as possible into the storm drain. Inlets are spaced so that as the runoff in the street begins to pond into the roadway it will be intercepted by an inlet. The hydraulic calculations summary tables and profiles for this alternate are in Appendix III, Sheets 11-17. Table 4 contains the design flow rates used for this alternate

TABLE 4
LITCHFIELD RD. - ALTERNATE 1

Location Along Neolin Ave.	Design (cfs)	Street (cfs)	Pipe (cfs)	Combined (cfs)
Fairway Dr. to Litchfield Rd.	44	0	44	44
Fairway - Cottonwood St.	96	32	64	96
Cottonwood - Wigwam Blvd.	96	12	84	96
Wigwam - Sagebrush St.	106	10	96	106
Sagebrush St. - Oeste Lane	111	5	106	111
Oeste Lane - Villa Nueva Dr.	116	5	111	116
Villa Nueva - Indian School	121	5	116	121
Indian School - Overchute	121	0	121	121

The capacity of the storm drain on Fairway Dr. is able to handle all of the runoff and carry it to the tee intersection with Litchfield Rd. Runoff collecting on Litchfield Rd. north of Fairway drive will pond across the entire street. Inlets on the north side of the intersection of Litchfield Rd. and Fairway Dr. will intercept approximately 40 % of the flow, allowing 32 cfs to continue as surface flow to Cottonwood St. While this will cause ponding into the driving lane for a short portion of Litchfield Rd. it will not prevent vehicular movement. The only option to allowing some minor street flooding is to extend the storm drain further north on Litchfield Rd. and install more inlets. This will have a negative impact on the hydraulic grade line at the intersection of Fairway Dr. and Litchfield Rd. and require increasing the Litchfield Rd. storm drain size so that the Fairway Dr. storm drain will function properly. This option was ruled out since the future ponding depth will be less than the present condition. Inlets in Litchfield Rd. on the north side of Cottonwood street will intercept 20 cfs which will limit the ponding so that travel will not be interrupted by runoff ponding in the travel lane. The remainder of Litchfield Road will experience ponding along the outside parking lane which should not impact vehicular travel. This alternate uses 36" storm drain form La Loma Ave. and Fairway Dr. to Cottonwood St. and Litchfield Rd. At Cottonwood St. the Litchfield Rd. storm drain increases to a 34" x 53" until Wigwam Blvd. where it changes to a 38" x 60" which will continue to the RID Overchute.

Litchfield Road - Alternate 2

This alternate will also collect all of the runoff from Fairway Dr. in the storm drain. Runoff will be allowed to pond to the top of curb for the entire length of Litchfield Rd. Inlets will be spaced to collect portions of the runoff prior to overtopping of the curb. This alternate will keep the storm drain pipe size as small as possible.

Reconstruction of the Litchfield Rd. from Wigwam Blvd. to Oeste Lane will be required to provide the required flow area. The hydraulic calculations summary tables and profiles for this alternate are in Appendix III, Sheets 18-23. Table 5 contains the design flow rates used for this alternate

TABLE 5
LITCHFIELD RD. - ALTERNATE 2

Location Along Neolin Ave.	Design (cfs)	Street (cfs)	Pipe (cfs)	Combined (cfs)
Fairway Dr. to Litchfield Rd.	44	0	44	44
Fairway - Cottonwood St.	96	52	44	96
Cottonwood - Wigwam Blvd.	96	52	44	96
Wigwam - Sagebrush St.	106	37*	69	106
Sagebrush St. - Oeste Lane	111	37*	74	111
Oeste Lane - Villa Nueva Dr.	116	37	79	116
Villa Nueva - Indian School	121	37	84	121
Indian School - Overchute	121	32	89	121

* Street Reconstruction Required

This alternate has the capacity to carry the design flows to the RID Overchute. However, Litchfield Rd. from Fairway Dr. to the RID Overchute will be flooded to the top of curb. Vehicular travel will be limited on Litchfield Rd and wave action may cause some problems to residential structures which are not set at least one foot above the low top of curb. During final design the detailed survey data may reveal that the right-of-way capacity is large enough to eliminate concerns about the wave action. Reconstruction of Litchfield Rd. will be required from Wigwam Blvd. to Oeste Lane. This alternate uses smaller pipe than Alternate 1, starting with a 30" storm drain in Fairway Dr., Litchfield Rd will have a 36" storm drain from Fairway Dr. to Wigwam Blvd. and a 34" x 53" storm drain from Wigwam Blvd. to the RID Overhute.

'The Lake' Outlet - Alternate 1

This alternate assumes that Litchfield Rd. from Villa Nueva Drive to Indian School Bypass will not be reconstructed. Only one of the two pipes and half of the design flow were used in the model, since this method will create an accurate hydraulic model and simplify the computer model. The street will not have the capacity to carry any surface flow for this alternate. The total discharge from 'The Lake' is 203 cfs (101.5 cfs per pipe) per Table 1. The alignment of the storm drain for this alternate will be behind the curb line along Litchfield Rd. which will reduce the pavement replacement quantity and utility conflicts. This alignment will also prevent conflicts with the new valley gutter on Villa Nueva Dr.

at Litchfield Rd. The hydraulic calculations summary tables and profiles for this alternate are in Appendix III, Sheets 27-29.

This alternate will function in combination with Litchfield Rd. Alternate 1 or Alternate 2. This alternate will use two 38" x 60" storm drains to carry 'The Lake' discharge to the RID Overchute. The inlet structures at 'The Lake' will vary slightly for Alternate 1 and 2 but not enough to have a noticeable impact on the project costs.

'The Lake' Outlet - Alternate 2

This alternate assumes that Litchfield Rd. from Villa Nueva Drive to Indian School Bypass will be reconstructed and that flooding to the top of the curb would be allowed on this section of Litchfield Rd. Only one of the two pipes and half of the design flow were used in the model, since this method will create an accurate hydraulic model and simplify the computer model. The alignment of the pipe was set to enter Litchfield Rd. just to the north of Villa Nueva Dr.. This alignment will prevent any conflicts with the new valley gutter on Villa Nueva Dr. at Litchfield Rd. The reconstructed street will have a capacity of 65 cfs if flooding to the top of curb is allowed. For the Litchfield Rd. storm drain Alternate 1 has 5 cfs of surface flow and Alternate 2 has 37 cfs of surface flow. The total discharge from 'The Lake' is 203 cfs per Table 1. Therefore, if this alternate is used with Litchfield Rd Alternate 1, 60 cfs (30 cfs per pipe) of the discharge from 'The Lake' can be surface flow. The pipe capacity will then have to be 143cfs (71.5 cfs per pipe). The hydraulic calculations summary tables and profiles for this alternate are in Appendix III, Sheets 24-26.

This alternate will function in combination with Litchfield Rd. Alternate 1 if flooding to the top of curb is allowed. This alternate cannot be used with Litchfield Rd. Alternate 2 because there would not be adequate capacity for the surface flow. During the final design and plan preparation phase the detailed survey data will be used to determine if the capacity of the right-of-way is adequate for this alternate to be used with Litchfield Rd. Alternate 2. This alternate will use two 34" x 53" storm drains to carry 'The Lake' discharge to the RID Overchute. The inlet structures at 'The Lake' will vary slightly for Alternate 1 and 2 but not enough to have a noticeable impact on the project costs.

VII. ENGINEERS ESTIMATES

The Engineers Estimates were compiled using quantities from the hydraulic models, and Exhibit No. 2. Unit prices were determined by using manufacturers data, the ADOT annual cost summaries and engineering judgment. Detailed engineers cost estimates for each alternate and phase are included in Appendix IV.

Table 6 below lists the cost for both alternates for the three main storm drain lines proposed in this report. In every case Alternate 1 will be the least expensive option. This is a positive result, since Alternate 1 will carry the greatest amount of runoff in the storm drain thereby reducing the street flooding.

TABLE 6
ENGINEERS ESTIMATES SUMMARY

Recommended

LOCATION	ALTERNATE 1	ALTERNATE 2
NEOLIN AVE.	$ 628,330.00	$ 662,285.00
LITCHFIELS RD.	$ 895,920.00	$ 987,315.00
'THE LAKE' OUTLET	$ 254,160.00	$ 289,125.00
CONSTRUCTION TOTAL	**$ 1,778,410.00**	**$ 1,938,725.00**
PREDESIGN STUDY	$40,000.00	$ 40,000.00
PUBLIC INVOLVEMENT	$ 15,000.00	$ 15,000.00
DESIGN ENGINEERING	$ 134,740.00	$ 134,740.00
PROJECT TOTAL	**$ 1,968,150.00**	**$ 2,128,465.00**

↳ INCLUDES 10% CONTINGENCIES

Table 7 below gives a more detailed look at how the two alternates vary in cost. It is estimated that the phases will be constructed over a period of from five to ten years. The cost estimates were prepared using present day costs which do not contain factors for future inflation. Refer to Exhibit No. 2 for the limits of the phases listed below.

TABLE 7
ENGINEERS ESTIMATES SUMMARY BY PHASE

PHASE	ALTERNATE 1	ALTERNATE 2
PHASE 1	$ 662,420.00	$ 684,225.00
PHASE 2A	$ 184,795.00	$ 225,120.00
PHASE 2B	$ 249,335.00	$ 297,395.00
PHASE3	$ 245,540.00	$ 328,855.00
PHASE 4	$ 251,950.00	$ 225,130.00
PHASE 5	$ 184,370.00	$ 178,000.00
CONSTRUCTION TOTAL	**$ 1,778,410.00**	**$ 1,938,725.00**
PREDESIGN STUDY	$ 40,000.00	$ 40,000.00
PUBLIC INVOLVEMENT	$ 15,000.00	$ 15,000.00
DESIGN ENGINEERING	$ 134,740.00	$ 134,740.00
PROJECT TOTAL	**$ 1,968,150.00**	**$ 2,128,465.00**

Alternate 1 is still the least expensive alternate for Phases 1, 2A, 2B, and 3. For Phases 4 and 5 Alternate 2 will be the least expensive. The reason for the cost reduction for Phase 4 is that the pipe size was reduced but no additional work was required on the street since the existing capacity for flooding to the top of curb was fairly high. Alternate 2 for Phase 5 is less expensive since the pipe was completely eliminated by reconstructing the street to carry all the runoff.

Alternate 2 Phases 4 and 5 cannot be directly interchanged with Alternate 1 Phases 4 and 5. Additional curb opening inlets and some additional pipe would be required at the point where the Alternate 2 phases meet the Alternate 1 phases. Since Alternate 1 is based on carrying larger volumes of runoff in the storm drain mixing Alternate 2 components with Alternate 1 components could result in excess street flooding if additional curb opening inlets are not added.

VIII. SUMMARY AND RECOMMENDATION

Alternate 1 minimizes the volume of runoff in the storm drains. This alternate also uses the maximum existing street capacity for surface flow with two exceptions. The existing capacity of Neolin Ave. from Sagebrush St. to Cascada Rd. will be reconstructed to increase the street runoff carrying capacity and to correct some minor ponding problems. If this potion of Neolin Ave. is not reconstructed then the storm drain would need to be increase by one size from Sagebrush St. to 'The Lake'. Since Litchfield Rd. is one of the main streets in the city the street flow will be limited so that one travel lane will be free of ponding runoff.

Alternate 2 maximizes the street capacity and minimizes the storm drain sizes. Reconstruction of all of Neolin Ave. and Litchfield Rd. from Wigwam Blvd. to Oeste Lane will be required. The reconstruction will increase the street carrying capacity by increasing the available flow area. The two approaches used for increasing flow area are to replace four inch roll curb and gutter with six inch vertical curb and gutter and lower the street two inches and to reduce the existing street cross slope in areas that have received multiple pavement treatments. In this alternate all of the streets will be allowed to flood to at least the top of the curb.

The cost of Alternate 1 is approximately nine percent less than Alternate 2. Considering the long project schedule (5 - 10 years) the cost differential between the alternates is relatively insignificant. Timing of the work may also have an impact on the overall project costs. Combining street rehabilitation projects with a phase of the storm drain project could reduce costs for both projects by eliminating duplicate tasks. Additional savings could come from lower unit prices which are often submitted for large projects with higher construction costs.

It is our recommendation that the City of Litchfield Park construct Alternate 1 from this report. The recommended alternate meets the requirements of the City Code and has a slightly lower construction cost. However, there are also many other factors which the City must consider before making their final decision about which alternate to construct. ASL is available to present the results of this study in a public forum where the residents of Litchfield Park may address issues which they feel are pertinent to the storm drainage issues.

VIII. SUMMARY AND RECOMMENDATION

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The cost of Alternate 1 is approximately nine percent less than Alternate 2. Considering the long project schedule (5 - 10 years) the cost differential between the alternates is relatively insignificant. Timing of the work may also have an impact on the overall project costs. Combining street rehabilitation projects with a phase of the storm drain project could reduce costs for both projects by eliminating duplicate tasks. Additional savings could come from lower unit prices which are often submitted for large projects with higher construction costs.

It is our recommendation that the City of Litchfield Park construct Alternate 1 from this report. The recommended alternate meets the requirements of the City Code and has a slightly lower construction cost. However, there are also many other factors which the City must consider before making their final decision about which alternate to construct. ASL is available to present the results of this study in a public forum where the residents of Litchfield Park may address issues which they feel are pertinent to the storm drainage issues.

APPENDIX I

Sept. 97 Flood Control District of Maricopa County
5-Year Capitol Improvement Program Application

City of Litchfield Park

Office of the City Manager

September 30, 1997

Mr. Gregory Rodzenko, P.E.
Planning and Project Management Division Manager
Flood Control District of Maricopa County
2801 West Durango Street
Phoenix, Arizona 85009

Re: FY 1998-99 Candidate Projects

Dear Mr. Rodzenko:

The City of Litchfield Park requests consideration of the attached project proposal for inclusion in the next 5-year Capital Improvement Program. The "Litchfield Road Storm Drain" will benefit multiple jurisdictions as well as mitigate flooding problems within the City of Litchfield Park.

Please feel free to call us if you should have any questions.

Sincerely,

Robert R. Musselwhite
City Manager

0706, G:\SRV\FLD\5YRPLAN.RRM
bc

214 West Wigwam Boulevard • Litchfield Park, Arizona 85340
Ph. (602) 935-5033 • Fax (602) 935-5427 • TDD Number 1-800-367-8939

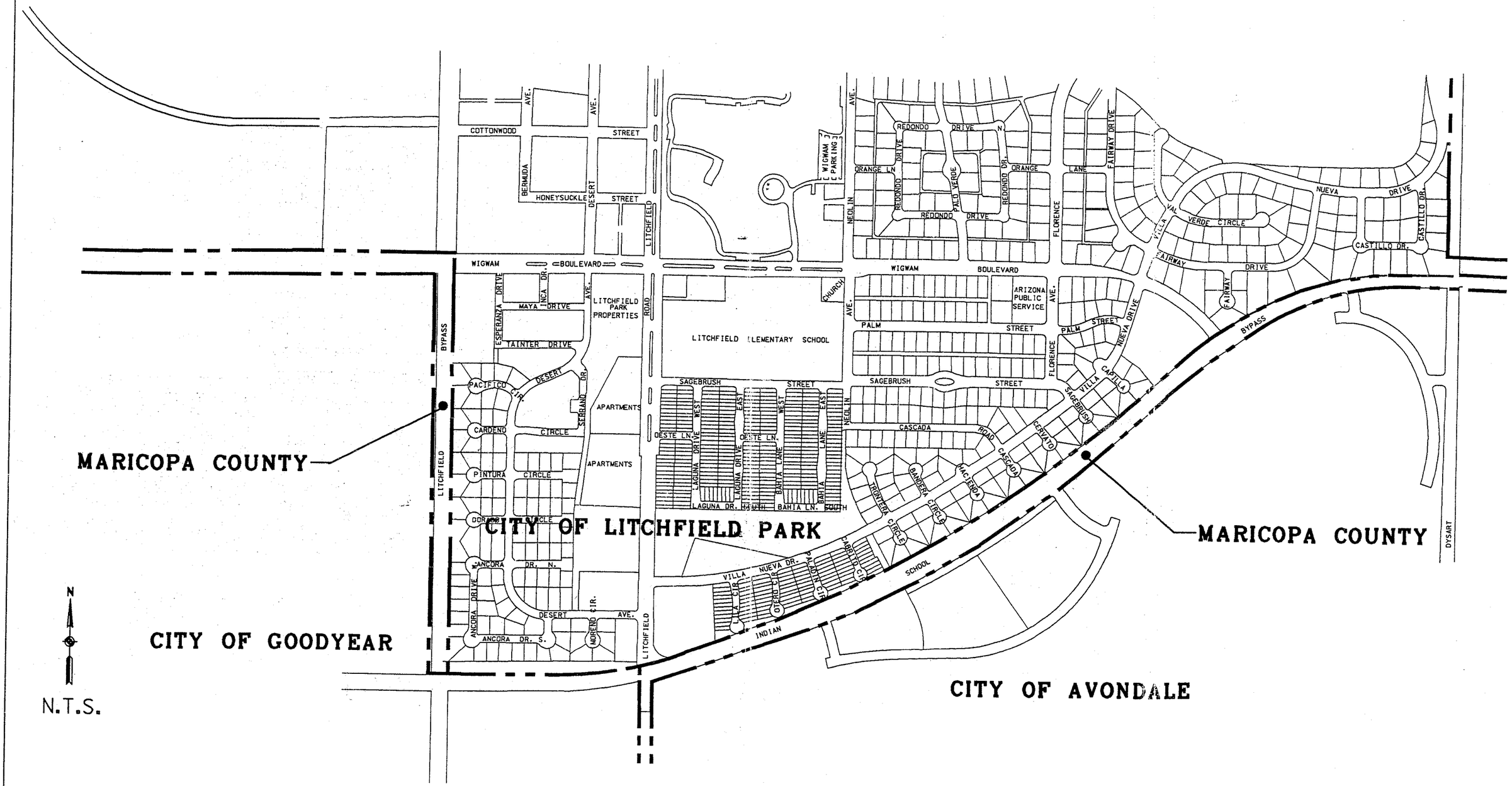
PROJECT OVERVIEW AND DETAILS

This project is located within the City of Litchfield Park, Arizona and will tie into the RID Overchute that was recently constructed by the Flood Control District of Maricopa County (FCDMC) just south of the City of Litchfield Park. The goals of the project are to eliminate flooding within the City during storms and to minimize the transport of stormwater on the surfaces of Litchfield Road, Wigwam Boulevard and through the intersection of Litchfield Road and Indian School Bypass. Stormwater flows through the Litchfield Road/Indian School Bypass intersection directly impact the communities of Goodyear and Avondale as well as Maricopa County, who owns the Indian School Bypass street right-of-way. Figure 1 presents a jurisdictional boundary map for this project.

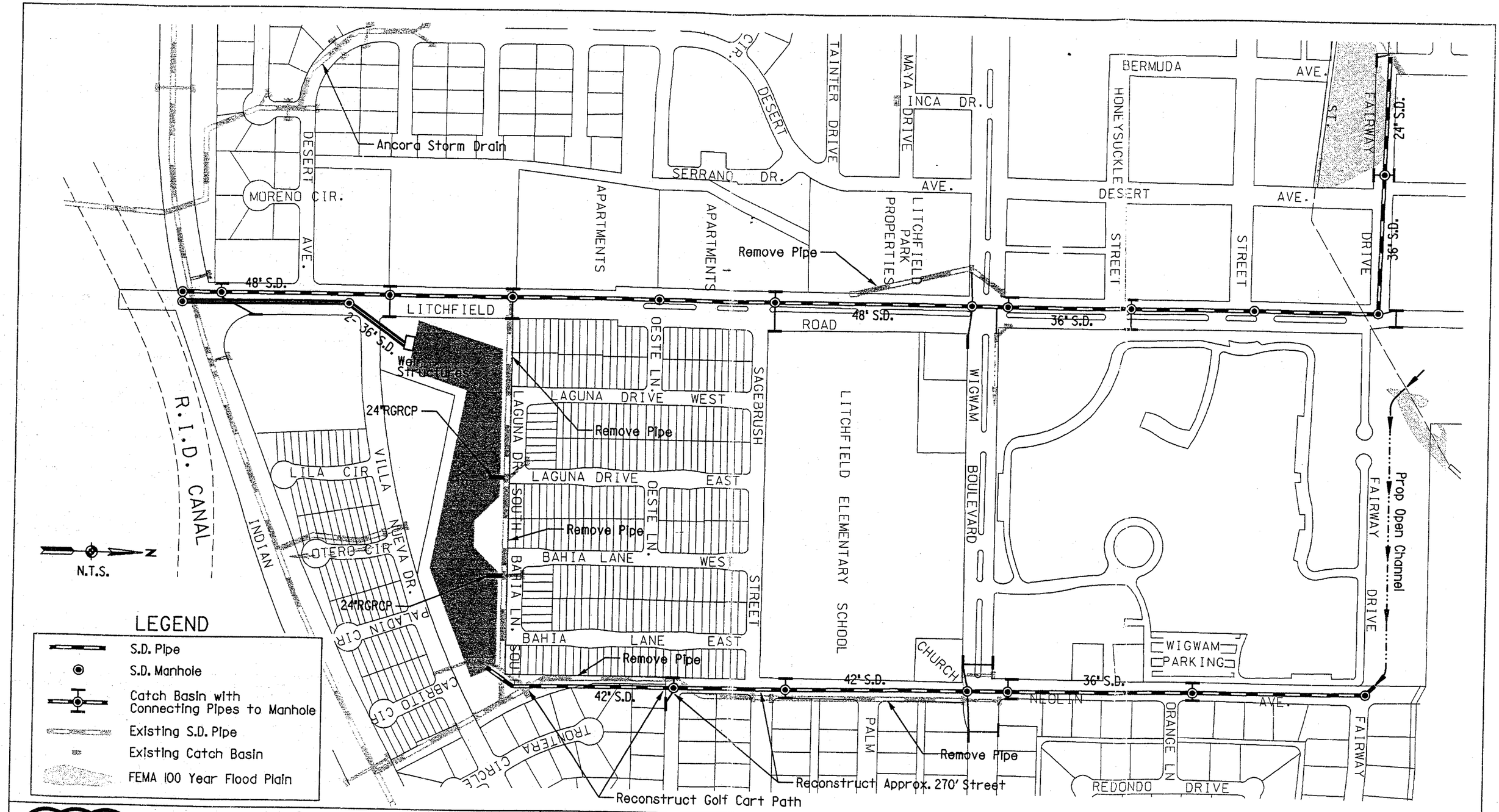
Although the Ancora Storm Drain was designed and constructed by the City in southwest Litchfield Park from 1992 through 1994, there are still areas within the City that experience flooding during storm events. These areas include the Neolin Avenue area between west Fairway Drive and the Airline Canal, the intersection of Wigwam Boulevard and Neolin Avenue and the intersection of Wigwam Boulevard and Litchfield Road (See Figure 2 Proposed Storm Drain Locations for locations). This project will install storm drains as shown in Figure 2 to eliminate flooding in the above mentioned problem areas. The sizes of the storm drains shown in Figure 2 are based on preliminary calculations and will need to be verified with a complete hydrologic and hydraulic analysis of the existing and proposed conditions. The City of Litchfield Park started the engineering for these storm drains in July 1997. With the addition of these storm drains, the aboveground flow of stormwater through the intersection of Litchfield Road and Indian School Bypass will be significantly reduced, thus improving a potentially hazardous condition on Maricopa County right of way during storm periods. The proposed 48" and double 36" pipes traveling southbound along Litchfield Road underneath Indian School Bypass will tie into the four stub outs provided in the RID Overchute south of this intersection.

1. Agency Priority

As this is the only project being submitted to the FCDMC by the City of Litchfield Park, this is the City's first priority, with the phases of the project planned to occur in a timely and efficient manner. The planning and pre-design for the project described herein is currently being completed by the City. A design report discussing the hydrologic conditions of the area and the hydraulics and costs of the various drainage options will be available in 90 days. If funding is available, the construction plans for the first phase of the drainage improvements will begin upon completion of the design report. This project is also a continuation of the FCDMC RID Overchute project which includes a weir for surface runoff from Litchfield Road and storm drain stub-outs for the storm drains shown in Figure 2.



CITY OF LITCHFIELD PARK	LITCHFIELD ROAD STORM DRAIN FCDMC APPLICATION	FIGURE 1 JURISDICTIONAL BOUNDARIES



CITY OF LITCHFIELD PARK

LITCHFIELD ROAD STORM DRAIN
FCDMC APPLICATION

FIGURE 2
PROPOSED STORM DRAIN LOCATIONS

2. Master Plan Element

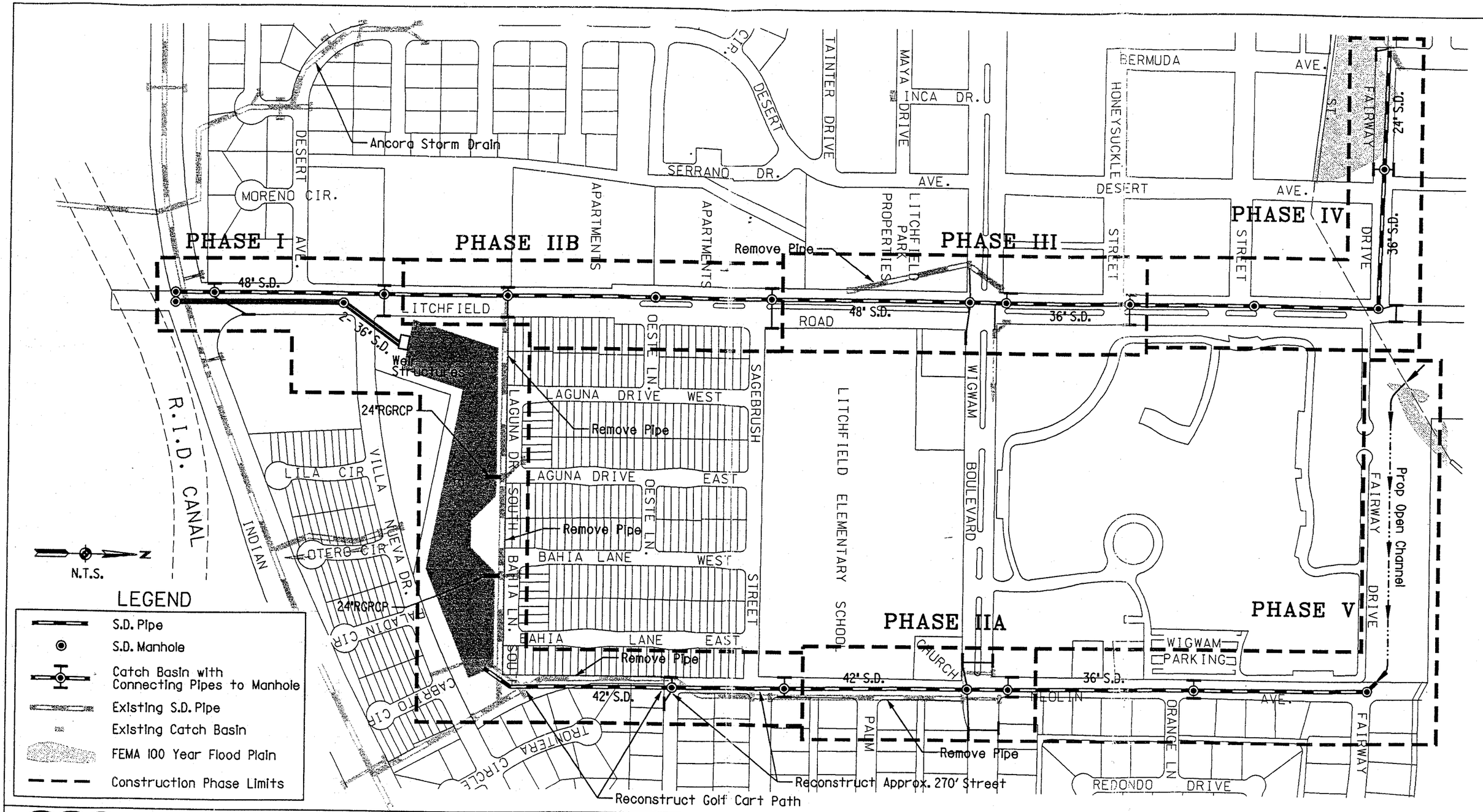
For several years the City has been working with the FCDMC and the Maricopa County Department of Transportation to eliminate the flooding created by offsite storm runoff. With the construction of the Dysart Channel, the Colter Channel, the RID Overchute and the completion of proposed improvements along Camelback Road, most of the offsite runoff which has historically caused flooding within the City will have been mitigated.

We are now completing the process of mitigating the remaining flood problems. As can be seen in Figure 2, the existing Indian School Bypass and Ancora Drain were the first storm drains in the City of Litchfield Park to address flooding areas. The City's drainage master plan includes storm drains along Litchfield Road, Wigwam Boulevard, Neolin Avenue, Villa Nueva Drive, and a pipe connecting the area near the Airline Canal to a drain on Wigwam Boulevard. The current proposed storm drains have eliminated the lines in Villa Nueva Drive by routing the water through the lake. Therefore, the storm drains shown in Figure 2 are consistent with the drainage master plan. These storm drains are to be completed in five phases as shown in Figure 3, Proposed Storm Drain Phasing. In addition, the planned storm drains were incorporated into the FCDMC study and design for the RID Overchute. The Overchute design included facilities for receiving both surface and storm drain flows from Litchfield Park. The first phase of the project includes connection of a 48" and two 36" storm drains to the four stub-outs provided in the RID Overchute.

The City also has a Pavement Management Plan which has been in effect for the last five years. Based on this Plan, Litchfield Road is in need of rehabilitation/reconstruction, and this work is planned to be completed in conjunction with, or shortly after the storm drain work. In addition, Neolin Avenue between Cascada Road and Wigwam Boulevard is scheduled to be overlaid, which is also planned to be completed in conjunction with this project.

3. Hydrologic/Hydraulic Significance

The existing watershed for this drainage area is approximately 200 acres. The slope of the streets where runoff collects varies from 0.38% to 0.88% with the smaller slopes occurring south of Wigwam Boulevard The watershed is completely developed and contains no contiguous open areas which could be used for routing storm runoff. The drainage area developments include single and multi-family residential, retail, commercial, public and educational facilities. Existing floodplains which have been identified by FEMA are located at the top (north) of the drainage area (See Figure 2). Furthermore, multiple flood prone areas exist within the watershed which have not been identified as floodplains by FEMA. These areas include Neolin Avenue (most significantly at the intersections of Wigwam Boulevard, Sagebrush Street and Cascada Road) and Litchfield Road from Wigwam Boulevard to Indian School Bypass. Whenever the rainfall exceeds the 25-year, 6 hour storm runoff, flooding occurs in the areas described above.



CITY OF LITCHFIELD PARK

LITCHFIELD ROAD STORM DRAIN
FCDMC APPLICATION

FIGURE 3
PROPOSED STORM DRAIN PHASING

The drainage report prepared by the FCDMC (April 1996) for the RID Overchute Project identified this drainage area as Sub-basin 270 with a peak 100-year discharge of 560 cfs. The outfall for this drainage area will be the new RID Overchute. An estimated 90% of the peak discharge currently drains overland through and adjacent to the intersection of Litchfield Road/Indian School Bypass before reaching the proposed RID Overchute. The other 10% of the water is carried to the Overchute and downstream channel by the Indian School Bypass and Ancora Storm Drains. As part of the design for the Overchute, 4 stub-out culverts have been installed for future extension north into Litchfield Park. Our proposed project will extend these stubbed pipes north and significantly reduce the overland flow which directly impacts Maricopa County, Goodyear and Avondale.

4. Level of Protection

Preliminary design is currently underway for the City of Litchfield Park storm drain system. The standard for the design is as listed in "Chapter 15 Flood Damage Prevention" of the City Code (See Appendix A). The basic criteria is all runoff from the 100-year event must be carried in the right-of-way and may not pond more than 4" above the top of curb. The ongoing study and design for this project will use the maximum street routing capacity so that the storm drain size and cost can be minimized.

PROJECT BENEFITS

5. Area Protected

The existing delineated flood plain located at the northern edge of the Airline Canal at Fairway Drive will be eliminated with the construction of the culverts in this Project. We estimate the flood plain reduction to be approximately 2½ acres. In addition, the Boy Scout Lodge and battered women's shelter are located immediately south of this area and have experienced flooding in the past.

There are an estimated 70 single family homes and 20 multi family units not located in the flood plain that will benefit from this project. These residential areas are primarily along southern Litchfield Road and Neolin Avenue. Commercial/retail facilities include the Mayfair Market located on the northwest corner of Wigwam Boulevard/Litchfield Road, and the southeastern corner of the Wigwam Resort. The combined estimated property value of these homes and businesses is approximately $10,000,000.

Public buildings and facilities to be protected include the City Hall Municipal Complex, Florence Brinton Litchfield Public Library, Litchfield Elementary School, the Boy Scout Lodge, the Rural Metro Fire Station serving the City of Litchfield Park, two churches, and two City parks. This project will also bring approximately one and one-half miles of roads into compliance with the City Code.

It is estimated that 20% of the agency's jurisdictional area will be protected against flooding by the construction of this project. Upon completion of this project approximately 90% of the City's jurisdictional limits will be protected from flooding. The remaining unprotected area is on the Wigwam golf course and an adjoining area which affects six homes. 3,500 City residents will be either directly or indirectly affected in addition to the 10,000 to 12,000 people who use Indian School Bypass each day for vehicular travel.

The City of Litchfield Park has been incorporated since 1987, and flooding and drainage problems have always been present in the City. Drainage regulations were adopted within the City Code in 1992 which require new developments to have on site retention and outline the storm drainage requirements for the City.

Completion of this storm drain project will result in a reduction in the flood plain within the City of Litchfield Park. One of the key benefits from this Project will be the elimination of flooding and significant reduction of overland stormflow along Indian School Bypass in the Cities of Goodyear and Avondale and in Maricopa County.

6. *Environmental Quality*

An extensive public involvement program is underway to address environmental quality issues. Thus far, two public meetings have been held to help identify important issues and alternative solutions. Elements such as detention basins and dedicated open space will be important parts of the Project and will be incorporated if possible. Approximately half of the storm runoff in this project will be routed through an existing lake. The lake is currently filled with high quality well water. As the runoff is routed through the lake the quality of the discharged runoff will be improved since sediments will settle in the lake and the storm water will be mixed with the higher quality lake water. Any turbidity developed in the lake during a storm event will settle out naturally within a few days of the storm event. There will be no reduction of vegetation or wildlife habitat because of this project and no environmentally sensitive areas will be impacted.

7. *Area-Wide Benefits*

As part of this Project, implementation of bicycle lanes and multi-use paths within drainage easements are planned. The design report for this project will include alternatives for open channels and detention facilities. The public involvement program will be completed in conjunction with design work.

This project will impact approximately one and one-half miles of roadways by reducing the amount of water flowing and ponding in the streets. Roadway pavement life should be extended since water related deterioration of the streets and subgrade will be reduced. Furthermore, travel in and around the City will be improved during storm events which may impact automobile accident frequencies.

PROJECT FUNDING

8. *Total Project Cost*

Proposed Schedule:

Activity	Anticipated Completion Date
Public Involvement/Project Planning	March 1998
Design	December 1998
Construction Phase 1	December 1999
Construction Phase 2	December 2000
Construction Phase 3	December 2001
Construction Phase 4	December 2002
Construction Phase 5	December 2003

Estimated Cost:

Element	Estimated Cost
Public Involvement/Project Planning	$15,000
Design	$134,740
Phase 1	$619,920
Phase 2	$384,180
Phase 3	$216,888
Phase 4	$228,612
Phase 5	$189,660
R/W	$0
Total	$1,789,000

Appendix B shows a detailed Engineer's Estimate for the various phases of the project.

9. *Level of Participation*

The City of Litchfield Park proposes to undertake the initial public involvement, project planning and design activities at no cost to the FCDMC (this work was started in July 1997). The City will also fund construction of Phases 2, 3, 4, and 5 which focus primarily on localized flooding issues within the City. This commitment constitutes over 65% of the total Project cost. Funding of Phase 1 (which benefits Maricopa County, Avondale and Goodyear) will be the responsibility of the FCDMC if this Project is approved.

Summary:	City of Litchfield Park	$1,169,080	65.35 %
	FCDMC	$ 619,920	34.65 %
	Total	$1,789,000	100 %

10. Operation and Maintenance Costs

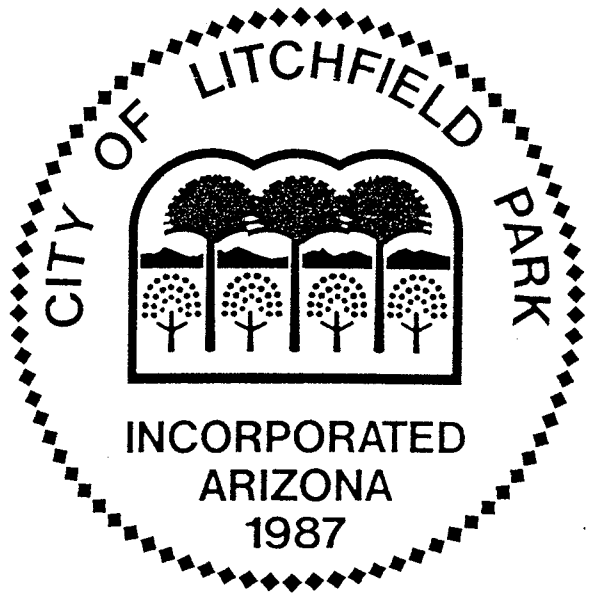
Operation and maintenance costs will be minimal since a majority of the facilities will be underground concrete storm drain. Detention basins and channels will be designed to City and County standards and will be maintained by the City's Public Works Department. The City has a history of quality care of their facilities because they truly understand the excessive costs associated with neglect and have a strong desire to maintain a beautiful community.

11. Operation and Maintenance Responsibility

The City of Litchfield Park will assume full responsibility for the operations and maintenance of the Project. All maintenance will be completed by the City's Public Works Department which has a reputation for thorough, quality work.

APPENDIX A

CITY CODE PERTAINING TO FLOOD PREVENTION



CITY CODE OF LITCHFIELD PARK, ARIZONA

TABLE OF CONTENTS

CHAPTER 15 FLOOD DAMAGE PREVENTION

Article 15-1 DESIGNATION OF AUTHORITY

The City of Litchfield Park designates the Maricopa County Flood Control District as the enforcement authority for all floodplain management activities within its corporate limits. The district is hereby authorized to exercise the powers and duties set forth in Title 48, Chapter 21, Arizona Revised Statutes, within all areas of the city.

Article 15-2 STORM DRAINAGE REQUIREMENTS

Section 15-2-1 Purpose

A. The purpose of these requirements are to ensure that developments in the city are not subject to flooding nor will they contribute to the flooding potential of properties both upstream and downstream, during construction and after full development has occurred.

B. It is not the intent of these stipulations to abrogate sound engineering judgment, but to establish some guidelines and criteria. In general, unless modified herein, the criteria and calculations shall be as specified in the "Hydraulic Design Manual for Maricopa County, Arizona".

Sec. 15-2-2 Conceptual Drainage Map and Report

The purpose of the map and report is to define the runoff, both before and after development, and indicate provisions proposed to handle onsite and offsite flows. In general, the plan is to accept offsite flows, handle these flows and the water that falls on the site in such a way that flows leaving the site shall exist in the same manner, and with less velocity and quantity than occurred prior to development. In lieu of this channel, detention/retention structures or other methods could be constructed downstream, providing the developer has control over the downstream property and makes provisions to conduct the waters to a proper disposal site, such as a natural stream or a government controlled drainage structure, and obtains written permission of the governmental agency having jurisdiction.

Sec. 15-2-3 Storm Drainage

A. Design Frequency. All developments must provide retention of the storm runoff generated by the 100-year, 6 hour storm (3 inches).

B. Drainage Area. The area to be considered as generating runoffs to be retained shall be the development itself and the contributing adjacent streets.

C. Street Capacity. Streets will be designed to carry runoff from a 5-year peak storm between the curbs. Arterial and major collectors (roads with four lanes for traffic or greater) shall be designed to concentrate the 5-year storm runoff such that one lane in each direction is free from runoff. The peak flows from the 100-year storm shall be carried within the cross-section between right-of-way lines and must not exceed 4 inches above top of curb. Inverted crown streets are not permitted.

D. Storm Sewer. In cases where the street flow from the design storm exceeds the street capacity, underground pipes or aesthetically pleasing channels, of sufficient size, shall be installed.

E. Retention. The right-of-way areas shall not be used for retention purposes. The retention areas shall be landscaped and shall have a maximum water depth of 3 feet and a maximum side slope of 4:1. Storm water shall not be retained in the basins longer than thirty-six hours. The basins must be drained by a gravity line.

F. Floor Elevations. Finished floor elevations for houses or other buildings shall be elevated above the runoff expected from a 100-year storm. Minimum floor elevations shall be 14 inches above the top of the low curb and a minimum of 6 inches above the top of the high curb. Basements may be approved if they are flood-proofed to a point above the finish floor elevation. A registered professional engineer or architect shall certify the means of flood-proofing.

G. Culverts and Bridges. Culverts or bridges for street and alley crossings of drainageways shall be sized to carry the 100-year storm.

Retention Calculations

$$V = \frac{AC}{4}$$

V = Volume to be retained (acre feet or cubic feet)
A = Drainage Area (acres or square feet)
C = Runoff Factor (see below)

Runoff Coefficient (for retention and rational formula use)

General

Pavement (asphalt, concrete, brick, etc.)	0.95
Roof	0.95
Grass Lawns (less than 7% slope)	0.20
Grass Lawns (more than 7% slope)	0.35
Desert Lawn or Rock Lawn	0.70
Farm Land	0.10
Bare Ground (vacant lots)	0.25
Undeveloped Desert	0.40
Commercial, Industrial Area	0.80
Residential Area	
Ranch Area 18,000 SF or Larger	0.35
Single Family Areas Less than 18,000 SF	0.40
Multi-Unit Area	
Townhouses, Mobile Home Park	0.50
Apartments	0.60

H. Compliance. It is the responsibility of the developer and his engineer to comply with these provisions and to design a project which will comply with high engineering standards. City review is not to be construed as endorsement or assurance that the plans comply with these standards. The responsibility for the proper drainage of the developer's property and the protection of adjacent property from flooding remains with the developer and his engineer.

APPENDIX B

ENGINEER'S ESTIMATE

ENGINEERS ESTIMATE

LITCHFIELD ROAD STORM DRAIN
FCDMC APPLICATION

26-Sep-97

PHASE I - FROM THE RID OVERCHUTE THROUGH LAKE TO NEOLIN AND SAGEBRUSH
AND 700 FEET OF LITCHFIELD ROAD BEGINNING AT THE RID OVERCHUTE

ITEM NO.	DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
1	PAVEMENT REMOVAL	SY	4,000	$2.00	$8,000.00
2	PAVEMENT REPLACEMENT	SY	2,800	$15.00	$42,000.00
3	48" RGRCP (W/EX. AND BACKFILL)	LF	700	$110.00	$77,000.00
4	42" RGRCP (W/EX. AND BACKFILL)	LF	1,000	$90.00	$90,000.00
5	36" RGRCP (W/EX. AND BACKFILL)	LF	1,600	$70.00	$112,000.00
6	24" RGRCP (W/EX. AND BACKFILL)	LF	220	$55.00	$12,100.00
7	STORMDRAIN MANHOLE	EA	8	$3,500.00	$28,000.00
8	CATCH BASIN/ INLET	EA	8	$3,500.00	$28,000.00
9	JUNCTION STRUCTURE (48" PIPE TO RID)	LS	1	$20,000.00	$20,000.00
10	WEIR STRUCTURE (LAKE TO 36" PIPES)	EA	2	$8,500.00	$17,000.00
11	CART PATH/ SWALE (6" CONCRETE)	SY	1,200	$35.00	$42,000.00
12	6" CURB AND GUTTER	LF	700	$15.00	$10,500.00
13	UTILITY RELOCATIONS	LS	1	$10,000.00	$10,000.00
14	MISCELLANEOUS REMOVALS	LS	1	$20,000.00	$20,000.00
15	CONTINGENCIES	LS	1	$103,320.00	$103,320.00

PHASE I TOTAL **$619,920.00**

PHASE II - LITCHFIELD ROAD FROM VILLA NUEVA DR. TO SAGEBRUSH ST.
NEOLIN AVE. FROM SAGEBRUSH ST. TO WIGWAM BLVD.

ITEM NO.	DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
1	PAVEMENT REMOVAL	SY	1,750	$2.00	$3,500.00
2	PAVEMENT REPLACEMENT	SY	1,750	$15.00	$26,250.00
3	48" RGRCP (W/EX. AND BACKFILL)	LF	1,250	$110.00	$137,500.00
4	42" RGRCP (W/EX. AND BACKFILL)	LF	700	$90.00	$63,000.00
5	24" RGRCP (W/EX. AND BACKFILL)	LF	180	$55.00	$9,900.00
6	STORMDRAIN MANHOLE	EA	4	$3,500.00	$14,000.00
7	CATCH BASIN/ INLET	EA	10	$3,500.00	$35,000.00
8	UTILITY RELOCATIONS	LS	1	$22,000.00	$22,000.00
9	MISCELLANEOUS REMOVALS	LS	1	$9,000.00	$9,000.00
10	CONTINGENCIES	LS	1	$64,030.00	$64,030.00

PHASE II TOTAL **$384,180.00**

PHASE III - LITCHFIELD ROAD FROM SAGEBRUSH ST. TO HONEYSUCKLE ST.

ITEM NO.	DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
1	PAVEMENT REMOVAL	SY	1,120	$2.00	$2,240.00
2	PAVEMENT REPLACEMENT	SY	1,120	$15.00	$16,800.00
3	48" RGRCP (W/EX. AND BACKFILL)	LF	750	$110.00	$82,500.00
4	36" RGRCP (W/EX. AND BACKFILL)	LF	400	$70.00	$28,000.00
5	24" RGRCP (W/EX. AND BACKFILL)	LF	140	$55.00	$7,700.00
6	STORMDRAIN MANHOLE	EA	3	$3,500.00	$10,500.00
7	CATCH BASIN/ INLET	EA	4	$3,500.00	$14,000.00
8	UTILITY RELOCATIONS	LS	1	$16,000.00	$16,000.00
9	MISCELLANEOUS REMOVALS	LS	1	$3,000.00	$3,000.00
10	CONTINGENCIES	LS	1	$36,148.00	$36,148.00

PHASE III TOTAL **$216,888.00**

PHASE IV - LITCHFIELD RD. FROM HONEYSUCKLE ST. TO FAIRWAY DRIVE AND FAIRWAY DRIVE TO LA LOMA AVE

ITEM NO.	DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
1	PAVEMENT REMOVAL	SY	1,180	$2.00	$2,360.00
2	PAVEMENT REPLACEMENT	SY	1,180	$15.00	$17,700.00
3	36" RGRCP (W/EX. AND BACKFILL)	LF	1,300	$70.00	$91,000.00
4	24" RGRCP (W/EX. AND BACKFILL)	LF	590	$55.00	$32,450.00
5	STORMDRAIN MANHOLE	EA	5	$3,500.00	$17,500.00
6	CATCH BASIN/ INLET	EA	5	$3,500.00	$17,500.00
7	UTILITY RELOCATIONS	LS	1	$10,000.00	$10,000.00
8	MISCELLANEOUS REMOVALS	LS	1	$2,000.00	$2,000.00
9	CONTINGENCIES	LS	1	$38,102.00	$38,102.00

PHASE IV TOTAL **$228,612.00**

PHASE V - NEOLIN AVE. FROM WIGWAM BLVD. TO THE AIRLINE CANAL (W/ CHANNEL ON THE GOLF COURSE)

ITEM NO.	DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
1	PAVEMENT REMOVAL	SY	1,000	$2.00	$2,000.00
2	PAVEMENT REPLACEMENT	SY	1,000	$15.00	$15,000.00
3	36" RGRCP (W/EX. AND BACKFILL)	LF	1,300	$70.00	$91,000.00
4	24" RGRCP (W/EX. AND BACKFILL)	LF	110	$55.00	$6,050.00
5	STORMDRAIN MANHOLE	EA	2	$3,500.00	$7,000.00
6	CATCH BASIN/ INLET	EA	2	$3,500.00	$7,000.00
7	CONSTRUCT GRASS LINED CHANNEL	LS	1	$20,000.00	$20,000.00
8	UTILITY RELOCATIONS	LS	1	$5,000.00	$5,000.00
9	MISCELLANEOUS REMOVALS	LS	1	$5,000.00	$5,000.00
10	CONTINGENCIES	LS	1	$31,610.00	$31,610.00

PHASE V TOTAL **$189,660.00**

CONSTRUCTION TOTAL	**$1,639,260.00**
PUBLIC INVOLVEMENT	**$15,000.00**
ENGINEERING	**$134,740.00**
PROJECT GRAND TOTAL	**$1,789,000.00**

APPENDIX II

Hydraulic Calculations for Streets and Channels

ASL/SIERRA CONSULTING ENGINEERS

SHEET NO. 1 OF

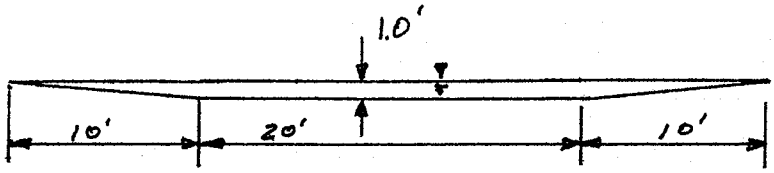
ENGINEER JLK DATE 9-17-97 JOB NO. 1376001 BY JLK

SUBJECT Litchfield Park Drainage - Golf Course Channel CHECKED BY

OFFICE Phoenix TELEPHONE (602) 244-2624

The channel would be used to route runoff from the point where the airline canal pipe begins east to Neolin Ave. The channel would be grass lined ($n = 0.027$) and would follow the natural slope ($S = 0.68\%$ +/-). Use Manning Equation ($Q = 1.486/n\,(S)^{1/2}(R)^{2/3}A$) to determine channel size. The Design $Q_{100} = 110$ cfs.

* Channel Option * 1



$A = 30$ S.F.

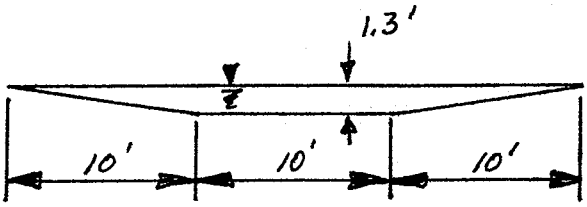
$P = 40.1$ L.F.

$$Q = \frac{1.486}{0.027}(.0068)^{1/2}\left(\frac{30}{40.1}\right)^{2/3}(30)$$

$Q = 112$ cfs ≥ 110 cfs $\therefore$ OK

$V = 3.74$ fps ≤ 5.0 fps $\therefore$ OK

* Channel Option 2



$A = 26$ S.F.

$P = 30.17$ L.F

$$Q = \frac{1.486}{0.027}(.0068)^{1/2}\left(\frac{26}{30.17}\right)^{2/3}(26)$$

$Q = 106.9$ cfs $\simeq 110$ cfs $\therefore$ OK

$V = 4.11$ fps ≤ 5.0 fps $\therefore$ OK

ASL SIERRA
CONSULTING ENGINEERS

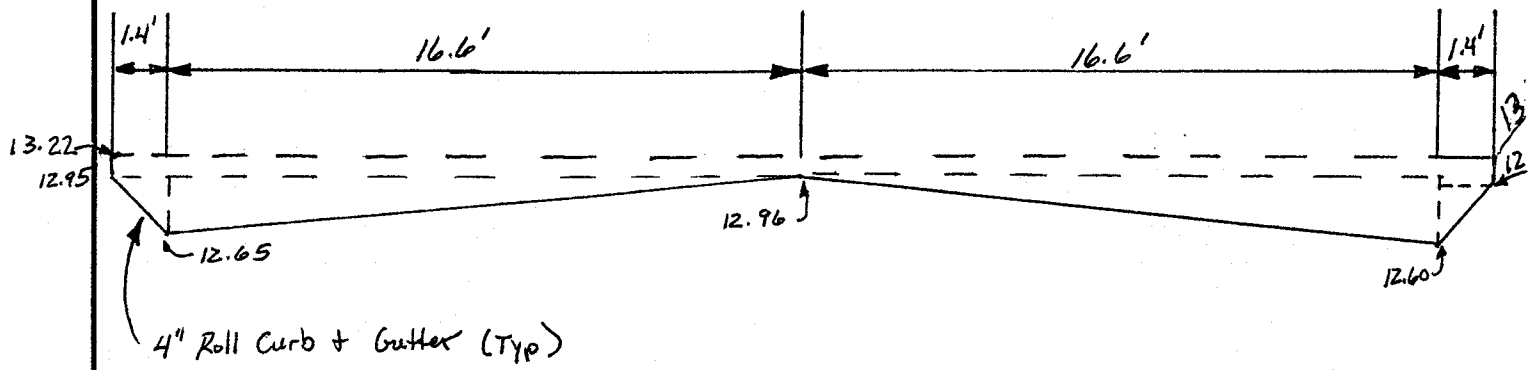
SHEET NO. 2 OF _____

ENGINEER JLK DATE 1-27-98 JOB NO. 1371.001 BY _____

SUBJECT Litchfield Park Drainage - North Neolin Ave CHECKED BY _____
Existing Section

OFFICE Phoenix TELEPHONE 244-2624

Existing Street Section for Neolin Ave @ Orange Lane



$A = (0.5 \times 0.30 \times 1.4) + (0.5 \times 0.31 \times 16.6) + (0.26 \times 18) + (0.5 \times .36 \times 16.6) + (0.26 \times 16.6) + (0.5 \times 0.29 \times 1.4') + (1.4' \times .33') = 15.43$ S.F.

$P = (1.4^2 + 0.30^2)^{1/2} + (16.6^2 + .30^2)^{1/2} + (16.6^2 + 0.36^2)^{1/2} + (1.4^2 + .29^2)^{1/2} = 36.07$ ft.

$$Q = \frac{1.486}{0.015} (0.0062)^{1/2} \left(\frac{15.43}{36.07}\right)^{2/3} (15.43) = 68.37 \text{ cfs}$$

$V = 4.43$ fps

Proposed Section - Maintain existing top of curb elevation, install 6" Vertical Curb & Gutter and drop street 2 inches.

ASL/SIERRA
CONSULTING ENGINEERS

SHEET NO. 3 OF _____

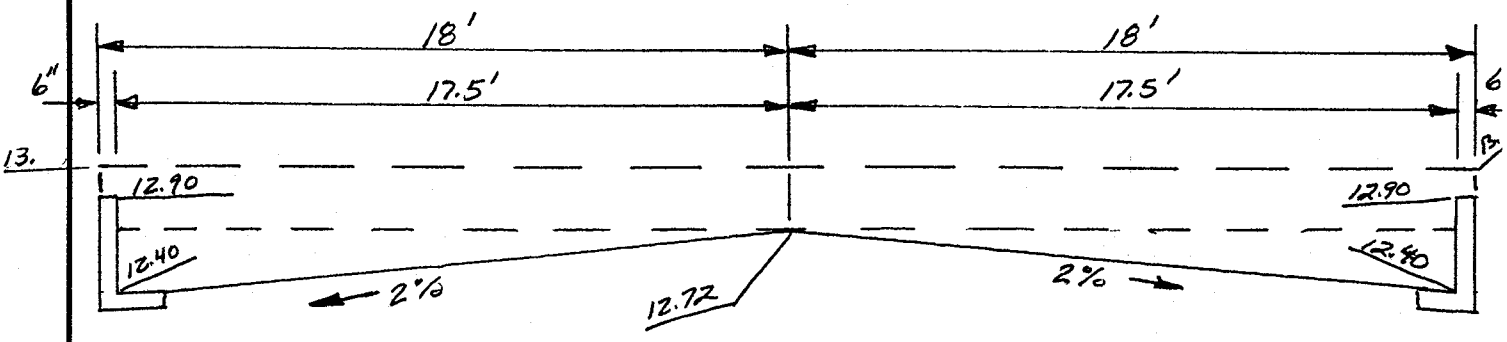
ENGINEER JLK DATE _____ JOB NO. 1371.001 BY _____

SUBJECT Litchfield Park Drainage – North Neolin Ave CHECKED BY _____

Proposed Section

OFFICE Phoenix TELEPHONE 244-2624

Proposed Street Section for North Neolin Ave



$A = 2(0.32 \times 0.5 \times 17.5) + 2(0.51 \times 17.5) + 2(0.5 \times 0.33) = 23.78$ S.F.

$P = 2(17.5^2 + 0.32^2)^{1/2} + 2(0.67') = 36.35$ L.F.

$$Q = \frac{1.486}{0.015} \times (0.0062)^{1/2} \left(\frac{23.78}{36.35}\right)^{2/3} 23.78 = 140 \text{ cfs}$$

$V = 5.88$ fps

ASL / SIERRA
CONSULTING ENGINEERS

SHEET NO. 4 OF _____

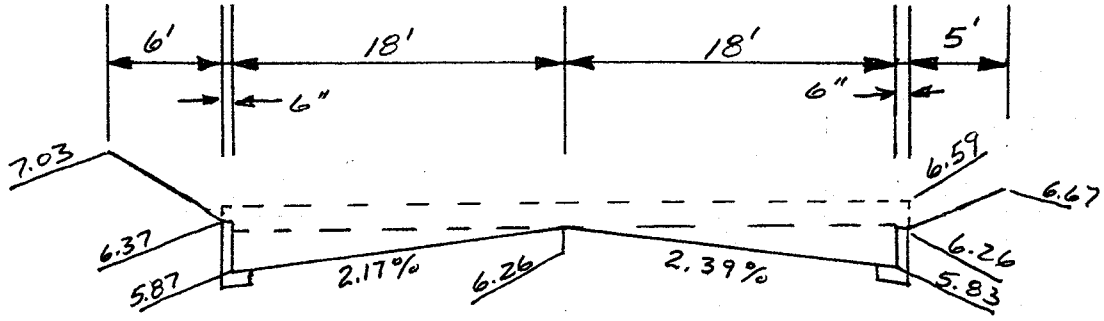
ENGINEER JLK DATE _____ JOB NO. 1371.001 BY _____

SUBJECT Litchfield Park Drainage - Neolin Ave - Wigwam to Sagebrush CHECKED BY _____

Existing Capacity

OFFICE _____ TELEPHONE _____

Existing Capacity of Neolin Ave from Wigwam Blvd. to Sagebrush St.



$A = (0.5 \times 0.39 \times 18') + (0.5 \times 0.43 \times 18') + (37 \times 0.33) = 19.59$ S.F.

$P = (2 \times (18^2 + 0.5^2)^{1/2}) + (2 \times 0.5') = 37.01$ ft.

$$Q = \frac{1.486}{0.015} (0.003)^{1/2} \left(\frac{19.59}{37.01}\right)^{2/3} 19.59 = 69.58 \text{ cfs.}$$

$V = 3.55$ fps

ASL/SIERRA
CONSULTING ENGINEERS

SHEET NO. 5 OF _____

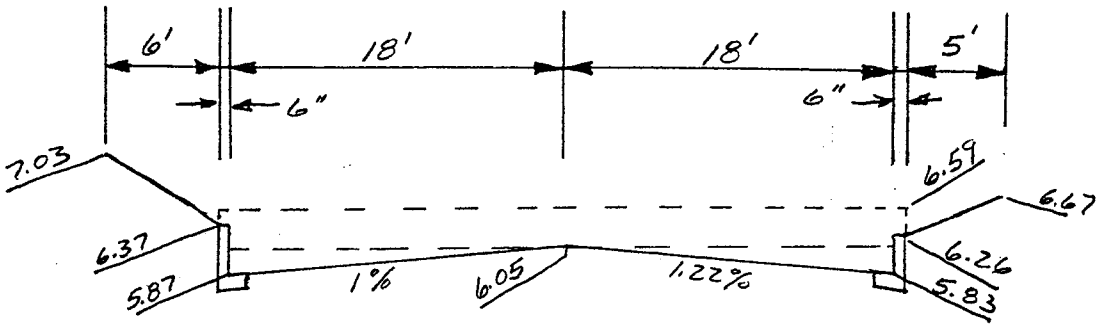
ENGINEER JLK DATE _____ JOB NO. 1371.001 BY _____

SUBJECT Litchfield Park Drainage - Neolin Ave - Wigwam to Sagebrush CHECKED BY _____

Proposed Capacity

OFFICE _____ TELEPHONE _____

Proposed Capacity of Neolin Ave from Wigwam Blvd. to Sagebrush St.



$A = (0.5 \times 0.18 \times 18') + (0.5 \times 0.22 \times 18') + (37 \times .54) = 23.58$ S.F.

$P = (2 \times (18^2 + 0.2^2)^{1/2}) + (2 \times 0.5') = 37.00$ ft.

$$Q = \frac{1.486}{0.015} (0.003)^{1/2} \left(\frac{23.58}{37.00}\right)^{2/3} 23.58 = 94.78 \text{ cfs.}$$

$V = 4.02$ fps

ASL/SIERRA
CONSULTING ENGINEERS

SHEET NO. 6 OF

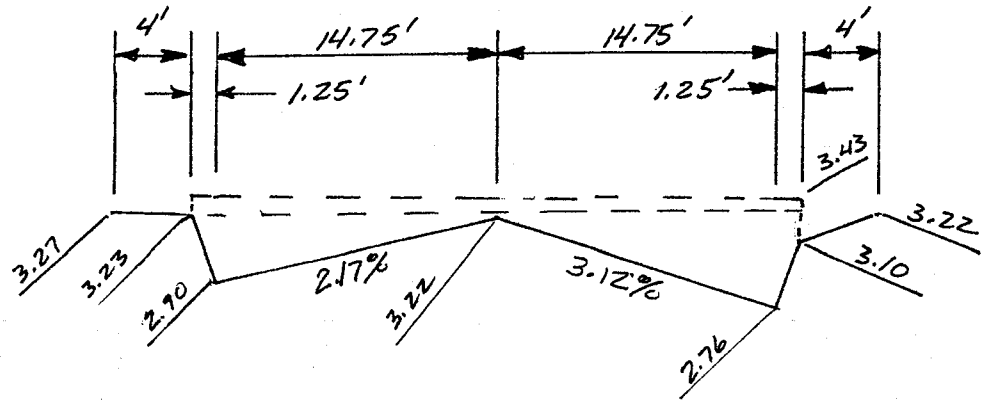
ENGINEER JLK DATE JOB NO. 1371.001 BY

SUBJECT Litchfield Park Drainage - Neolin Ave - Sagebrush to Cascada CHECKED BY

Existing Section

OFFICE Phoenix TELEPHONE 244-2624

Existing Capacity of Neolin Ave. From Sagebrush Street to Cascada Rd.



$A = (0.5 \times .33 \times 1.25) + (0.5 \times .32 \times 14.75) + (0.5 \times .46 \times 14.75) + (0.5 \times .46 \times 1.25) + (32 \times .21) = 12.97$ S.

$P = (.33^2 + 1.25^2)^{1/2} + (.32^2 + 14.75^2)^{1/2} + (.46^2 + 14.75^2)^{1/2} + (0.46^2 + 1.25^2)^{1/2} = 32.14$ ft.

$$Q = \frac{1.486}{0.015} (0.0074)^{1/2} \left(\frac{12.97}{32.14}\right)^{2/3} (12.97) = 60.40 \text{ cfs.}$$

$V = 4.66$ fps

ASL/SIERRA
CONSULTING ENGINEERS

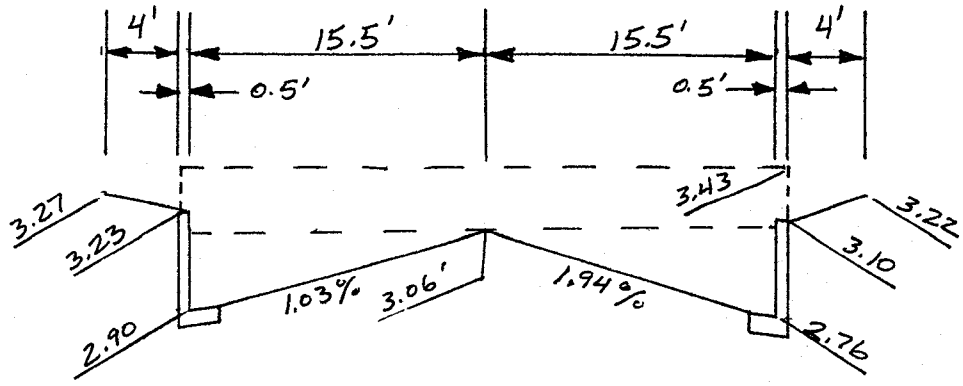
SHEET NO. 7 OF _____

ENGINEER JLK DATE _____ JOB NO. _____ BY _____

SUBJECT Litchfield Park Drainage - Neolin Ave - Sagebrush to Cascada CHECKED BY _____
Proposed Capacity

OFFICE Phoenix TELEPHONE 244-2624

Proposed Capacity of Neolin Ave From Sagebrush St. to Cascada Rd.



$A = (0.5 \times .16 \times 15.5) + (0.5 \times 0.30 \times 15.5) + (32 \times 0.37) = 15.41$ S.F.

$P = (.16^2 + 15.5^2)^{1/2} + (0.3^2 + 15.5^2)^{1/2} + (2 \times 0.5') = 32$ ft.

$$Q = \frac{1.486}{0.015}(0.0072)^{1/2}\left(\frac{15.41}{32.0}\right)^{2/3} 15.41 = 79.62 \text{ cfs}$$

$V = 5.17$ fps

ASL/SIERRA CONSULTING ENGINEERS

SHEET NO. 8 OF

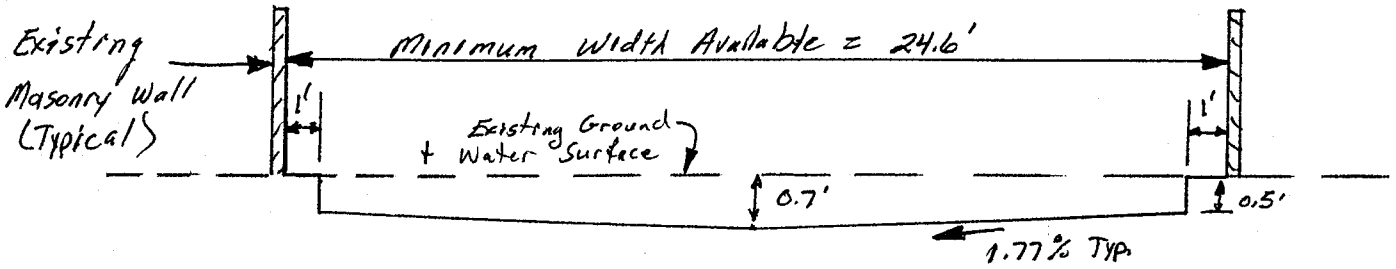
ENGINEER JLK DATE JOB NO. 1371.001 BY

SUBJECT Litchfield Park Drainage - Sidewalk / Cart Path CHECKED BY

Proposed Section

OFFICE Phoenix TELEPHONE 244-2624

Proposed Sections For Sidewalk / Cart Path from Cascada Rd. to 'The Lake'

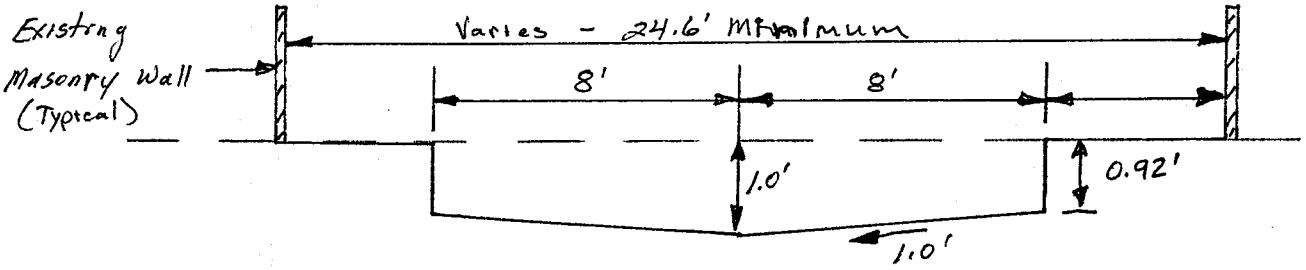


Area = $(0.5 \times 22.30') + (0.5 \times 0.2 \times 11.3) \times 2$ = 13.41 S.F.

P = $(0.2^2 + 11.3^2)^{1/2} \times 2 + (2 \times 0.5')$ = 23.60 ft.

$$Q = \frac{1.486}{0.013}(0.0059)^{1/2}\left(\frac{13.41}{23.60}\right)^{2/3} 13.41 = 80.80 \text{ cfs}$$

V = 6.03 fps



A = $(0.5 \times 0.08 \times 8) \times 2 + (0.72 \times 16)$ = 12.16 S.F.

P = $(0.08^2 + 8^2)^{1/2} \times 2 + (2 \times 0.72)$ = 17.44 ft.

$$Q = \frac{1.486}{0.013}(0.0059)^{1/2}\left(\frac{12.16}{17.44}\right)^{2/3} 12.16 = 83.97 \text{ cfs}$$

V = 6.91 fps

ASL/SIERRA CONSULTING ENGINEERS

SHEET NO. 9 OF

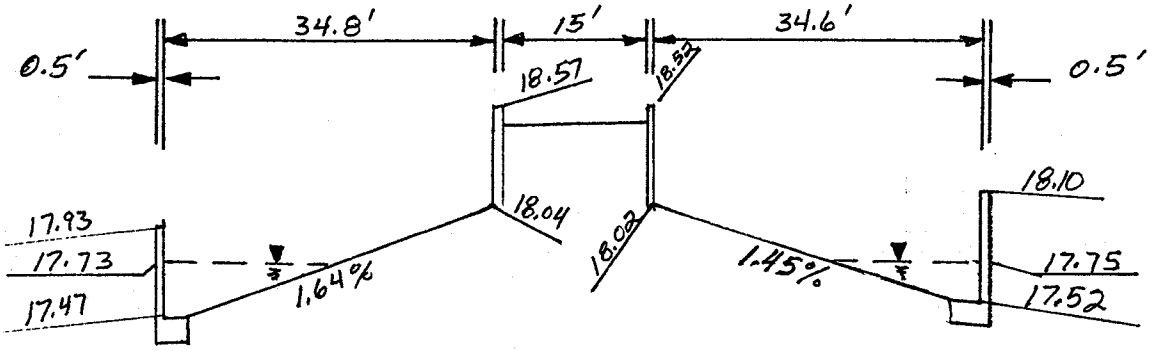
ENGINEER JLK DATE JOB NO. 1371.001 BY

SUBJECT Litchfield Park Drainage – Litchfield Rd @ Cottwood St. CHECKED BY

Existing Capacity

OFFICE TELEPHONE

Existing Capacity of Litchfield Rd @ Cottonwood Street.



Only 16' of road may be flooded so that cars may be parked along the center median and traffic will still be able to move with excessive obstruction from water.

$A = (0.26 \times 0.5 \times 16) + (0.5 \times 0.23 \times 16) = 3.92$ S.F.

$P = 0.26 + (0.26^2 + 16^2)^{1/2} + (0.23^2 + 16^2)^{1/2} + 0.23 = 32.49$ ft.

The slope = 0.84% north of Cottonwood and 0.81% south of cottonwood.
∴ Solve using average slope of 0.82%

$$Q = \frac{1.486}{0.015}(0.0082)^{1/2}\left(\frac{3.92}{32.49}\right)^{2/3}(3.92) = 8.6 \text{ cfs}$$

$V = 2.19$ fps

Capacity if allowed to flood to Top of Curb.

$A = (0.5 \times 0.47 \times 28') + (0.5 \times 0.50 \times 34.5') = 15.21$ S.F.

$P = (0.47^2 + 28^2)^{1/2} + (0.5^2 + 34.5^2)^{1/2} + 0.47 + 0.50 = 63.48$ ft.

$$Q = \frac{1.486}{0.015}(0.0082)^{1/2}\left(\frac{15.21}{63.48}\right)^{2/3}(15.21) = 52.6 \text{ cfs}$$

$V = 3.46$ fps

ASL/SIERRA
CONSULTING ENGINEERS

SHEET NO. 10 OF

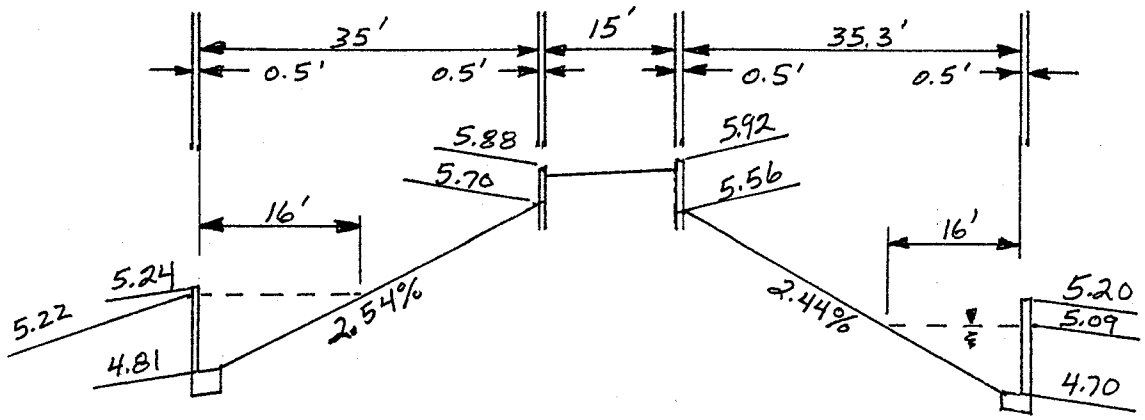
ENGINEER JLK DATE JOB NO. 1371.001 BY

SUBJECT Litchfield Park Drainage - Litchfield Rd - Wigwam to Oeste Ln. CHECKED BY

Existing Capacity

OFFICE TELEPHONE

Existing Capacity Litchfield Rd from Wigwam Blvd to Oeste Lane



Limit flooding to 16' from outside curb so that vehicles can travel road with minimal impact.

$A = (0.5 \times 0.41 \times 16) + (0.5 \times 0.39 \times 16) = 6.40$

$P = (0.41^2 + 16^2)^{1/2} + (0.39^2 + 16^2)^{1/2} + 0.41 + 0.39 = 32.81$

$Q = \frac{1.486}{0.015} (0.0054)^{1/2} \left(\frac{6.40}{32.81}\right)^{2/3} 6.40 = 15.69 \text{ cfs}$

$V = 2.45 \text{ fps}$

ASL SIERRA
CONSULTING ENGINEERS

SHEET NO. 11 OF

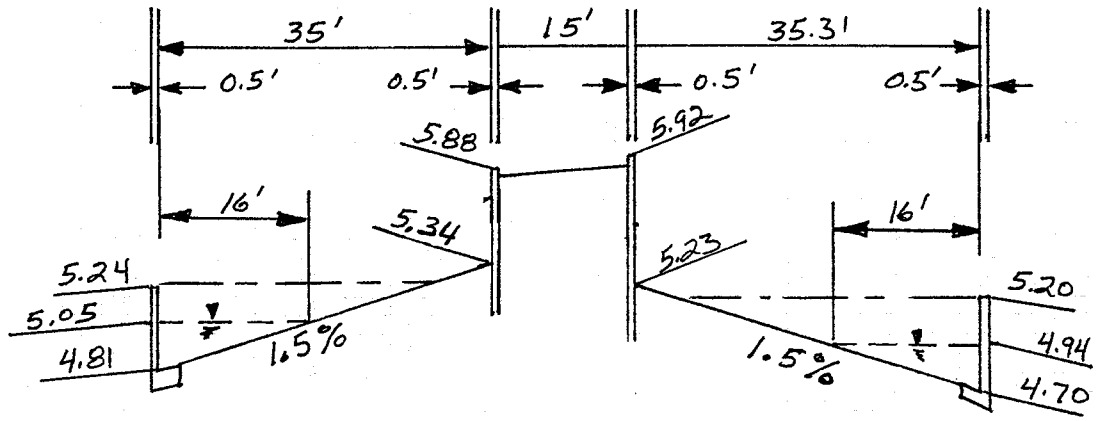
ENGINEER JLK DATE JOB NO. 1371.001 BY

SUBJECT Litchfield Park Drainage - Litchfield Rd - Wigwam to Oeste Ln CHECKED BY

Proposed Capacity

OFFICE TELEPHONE

Proposed Capacity Litchfield Rd from Wigwam Blvd to Oeste Lane



Limit Flooding to with 16' of the outside Curb.
Reconstruction assumes that only pavement & damage curb will be replace, and the cross slope will be reduced to accomodate future overlays.

$A = (0.5 \times 0.24 \times 16) + (0.5 \times 0.24 \times 16) = 3.92$ S.F.

$P = (0.24^2 + 16^2)^{1/2} \times 2 + (2 \times 0.24) = 34.48$ ft.

$$Q = \frac{1.486}{0.015}(0.0054)^{1/2}\left(\frac{3.92}{34.48}\right)^{2/3}(3.92) = 6.71 \text{ cfs}$$

$V = 1.71$ fps

Capacity if allowed to flood to top of curb

$A = (0.5 \times .43 \times 28.7') + (0.5 \times 0.5 \times 33.3') = 14.50$ S.F.

$P = (0.43^2 + 28.7^2)^{1/2} + (0.5^2 + 33.3^2)^{1/2} + 0.5 + 0.43 = 62.94$ ft.

$$Q = \frac{1.486}{0.015}(0.0054)^{1/2}\left(\frac{14.50}{62.94}\right)^{2/3}(14.50) = 39.70 \text{ cfs}$$

$V = 2.74$ fps

ASL/SIERRA CONSULTING ENGINEERS

SHEET NO. 12 OF

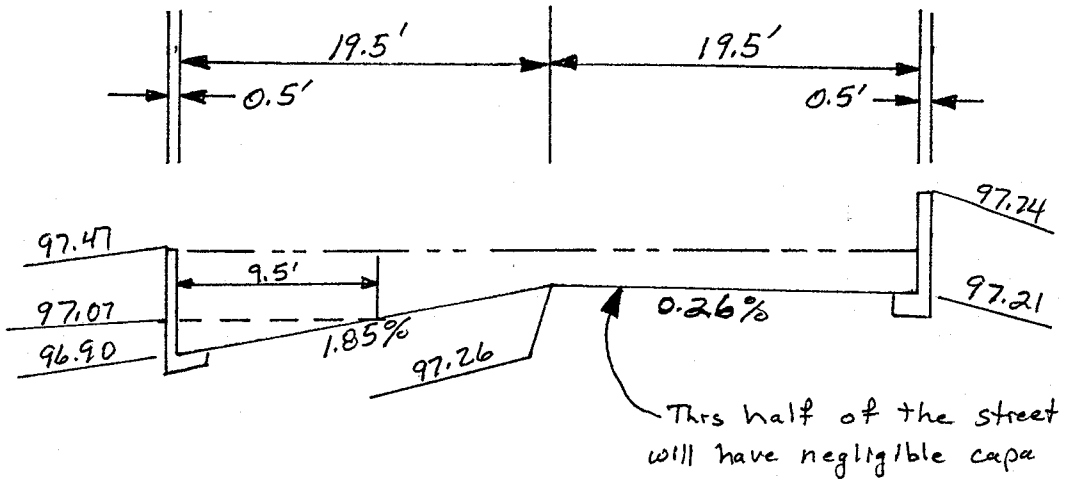
ENGINEER JLK DATE JOB NO. 1371.001 BY

SUBJECT Litchfield Park Drainage - Litchfield Rd - Oeste Ln to Indian School CHECKED BY

Existing Capacity

OFFICE Phoenix TELEPHONE 244-2624

Existing Capacity of Litchfield Road From South of Oeste Ln to Indian School



Determine Capacity with 10' from Centerline with no ponding

$A = (0.5 \times 0.17 \times 9.5') \approx 0.81$ S.F.

$P = 9.5' + 0.17' = 9.67'$ ft.

$$Q = \frac{1.486}{0.015}(0.0052)^{1/2}\left(\frac{0.81}{9.67}\right)^{2/3}(0.81) = 1.11 \text{ cfs}$$

$V = 1.37$ fps

Determine Capacity if allowed to flood to Top of Curb.

$A = (0.5 \times 0.36 \times 19.5) + (0.21 \times 39) + (0.5 \times 0.05 \times 19.5) = 12.19$ S.F.

$P = (0.36^2 + 19.5^2)^{1/2} + 0.57 + (0.05^2 + 19.5^2)^{1/2} + 0.26 = 39.83$ L.F.

$$Q = \frac{1.486}{0.015} \times (0.0052)^{1/2}\left(\frac{12.19}{39.83}\right)^{2/3}(12.19) = 39.58 \text{ cfs}$$

$V = 3.25$ fps

ASL/SIERRA
CONSULTING ENGINEERS

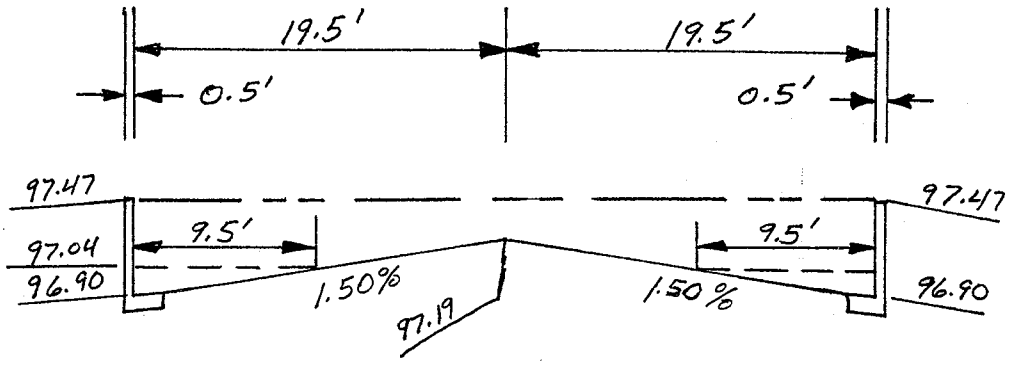
SHEET NO. 13 OF

ENGINEER JLK DATE JOB NO. 1371.001 BY

SUBJECT Litchfield Park Drainage - Litchfield Rd - Oeste Ln to Indian School CHECKED BY
Proposed Capacity

OFFICE Phoenix TELEPHONE 244-2624

Proposed Capacity of Litchfield Rd from South of Oeste Ln to Indian School



The proposed section will replace curb as required to place both curbs on the same profile line

Determine Capacity with 10' from Centerline with no ponding

$A = (0.5 \times 0.14 \times 9.5) \times 2 = 1.33$ S.F.

$P = (.14^2 + 9.5^2)^{1/2} \times 2 + (2 \times 0.14) = 19.28$ L.F.

$$Q = \frac{1.486}{0.015}(0.0052)^{1/2}\left(\frac{1.33}{19.28}\right)^{2/3}(1.33) = 1.60 \text{ cfs}$$

$V = 1.20$ fps

Determine Capacity if allowed to flood to Top of Curb

$A = (0.5 \times 0.29 \times 19.5) \times 2 + (0.28 \times 39) = 16.58$ S.F.

$P = (.29^2 + 19.5^2)^{1/2} \times 2 + (0.57 \times 2) = 40.14$

$$Q = \frac{1.486}{0.015}(0.0052)^{1/2}\left(\frac{16.58}{40.14}\right)^{2/3}(16.58) = 65.73 \text{ cfs}$$

$V = 3.96$ fps

ASL SIERRA
CONSULTING ENGINEERS

SHEET NO. 14 OF

ENGINEER Jim KARY DATE 10-1-97 JOB NO. 1371.001 BY JLK

SUBJECT Litchfield Park Drainage - Lake Outlet Structures CHECKED BY

OFFICE Phoenix TELEPHONE (602) 244-2624

Their are two basic options for the outlets to the lake. The first is a box which will inlet to the 36" Pipe Culverts and the second is curb opening inlet catch Basins.

Maximum Q = 120 cfs Maximum Water Depth = 1.0'
Per Pipe Q = 60 cfs

* Box (Grated Inlet) Outlet Structures (one per culvert)

Per FCD (weir) $Q_i = C_w P d^{1.5}$ $Q_i = C_o (A)(2gd)^{0.5}$

$C_w = 3.0$ $C_o = 0.67$

Assume 2 - 6'x4' Rectangular Boxes Assume Open Area = 14.4 ft²

$Q_i = 3.0(20)(1.0)^{1.5}$ $Q_i = 0.67(14.4)(2(32.2)(1.0))^{0.5}$

$Q_i = 60$ cfs $= 60$ cfs ∴ OK $Q_i = 77.42$ cfs ≥ 60 cfs ∴ OK

The box will function as a weir since the weir capacity is lower

* Curb opening inlet. (One per culvert)

Per FCD $Q_i = C_w (L + 1.8W) d^{1.5}$

$C_w = 2.3$ W = Width of depression = 2 ft.

Assume ADOT C-15.20 inlet and solve for d

2 - 10' wings + 4' Box 2 - 17' wings + 4' Box

$60 = 2.3(24 + 1.8(2))(d)^{1.5}$ $60 = 2.3(38 + 1.8(2))(d)^{1.5}$

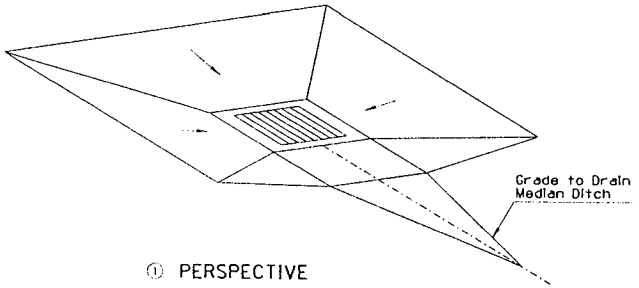
$\frac{60}{2.3(27.6)} = d^{1.5}$ $\frac{60}{2.3(41.6)} = d^{1.5}$

$0.9631' = d$ $0.6271' = d$

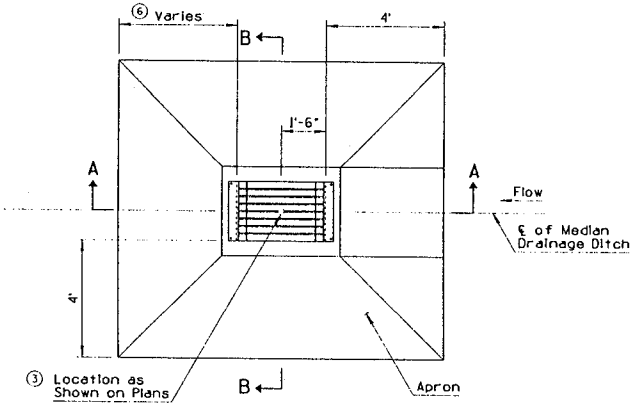
or 11.56" or 7.53"

NO.	DESCRIPTION OF REVISIONS	MADE BY	DATE
1	REVISED PERSPECTIVE	PMB	7/94
2	REVISED SLOPE	PMB	7/94
3	ADDED NOTE	PMB	7/94
4	ADDED DETAIL	PMB	7/94

NO.	DESCRIPTION OF REVISIONS	MADE BY	DATE
5	REVISED DIMENSION	PMB	7/94
6	ADDED DIMENSION	PMB	7/94
7			
8			



① PERSPECTIVE

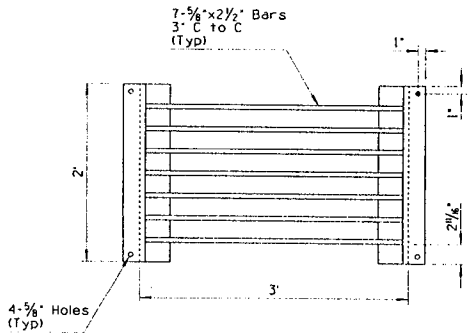


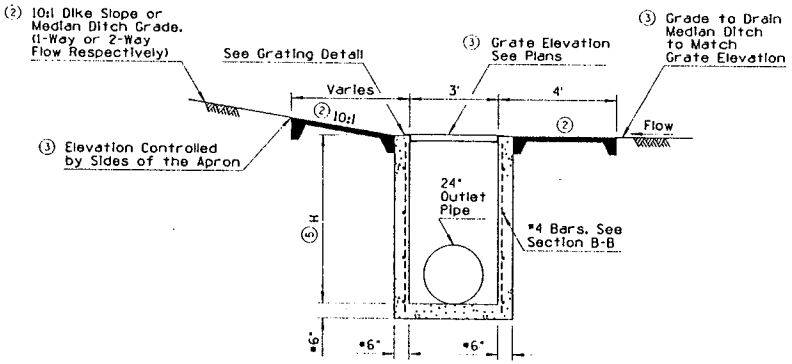
PLAN

GENERAL NOTES

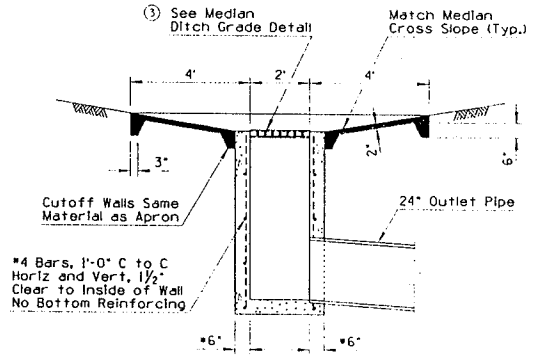
1. Apron shall be AC or portland cement concrete as specified on plans.
2. All concrete shall be Class B.
3. Grating shall be fabricated of structural steel.
4. Structural steel shall be in accordance with ASTM A36.
5. Welding shall be in accordance with Standard Welding Specifications.
6. Grating assembly shall be given one shop coat of No. 1 paint.
7. 'H' Indicated on plans.

* 8" When Wall Height Exceeds 8'

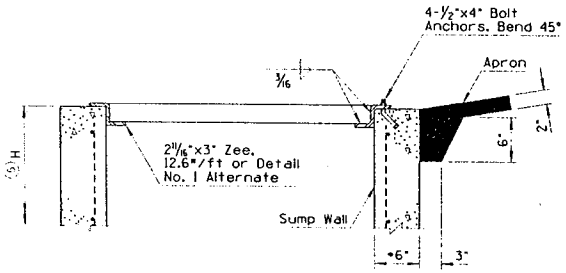




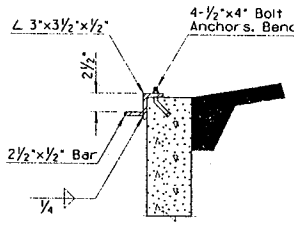
SECTION A-A



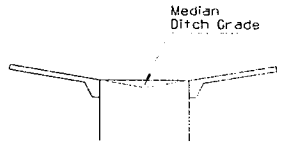
SECTION B-B



GRATING DETAIL



DETAIL NO. 1

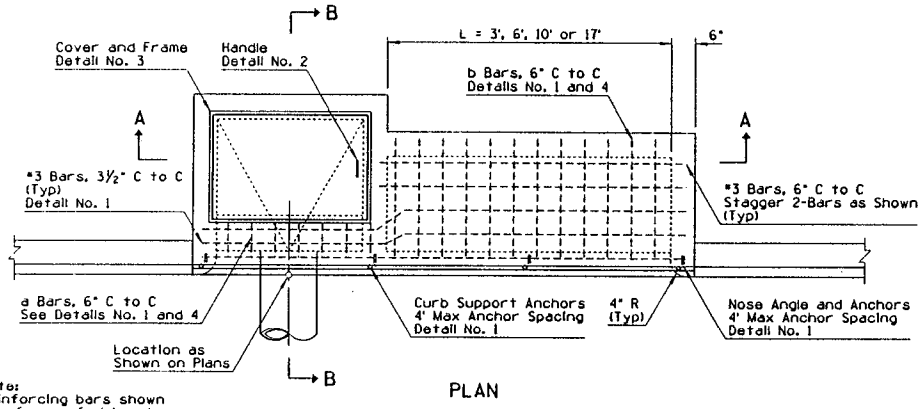


④ MEDIAN DITCH GRADE DETAIL

15

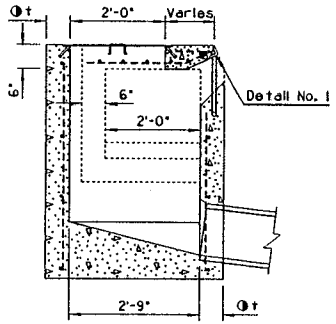
DESIGN APPROVED: Lloyd H. Otteman	STATE OF ARIZONA DEPARTMENT OF TRANSPORTATION DIVISION OF HIGHWAYS STANDARD DRAWINGS	DATE: 7/94
APPROVED FOR DISTRIBUTION: Paul Ward	CATCH BASIN, MEDIAN FLUSH	DRAWING NO.: C-15.80

NO.	DESCRIPTION OF REVISIONS	MADE BY	DATE
1	CHANGED "GUTTER" TO "INLET"	PNB	10/95
2			
3			
4			

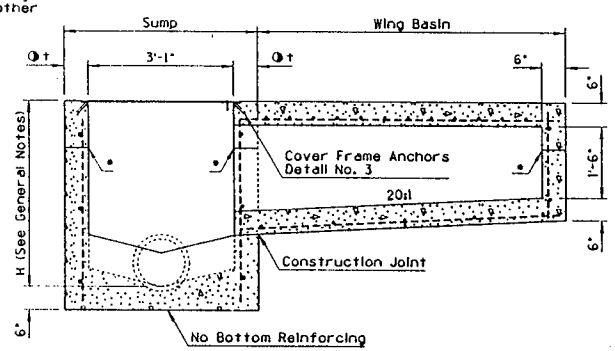


PLAN

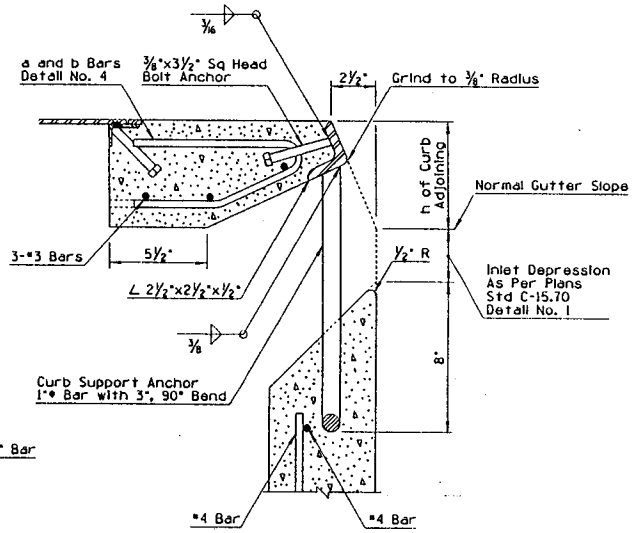
Note:
Reinforcing bars shown are for roof slab only. See Sections for other Reinforcing.



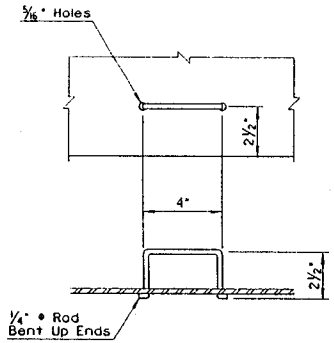
SECTION B-B



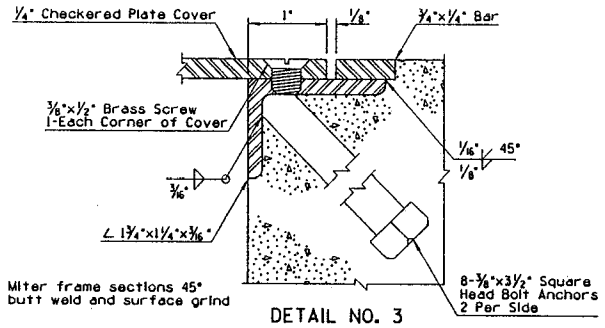
SECTION A-A



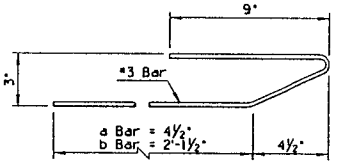
DETAIL NO. 1



DETAIL NO. 2



DETAIL NO. 3



DETAIL NO. 4

GENERAL NOTES

1. Type 3 - sump only.
2. Type 3-Wing (illustrated), sump with wing basin upstream.
3. Type 3-Double wing, sump with symetrical wing basin each side.
4. Pipes can be placed in any wall except wall adjacent to wing basin.
5. Sump floor shall have a wood trowel finish and a minimum slope of 4:1 in all directions toward outlet pipe.
6. (1) Any specified inlet depression shall be warped to opening according to Std C-15.70.
7. All structural steel shall be ASTM A36.
8. Nose angle, frame and cover shall be given one shop coat of No. 1 paint.
9. All concrete shall be class B.
10. All reinforcing bars shall be #4, 1'-6" C to C both ways and 1½" clear to inside of walls and outside of wing basin floor except as shown.
11. (1) Curb opening area (sq ft) per inch of curb "h" + inlet depression = curb opening length (ft) x 0.0833.
12. Welding shall be in accordance with Standard Welding Specifications.
13. * - Construction joints at or below bottom of curb line. Construction joints and drains shall be placed to meet field conditions. Std C-15.70.

    ◑t = 6" when H is 8' or less.
    8" when H is greater than 8'.
    See Section B-B, Std C-15.10.

    H = 2'-10" min when L = 3'
    3'-0" min when L = 6'
    3'-2" min when L = 10'
    3'-7" min when L = 17'

DESIGN APPROVED	STATE OF ARIZONA DEPARTMENT OF TRANSPORTATION DIVISION OF HIGHWAYS STANDARD DRAWINGS	REV. 10/95
APPROVED FOR DISTRIBUTION	CATCH BASIN, TYPE 3	DRAWING NO. C-15.20

ASL/SIERRA
CONSULTING ENGINEERS

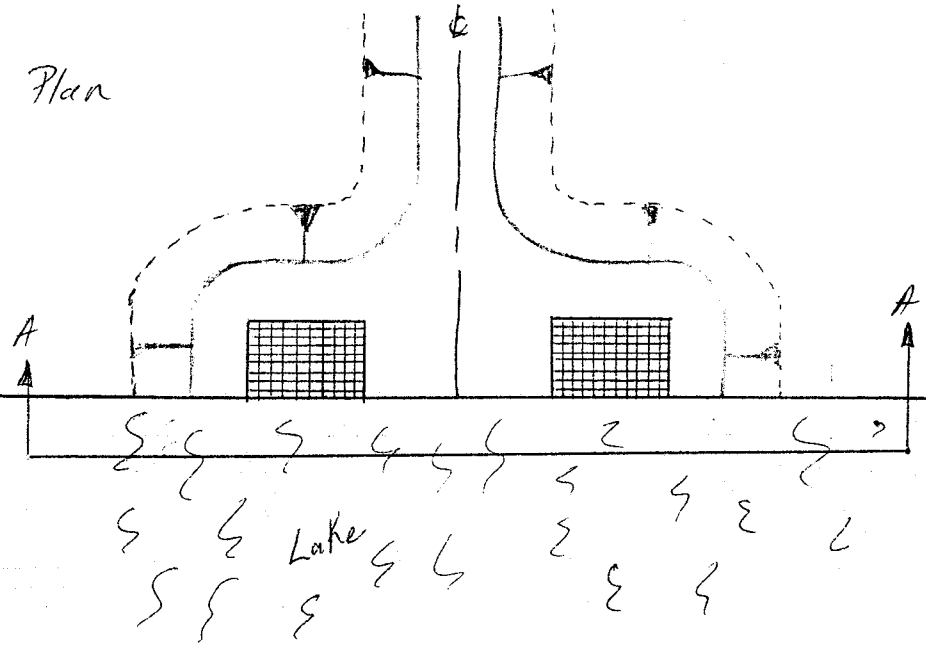
SHEET NO. 17 OF _____

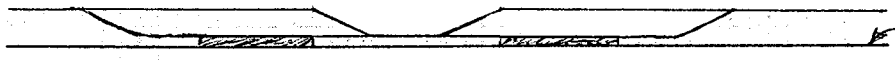
ENGINEER Jim KARY DATE 10-1-97 JOB NO. 1371.001 BY SLK

SUBJECT Litchfield Park Drainage -- Lake Outlet Structures CHECKED BY _____

OFFICE _____ TELEPHONE _____

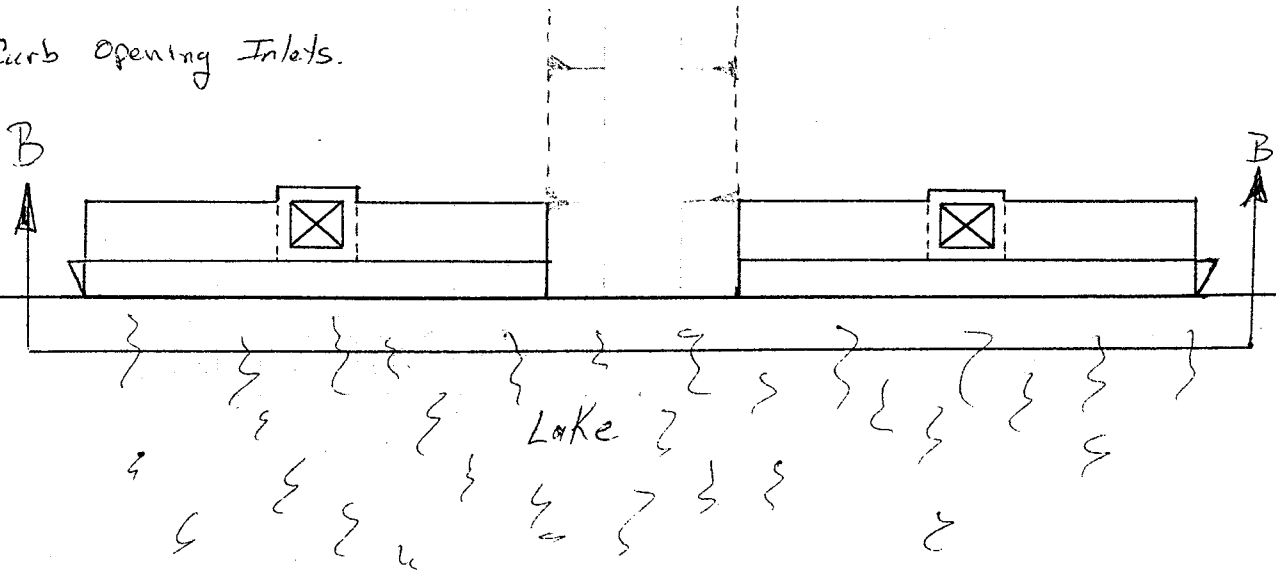
Box Inlet Plan

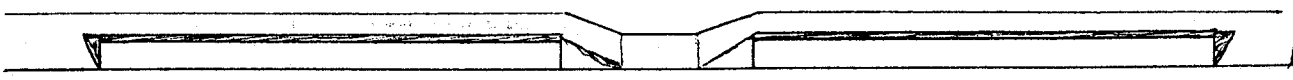




Section A-A

Curb Opening Inlets.



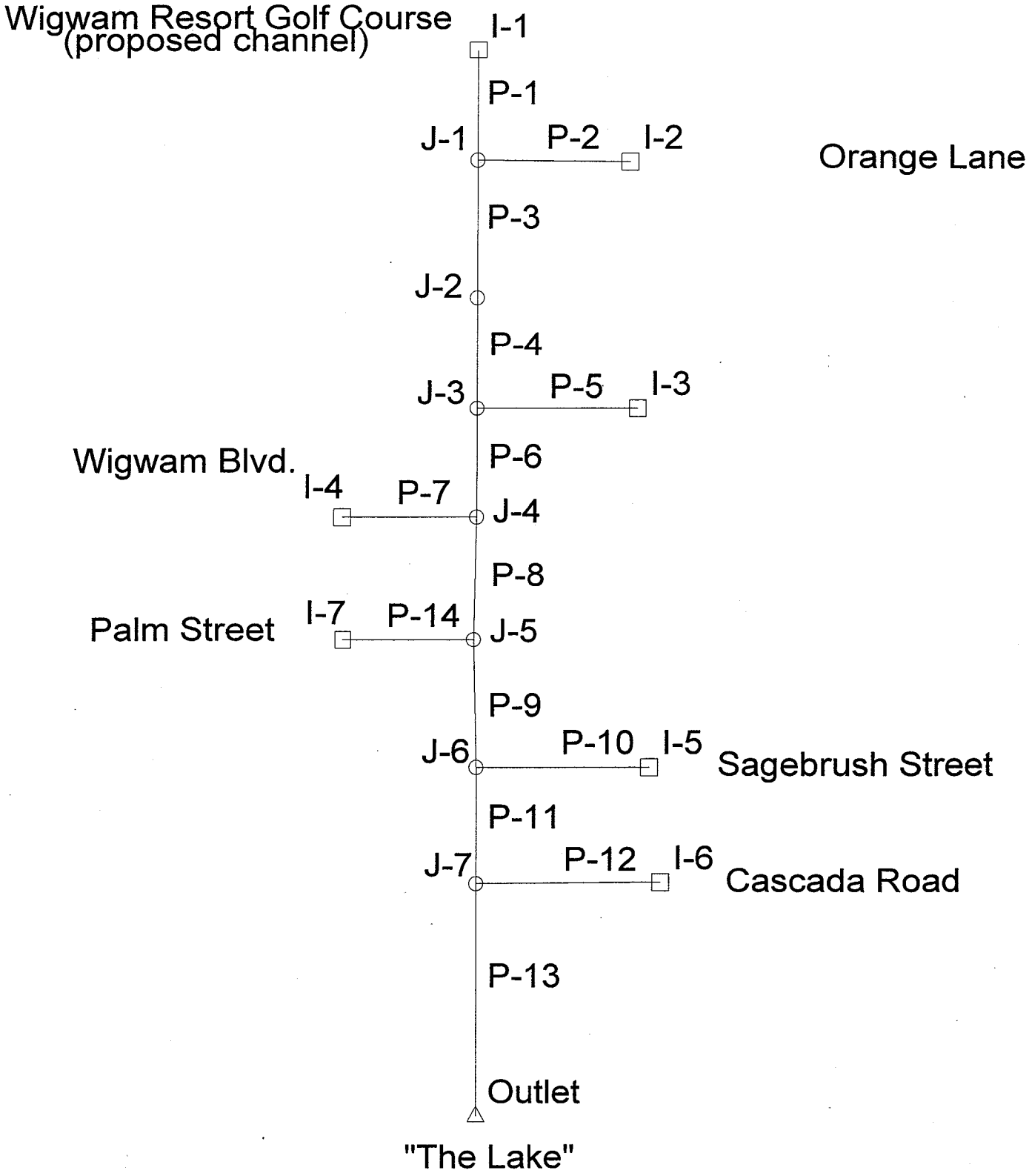


Section B-B

APPENDIX III

Hydraulic Calculations and Profiles for Storm Drains

SHEET NO.	DESCRIPTION
1 - 5	Neolin Ave. - Alternate 1
5 - 10	Neolin Ave. - Alternate 2
11 -17	Litchfield Rd. - Alternate 1
18 - 23	Litchfield Rd. - Alternate 2
24 - 27	'The Lake' Outlet - Alternate 1
28 - 31	'The Lake' Outlet - Alternate 2



ASL Sierra Consulting Engineers, Inc.
37 Brookside Road Waterbury, CT 06708 USA (203) 755-1666

Combined Pipe/Node Report

Pipe	Upstream Node	Downstream Node	Upstream Ground Elevation (ft)	Upstream HGL (ft)	Downstream Ground Elevation (ft)	Downstream HGL (ft)	Upstream Invert Elevation (ft)	Downstream Invert Elevation (ft)	Constructed Slope (ft/ft)	Length (ft)	Section Size	Discharge (cfs)	Average Velocity (ft/s)	Pipe
P-12	I-6	J-7	102.83	102.62	102.83	102.61	99.33	97.99	0.067000	20.00	24 inch	5.00	1.59	P-12
P-10	I-5	J-6	104.54	104.04	104.54	104.03	101.04	99.22	0.091000	20.00	24 inch	6.00	1.91	P-10
P-14	I-7	J-5	105.97	105.86	105.97	105.85	101.97	101.03	0.047000	20.00	30 inch	12.00	2.44	P-14
P-7	I-4	J-4	107.24	107.14	107.24	107.13	103.24	102.35	0.044500	20.00	24 inch	6.00	1.91	P-7
P-5	I-3	J-3	107.68	107.46	107.68	107.44	103.68	102.64	0.052000	20.00	24 inch	6.00	1.91	P-5
P-2	I-2	J-1	112.96	112.74	112.96	112.73	109.46	107.56	0.095000	20.00	24 inch	5.00	1.59	P-2
P-1	I-1	J-1	115.64	114.57	112.96	112.73	109.81	107.56	0.005810	387.26	36 inch	46.00	6.51	P-1
P-3	J-1	J-2	112.96	112.57	110.24	110.01	107.56	105.12	0.005571	438.00	36 inch	51.00	7.22	P-3
P-4	J-2	J-3	110.24	109.84	107.68	107.44	105.12	102.64	0.006034	411.00	36 inch	51.00	7.22	P-4
P-6	J-3	J-4	107.68	107.34	107.24	107.13	102.64	102.35	0.003452	84.00	34x53 inch	57.00	5.59	P-6
P-8	J-4	J-5	107.24	107.01	105.97	105.85	102.35	101.03	0.003520	375.00	34x53 inch	63.00	6.18	P-8
P-9	J-5	J-6	105.97	105.68	104.54	104.03	101.03	99.22	0.004827	375.00	34x53 inch	75.00	7.35	P-9
P-11	J-6	J-7	104.54	103.83	102.83	102.61	99.22	97.99	0.005190	237.00	34x53 inch	81.00	7.94	P-11
P-13	J-7	Outlet	102.83	102.39	99.70	98.81	97.99	95.28	0.004385	618.00	34x53 inch	86.00	8.43	P-13

SHEET NO. 2

ASL Sierra Consulting Engineers, Inc.
37 Brookside Road Waterbury, CT 06708 USA (203) 755-1666

```
------------------ Beginning Calculation Cycle -------------------
Discharge: 46.00 cfs  at node I-1
Discharge: 5.00 cfs  at node I-2
Discharge: 51.00 cfs  at node J-1
Discharge: 51.00 cfs  at node J-2
Discharge: 6.00 cfs  at node I-3
Discharge: 57.00 cfs  at node J-3
Discharge: 6.00 cfs  at node I-4
Discharge: 63.00 cfs  at node J-4
Discharge: 12.00 cfs  at node I-7
Discharge: 75.00 cfs  at node J-5
Discharge: 6.00 cfs  at node I-5
Discharge: 81.00 cfs  at node J-6
Discharge: 5.00 cfs  at node I-6
Discharge: 86.00 cfs  at node J-7
Discharge: 86.00 cfs  at node Outlet
Beginning iteration 1
Discharge: 46.00 cfs  at node I-1
Discharge: 5.00 cfs  at node I-2
Discharge: 51.00 cfs  at node J-1
Discharge: 51.00 cfs  at node J-2
Discharge: 6.00 cfs  at node I-3
Discharge: 57.00 cfs  at node J-3
Discharge: 6.00 cfs  at node I-4
Discharge: 63.00 cfs  at node J-4
Discharge: 12.00 cfs  at node I-7
Discharge: 75.00 cfs  at node J-5
Discharge: 6.00 cfs  at node I-5
Discharge: 81.00 cfs  at node J-6
Discharge: 5.00 cfs  at node I-6
Discharge: 86.00 cfs  at node J-7
Discharge: 86.00 cfs  at node Outlet
Discharge Convergence Achieved in 1 iterations: relative error:  0.0
** Warning: Design constraints not met.
Warning: No Duration data exists in IDF Table
Information: Outlet Known flow propagated from upstream junctions.
Information: P-13 Surcharged condition
Violation: P-13 does not meet minimum cover constraint at downstream end.
Information: J-7 Known flow propagated from upstream junctions.
Information: P-11 Surcharged condition
Information: P-12 Surcharged condition
Violation: P-12 does not meet minimum cover constraint at upstream end.
Information: J-6 Known flow propagated from upstream junctions.
Information: P-9 Surcharged condition
Information: P-10 Surcharged condition
Violation: P-10 does not meet minimum cover constraint at upstream end.
Information: J-5 Known flow propagated from upstream junctions.
Information: P-8 Surcharged condition
Information: P-14 Surcharged condition
Violation: P-14 does not meet minimum cover constraint at upstream end.
Information: J-4 Known flow propagated from upstream junctions.
Information: P-6 Surcharged condition
Information: P-7 Surcharged condition
Information: J-3 Known flow propagated from upstream junctions.
Information: P-4 Surcharged condition
Information: P-5 Surcharged condition
Information: J-2 Known flow propagated from upstream junctions.
Information: P-3 Surcharged condition
Information: J-1 Known flow propagated from upstream junctions.
Information: P-1 Surcharged condition
Information: P-2 Surcharged condition
Violation: P-2 does not meet minimum cover constraint at upstream end.
---------------------- Calculations Complete ----------------------

** Analysis Options **
Friction method:  Manning's Formula
HGL Convergence Test:  0.001000
Maximum Network Traversals:  5
Number of Flow Profile Steps:  5
```

Discharge Convergence Test: 0.001000
Maximum Design Passes: 3

---------- Network Quick View ----------

Label	Length	Size	Discharge	Hydraulic Grade Upstream	Hydraulic Grade Downstream
P-1	387.26	36 inch	46.00	114.57	112.73
P-2	20.00	24 inch	5.00	112.74	112.73
P-3	438.00	36 inch	51.00	112.57	110.01
P-4	411.00	36 inch	51.00	109.84	107.44
P-5	20.00	24 inch	6.00	107.46	107.44
P-6	84.00	34x53 inch	57.00	107.34	107.13
P-7	20.00	24 inch	6.00	107.14	107.13
P-8	375.00	34x53 inch	63.00	107.01	105.85
P-9	375.00	34x53 inch	75.00	105.68	104.03
P-10	20.00	24 inch	6.00	104.04	104.03
P-11	237.00	34x53 inch	81.00	103.83	102.61
P-12	20.00	24 inch	5.00	102.62	102.61
P-13	618.00	34x53 inch	86.00	102.39	98.81
P-14	20.00	30 inch	12.00	105.86	105.85

Label	Discharge	Elevations Ground	Elevations Upstream HGL	Elevations Downstream HGL
I-1	46.00	115.64	114.90	114.57
J-1	51.00	112.96	112.73	112.57
I-2	5.00	112.96	112.74	112.74
J-2	51.00	110.24	110.01	109.84
J-3	57.00	107.68	107.44	107.34
I-3	6.00	107.68	107.48	107.46
J-4	63.00	107.24	107.13	107.01
I-4	6.00	107.24	107.17	107.14
J-5	75.00	105.97	105.85	105.68
J-6	81.00	104.54	104.03	103.83
I-5	6.00	104.54	104.07	104.04
J-7	86.00	102.83	102.61	102.39
I-6	5.00	102.83	102.62	102.62
Outlet	86.00	99.70	98.81	98.81
I-7	12.00	105.97	105.90	105.86

Elapsed: 0 minute(s) 4 second(s)

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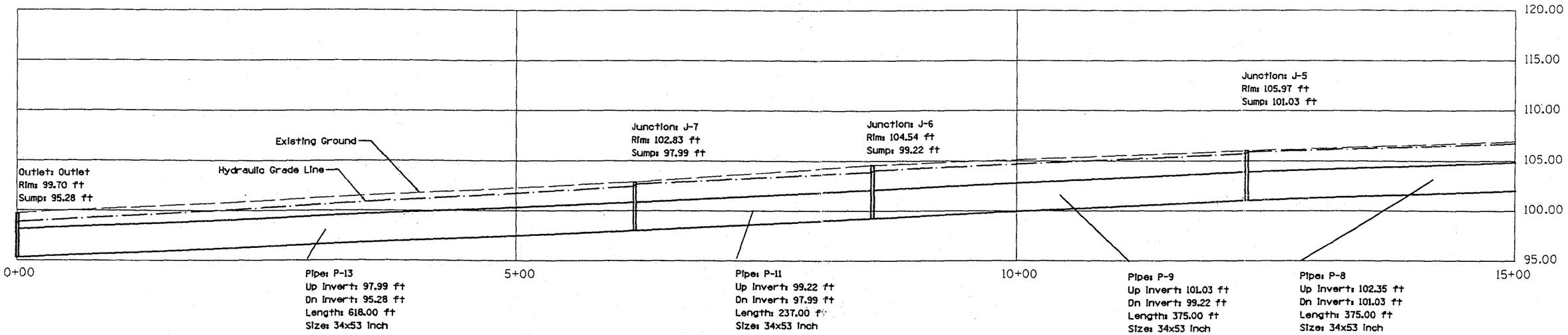
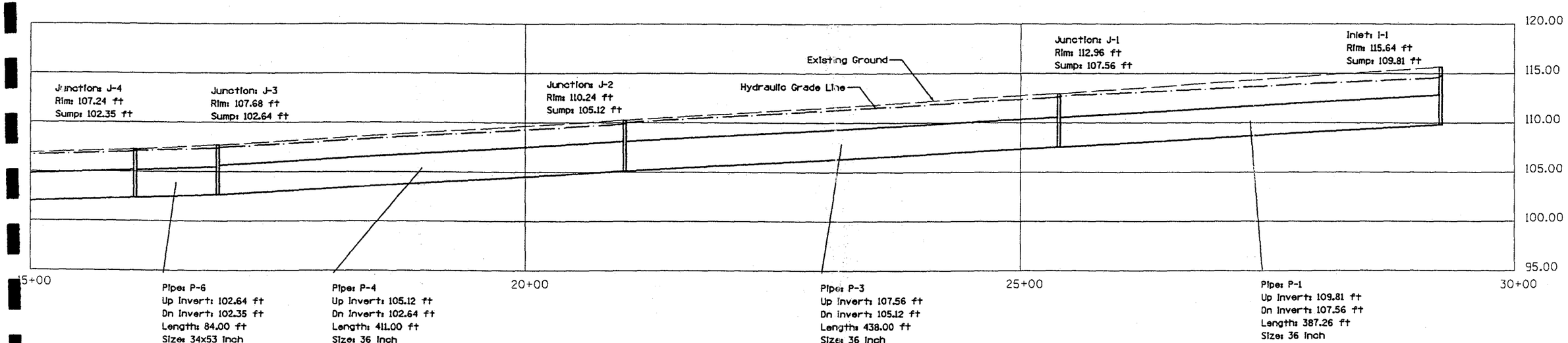
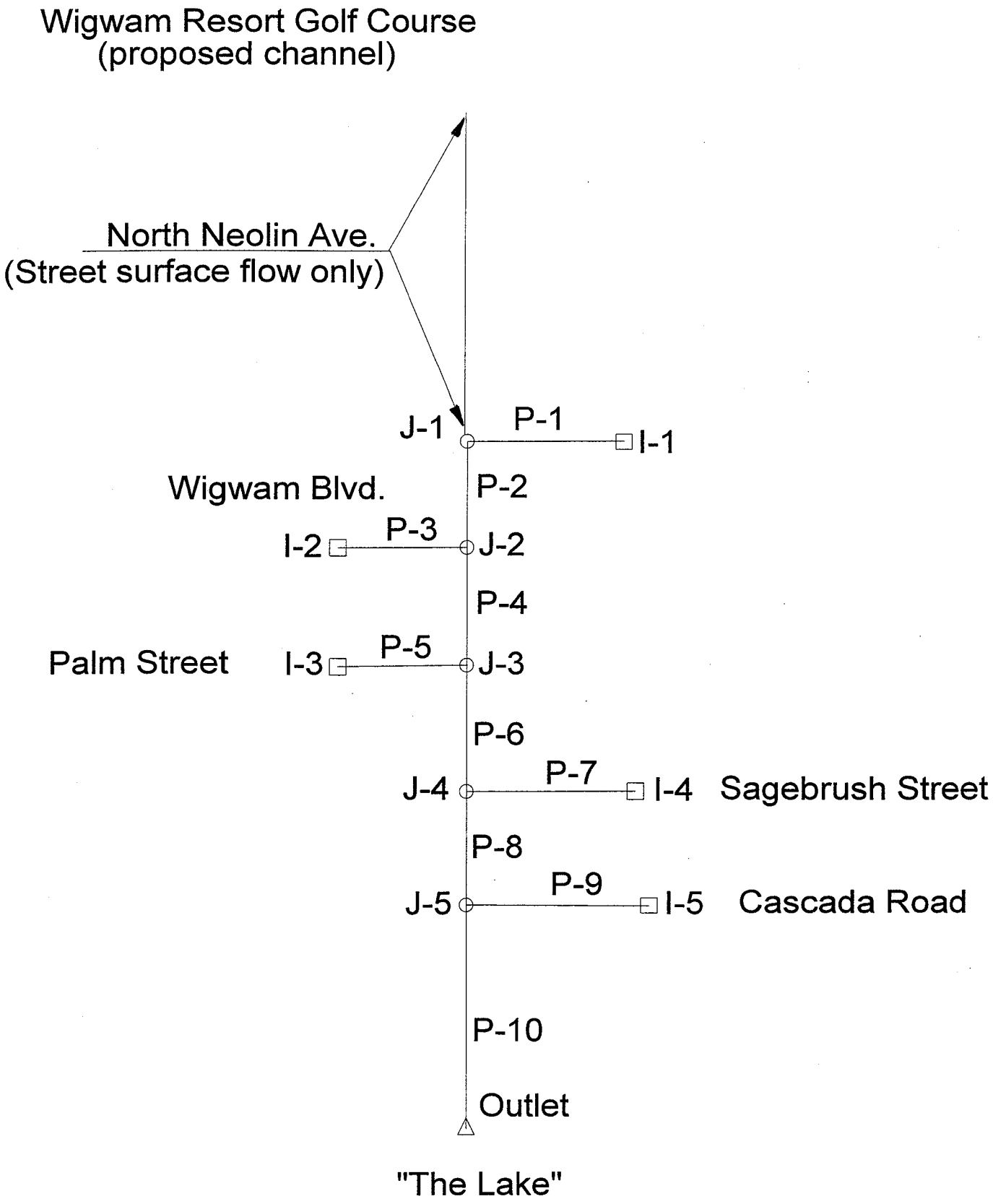




ASL Consulting Engineers

STORM DRAIN PROFILES

FILE: AINEOLIN.STM SHT 1/ 1


Wigwam Resort Golf Course
(proposed channel)
North Neolin Ave.
(Street surface flow only)
J-1
P-1
I-1
Wigwam Blvd.
P-2
I-2
P-3
J-2
P-4
Palm Street
I-3
P-5
J-3
P-6
J-4
P-7
I-4
Sagebrush Street
P-8
J-5
P-9
I-5
Cascada Road
P-10
Outlet
"The Lake"

```
------------------ Beginning Calculation Cycle ------------------
Discharge: 20.00 cfs  at node I-1
Discharge: 20.00 cfs  at node J-1
Discharge: 20.00 cfs  at node I-2
Discharge: 40.00 cfs  at node J-2
Discharge: 25.00 cfs  at node I-3
Discharge: 65.00 cfs  at node J-3
Discharge: 10.00 cfs  at node I-4
Discharge: 75.00 cfs  at node J-4
Discharge: 12.00 cfs  at node I-5
Discharge: 87.00 cfs  at node J-5
Discharge: 87.00 cfs  at node Outlet
Beginning iteration 1
Discharge: 20.00 cfs  at node I-1
Discharge: 20.00 cfs  at node J-1
Discharge: 20.00 cfs  at node I-2
Discharge: 40.00 cfs  at node J-2
Discharge: 25.00 cfs  at node I-3
Discharge: 65.00 cfs  at node J-3
Discharge: 10.00 cfs  at node I-4
Discharge: 75.00 cfs  at node J-4
Discharge: 12.00 cfs  at node I-5
Discharge: 87.00 cfs  at node J-5
Discharge: 87.00 cfs  at node Outlet
Discharge Convergence Achieved in 1 iterations: relative error:  0.0
Warning: No Duration data exists in IDF Table
Information: Outlet Known flow propagated from upstream junctions.
Information: P-10 Surcharged condition
Information: J-5 Known flow propagated from upstream junctions.
Information: P-8 Surcharged condition
Information: P-9 Surcharged condition
Information: J-4 Known flow propagated from upstream junctions.
Information: P-6 Surcharged condition
Information: P-7 Surcharged condition
Information: J-3 Known flow propagated from upstream junctions.
Information: P-4 Surcharged condition
Information: P-5 Surcharged condition
Information: J-2 Known flow propagated from upstream junctions.
Information: P-2 Surcharged condition
Information: P-3 Surcharged condition
Information: J-1 Known flow propagated from upstream junctions.
Information: P-1 Surcharged condition
--------------------- Calculations Complete ----------------------

** Analysis Options **
Friction method:  Manning's Formula
HGL Convergence Test:  0.001000
Maximum Network Traversals:  5
Number of Flow Profile Steps:  5
Discharge Convergence Test:  0.001000
Maximum Design Passes:  3


 ----------------- Network Quick View -------------------------
```

Label	Length	Size	Discharge	Hydraulic Grade Upstream	Hydraulic Grade Downstream
P-1	20.00	24 inch	20.00	107.14	106.98
P-2	84.00	30 inch	20.00	106.93	106.73
P-3	20.00	24 inch	20.00	106.89	106.73
P-4	375.00	36 inch	40.00	106.63	105.28
P-6	375.00	34x53 inch	65.00	105.15	103.91
P-7	20.00	24 inch	10.00	103.95	103.91
P-8	237.00	34x53 inch	75.00	103.74	102.70
P-9	20.00	24 inch	12.00	102.76	102.70
P-10	618.00	34x53 inch	87.00	102.47	98.81
P-5	20.00	24 inch	25.00	105.52	105.28

| ---------- Elevations ---------- |

Label	Discharge	Ground	Upstream HGL	Downstream HGL
J-1	20.00	107.68	106.98	106.93
I-1	20.00	107.68	107.45	107.14
J-2	40.00	107.24	106.73	106.63
I-2	20.00	107.24	107.20	106.89
J-3	65.00	105.97	105.28	105.15
J-4	75.00	104.54	103.91	103.74
I-4	10.00	104.54	104.03	103.95
J-5	87.00	102.83	102.70	102.47
I-5	12.00	102.83	102.76	102.76
Outlet	87.00	99.70	98.81	98.81
I-3	25.00	105.97	105.92	105.52

Elapsed: 0 minute(s) 2 second(s)

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Combined Pipe/Node Report

Pipe	Upstream Node	Downstream Node	Upstream Ground Elevation (ft)	Upstream HGL (ft)	Downstream Ground Elevation (ft)	Downstream HGL (ft)	Upstream Invert Elevation (ft)	Downstream Invert Elevation (ft)	Constructed Slope (ft/ft)	Length (ft)	Section Size	Discharge (cfs)	Average Velocity (ft/s)	Pipe
P-9	I-5	J-5	102.83	102.76	102.83	102.70	99.33	97.99	0.067000	20.00	24 inch	12.00	3.82	P-9
P-7	I-4	J-4	104.54	103.95	104.54	103.91	101.04	99.22	0.091000	20.00	24 inch	10.00	3.18	P-7
P-5	I-3	J-3	105.97	105.52	105.97	105.28	101.97	101.03	0.047000	20.00	24 inch	25.00	7.96	P-5
P-3	I-2	J-2	107.24	106.89	107.24	106.73	103.24	102.35	0.044500	20.00	24 inch	20.00	6.37	P-3
P-1	I-1	J-1	107.68	107.14	107.68	106.98	103.68	102.64	0.052000	20.00	24 inch	20.00	6.37	P-1
P-2	J-1	J-2	107.68	106.93	107.24	106.73	102.64	102.35	0.003452	84.00	30 inch	20.00	4.07	P-2
P-4	J-2	J-3	107.24	106.63	105.97	105.28	102.35	101.03	0.003520	375.00	36 inch	40.00	5.66	P-4
P-6	J-3	J-4	105.97	105.15	104.54	103.91	101.03	99.22	0.004827	375.00	34x53 inch	65.00	6.37	P-6
P-8	J-4	J-5	104.54	103.74	102.83	102.70	99.22	97.99	0.005190	237.00	34x53 inch	75.00	7.35	P-8
P-10	J-5	Outlet	102.83	102.47	99.70	98.81	97.99	95.28	0.004385	618.00	34x53 inch	87.00	8.53	P-10

SHEET NO. 9

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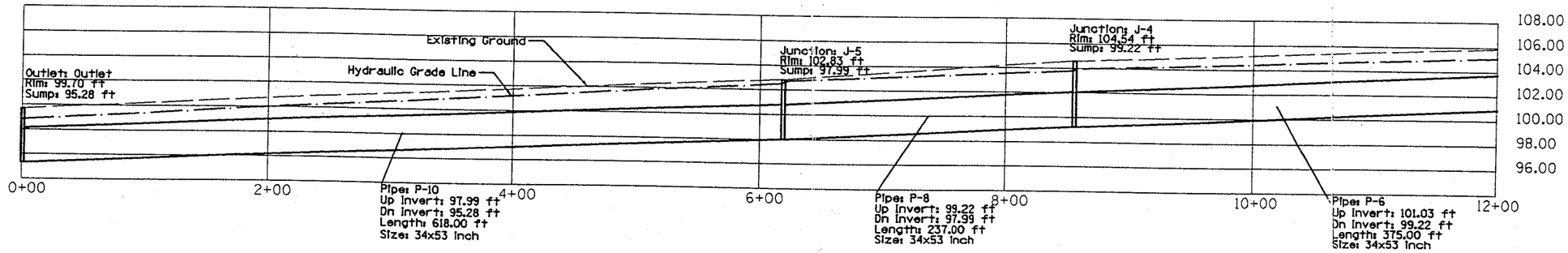

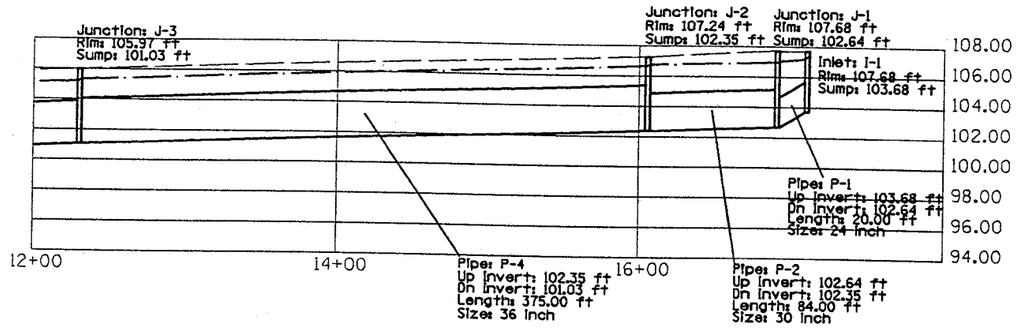

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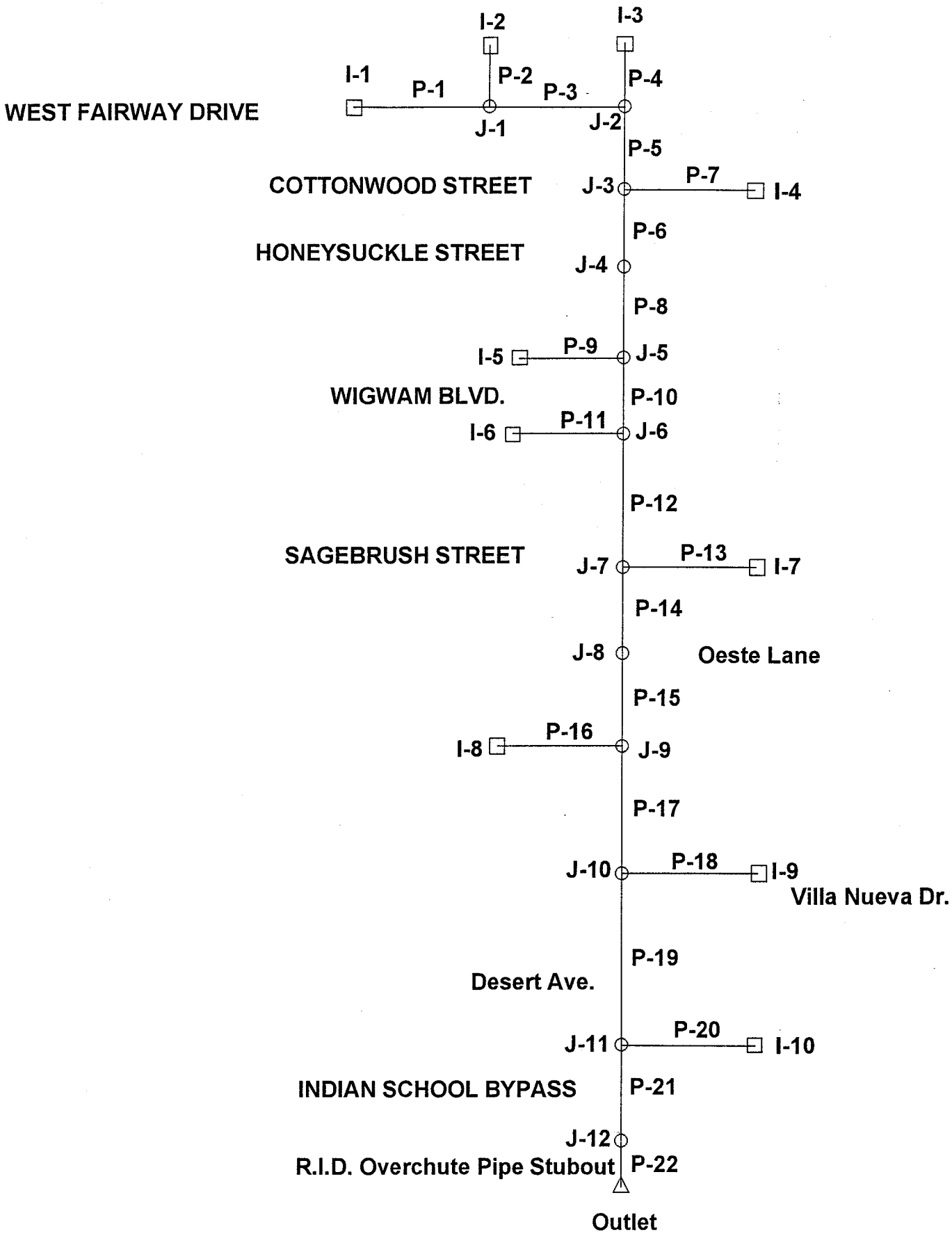
STORM DRAIN PROFILES

FILE: A2NEOLIN.STM SHT 1/ 1


I-1
I-2
I-3
P-1
P-2
P-3
P-4
WEST FAIRWAY DRIVE
J-1
J-2
P-5
COTTONWOOD STREET
J-3
P-7
I-4
P-6
HONEYSUCKLE STREET
J-4
P-8
I-5
P-9
J-5
WIGWAM BLVD.
P-10
I-6
P-11
J-6
P-12
SAGEBRUSH STREET
J-7
P-13
I-7
P-14
J-8
Oeste Lane
P-15
I-8
P-16
J-9
P-17
J-10
P-18
I-9
Villa Nueva Dr.
P-19
Desert Ave.
J-11
P-20
I-10
INDIAN SCHOOL BYPASS
P-21
J-12
R.I.D. Overchute Pipe Stubout
P-22
Outlet

Combined Pipe/Node Report

Pipe	Upstream Node	Downstream Node	Upstream Ground Elevation (ft)	Upstream HGL (ft)	Downstream Ground Elevation (ft)	Downstream HGL (ft)	Upstream Invert Elevation (ft)	Downstream Invert Elevation (ft)	Constructed Slope (ft/ft)	Length (ft)	Section Size	Discharge (cfs)	Average Velocity (ft/s)	Pipe
P-20	I-10	J-11	97.06	96.63	97.06	96.61	93.06	91.33	0.069200	25.00	24 inch	5.00	1.59	P-20
P-18	I-9	J-10	100.30	100.10	100.30	100.09	96.30	94.30	0.080000	25.00	24 inch	5.00	1.59	P-18
P-13	I-7	J-7	107.55	107.15	107.55	107.10	103.55	101.11	0.081333	30.00	24 inch	10.00	3.18	P-13
P-11	I-6	J-6	111.43	109.92	111.43	109.89	107.43	105.05	0.059500	40.00	24 inch	6.00	1.91	P-11
P-9	I-5	J-5	111.58	110.33	111.58	110.30	107.58	105.49	0.052250	40.00	24 inch	6.00	1.91	P-9
P-7	I-4	J-3	118.00	115.61	118.00	115.27	114.00	110.94	0.153000	20.00	24 inch	20.00	6.88	P-7
P-4	I-3	J-2	121.75	119.62	121.75	119.56	116.75	113.07	0.147200	25.00	30 inch	20.00	4.07	P-4
P-2	I-2	J-1	122.71	121.61	122.71	121.45	118.71	115.20	0.140400	25.00	24 inch	18.00	5.73	P-2
P-1	I-1	J-1	122.27	122.05	122.71	121.45	117.29	115.20	0.005278	396.00	36 inch	26.00	3.68	P-1
P-3	J-1	J-2	122.71	121.33	121.75	119.56	115.20	113.07	0.005221	408.00	36 inch	44.00	6.22	P-3
P-5	J-2	J-3	121.75	119.30	118.00	115.27	113.07	110.94	0.004863	438.00	36 inch	64.00	9.05	P-5
P-6	J-3	J-4	118.00	115.06	114.80	112.72	110.94	108.56	0.005640	422.00	34x53 inch	84.00	8.24	P-6
P-8	J-4	J-5	114.80	112.51	111.58	110.30	108.56	105.49	0.007675	400.00	34x53 inch	84.00	8.24	P-8
P-10	J-5	J-6	111.58	110.15	111.43	109.89	105.49	105.05	0.005789	76.00	38x60 inch	90.00	6.98	P-10
P-12	J-6	J-7	111.43	109.72	107.55	107.10	105.05	101.11	0.005803	679.00	38x60 inch	96.00	7.44	P-12
P-14	J-7	J-8	107.55	106.89	105.10	104.76	101.10	98.77	0.005178	450.00	38x60 inch	106.00	8.22	P-14
P-15	J-8	J-9	105.10	104.55	102.50	102.39	98.77	96.38	0.005196	460.00	38x60 inch	106.00	8.22	P-15
P-16	I-8	J-9	102.50	102.40	102.50	102.39	98.50	96.38	0.084800	25.00	24 inch	5.00	1.59	P-16
P-17	J-9	J-10	102.50	102.16	100.30	100.09	96.38	94.30	0.005200	400.00	38x60 inch	111.00	8.60	P-17
P-19	J-10	J-11	100.30	99.84	97.06	96.61	94.30	91.33	0.005201	571.00	38x60 inch	116.00	8.99	P-19
P-21	J-11	J-12	97.06	96.55	96.72	96.37	91.33	90.74	0.005175	114.00	38x60 inch	121.00	4.69	P-21
P-22	J-12	Outlet	96.72	96.34	96.29	96.29	90.74	90.29	0.015000	30.00	38x60 inch	121.00	4.69	P-22

SHEET NO. 12

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```
------------------ Beginning Calculation Cycle ------------------
Discharge: 5.00 cfs  at node I-8
Discharge: 26.00 cfs  at node I-1
Discharge: 18.00 cfs  at node I-2
Discharge: 44.00 cfs  at node J-1
Discharge: 20.00 cfs  at node I-3
Discharge: 64.00 cfs  at node J-2
Discharge: 20.00 cfs  at node I-4
Discharge: 84.00 cfs  at node J-3
Discharge: 84.00 cfs  at node J-4
Discharge: 6.00 cfs  at node I-5
Discharge: 90.00 cfs  at node J-5
Discharge: 6.00 cfs  at node I-6
Discharge: 96.00 cfs  at node J-6
Discharge: 10.00 cfs  at node I-7
Discharge: 106.00 cfs  at node J-7
Discharge: 106.00 cfs  at node J-8
Discharge: 111.00 cfs  at node J-9
Discharge: 5.00 cfs  at node I-9
Discharge: 116.00 cfs  at node J-10
Discharge: 5.00 cfs  at node I-10
Discharge: 121.00 cfs  at node J-11
Discharge: 121.00 cfs  at node J-12
Discharge: 121.00 cfs  at node Outlet
Beginning iteration 1
Discharge: 5.00 cfs  at node I-8
Discharge: 26.00 cfs  at node I-1
Discharge: 18.00 cfs  at node I-2
Discharge: 44.00 cfs  at node J-1
Discharge: 20.00 cfs  at node I-3
Discharge: 64.00 cfs  at node J-2
Discharge: 20.00 cfs  at node I-4
Discharge: 84.00 cfs  at node J-3
Discharge: 84.00 cfs  at node J-4
Discharge: 6.00 cfs  at node I-5
Discharge: 90.00 cfs  at node J-5
Discharge: 6.00 cfs  at node I-6
Discharge: 96.00 cfs  at node J-6
Discharge: 10.00 cfs  at node I-7
Discharge: 106.00 cfs  at node J-7
Discharge: 106.00 cfs  at node J-8
Discharge: 111.00 cfs  at node J-9
Discharge: 5.00 cfs  at node I-9
Discharge: 116.00 cfs  at node J-10
Discharge: 5.00 cfs  at node I-10
Discharge: 121.00 cfs  at node J-11
Discharge: 121.00 cfs  at node J-12
Discharge: 121.00 cfs  at node Outlet
Discharge Convergence Achieved in 1 iterations: relative error:  0.0
Warning: No Duration data exists in IDF Table
Information: Outlet Known flow propagated from upstream junctions.
Information: P-22 Surcharged condition
Information: J-12 Known flow propagated from upstream junctions.
Information: P-21 Surcharged condition
Information: J-11 Known flow propagated from upstream junctions.
Information: P-19 Surcharged condition
Information: P-20 Surcharged condition
Information: J-10 Known flow propagated from upstream junctions.
Information: P-17 Surcharged condition
Information: P-18 Surcharged condition
Information: J-9 Known flow propagated from upstream junctions.
Information: P-16 Surcharged condition
Information: P-15 Surcharged condition
Information: J-8 Known flow propagated from upstream junctions.
Information: P-14 Surcharged condition
Information: J-7 Known flow propagated from upstream junctions.
Information: P-12 Surcharged condition
Information: P-13 Surcharged condition
Information: J-6 Known flow propagated from upstream junctions.
```

```
Information: P-10 Surcharged condition
Information: P-11 Surcharged condition
Information: J-5 Known flow propagated from upstream junctions.
Information: P-8 Surcharged condition
Information: P-9 Surcharged condition
Information: J-4 Known flow propagated from upstream junctions.
Information: P-6 Surcharged condition
Information: J-3 Known flow propagated from upstream junctions.
Information: P-5 Surcharged condition
Information: J-2 Known flow propagated from upstream junctions.
Information: P-3 Surcharged condition
Information: P-4 Surcharged condition
Information: J-1 Known flow propagated from upstream junctions.
Information: P-1 Surcharged condition
Information: P-2 Surcharged condition
---------- Calculations Complete ----------

** Analysis Options **
Friction method:  Manning's Formula
HGL Convergence Test:  0.001000
Maximum Network Traversals:  5
Number of Flow Profile Steps:  5
Discharge Convergence Test:  0.001000
Maximum Design Passes:  3
```

---------- Network Quick View ----------

				Hydraulic Grade	
Label	Length	Size	Discharge	Upstream	Downstream
P-1	396.00	36 inch	26.00	122.05	121.45
P-3	408.00	36 inch	44.00	121.33	119.56
P-2	25.00	24 inch	18.00	121.61	121.45
P-4	25.00	30 inch	20.00	119.62	119.56
P-8	400.00	34x53 inch	84.00	112.51	110.30
P-10	76.00	38x60 inch	90.00	110.15	109.89
P-9	40.00	24 inch	6.00	110.33	110.30
P-11	40.00	24 inch	6.00	109.92	109.89
P-12	679.00	38x60 inch	96.00	109.72	107.10
P-17	400.00	38x60 inch	111.00	102.16	100.09
P-19	571.00	38x60 inch	116.00	99.84	96.61
P-13	30.00	24 inch	10.00	107.15	107.10
P-16	25.00	24 inch	5.00	102.40	102.39
P-18	25.00	24 inch	5.00	100.10	100.09
P-5	438.00	36 inch	64.00	119.30	115.27
P-6	422.00	34x53 inch	84.00	115.06	112.72
P-14	450.00	38x60 inch	106.00	106.89	104.76
P-15	460.00	38x60 inch	106.00	104.55	102.39
P-21	114.00	38x60 inch	121.00	96.55	96.37
P-22	30.00	38x60 inch	121.00	96.34	96.29

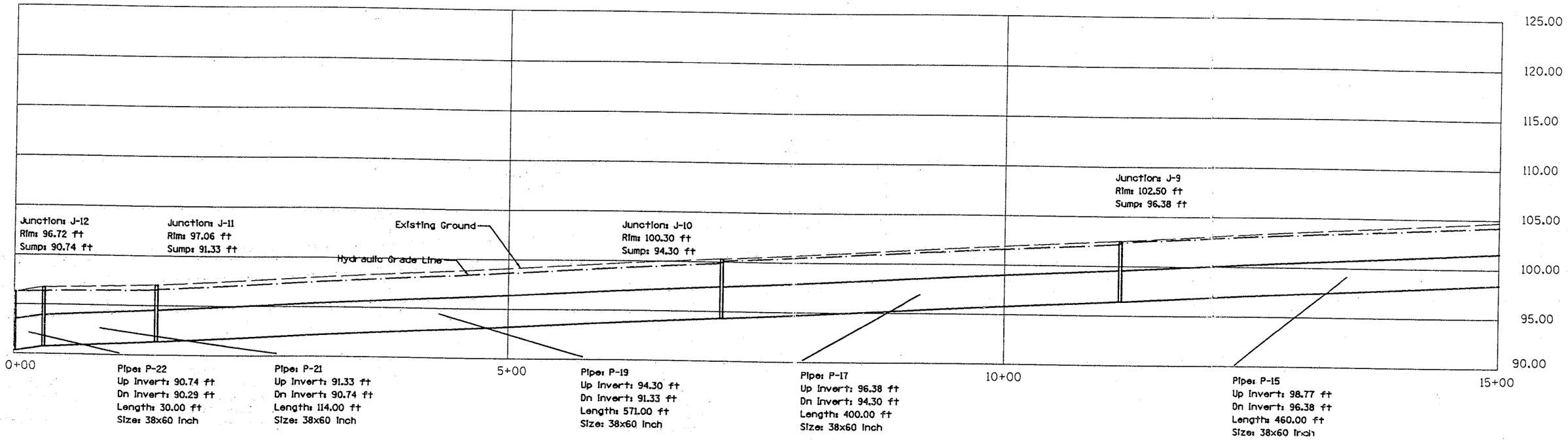
				Hydraulic Grade	
Label	Length	Size	Discharge	Upstream	Downstream
P-20	25.00	24 inch	5.00	96.63	96.61
P-7	20.00	24 inch	20.00	115.61	115.27

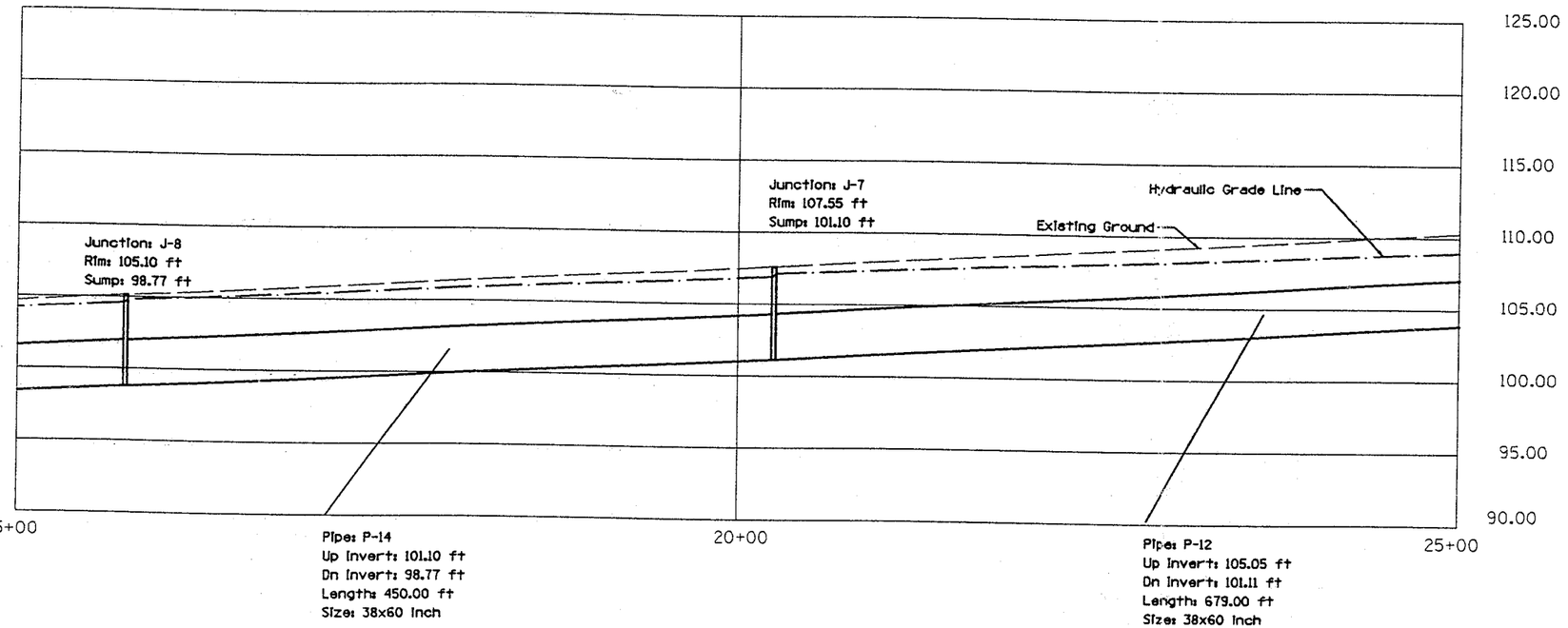
		Elevations		
Label	Discharge	Ground	Upstream HGL	Downstream HGL
I-1	26.00	122.27	122.10	122.05
J-1	44.00	122.71	121.45	121.33
J-2	64.00	121.75	119.56	119.30
I-2	18.00	122.71	121.87	121.61
I-3	20.00	121.75	119.74	119.62
J-4	84.00	114.80	112.72	112.51
J-5	90.00	111.58	110.30	110.15
J-6	96.00	111.43	109.89	109.72
I-5	6.00	111.58	110.36	110.33
I-6	6.00	111.43	109.95	109.92
J-7	106.00	107.55	107.10	106.89

J-9	111.00	102.50	102.39	102.16
J-10	116.00	100.30	100.09	99.84
Outlet	121.00	96.29	96.29	96.29
J-11	121.00	97.06	96.61	96.55
I-7	10.00	107.55	107.23	107.15
I-8	5.00	102.50	102.42	102.40
I-9	5.00	100.30	100.12	100.10
J-3	84.00	118.00	115.27	115.06
J-8	106.00	105.10	104.76	104.55

		Elevations	
Label	Discharge	Ground	Upstream HGL	Downstream HGL
J-12	121.00	96.72	96.37	96.34
I-10	5.00	97.06	96.63	96.63
I-4	20.00	118.00	115.78	115.61

Elapsed: 0 minute(s) 6 second(s)





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STORM DRAIN PROFILES

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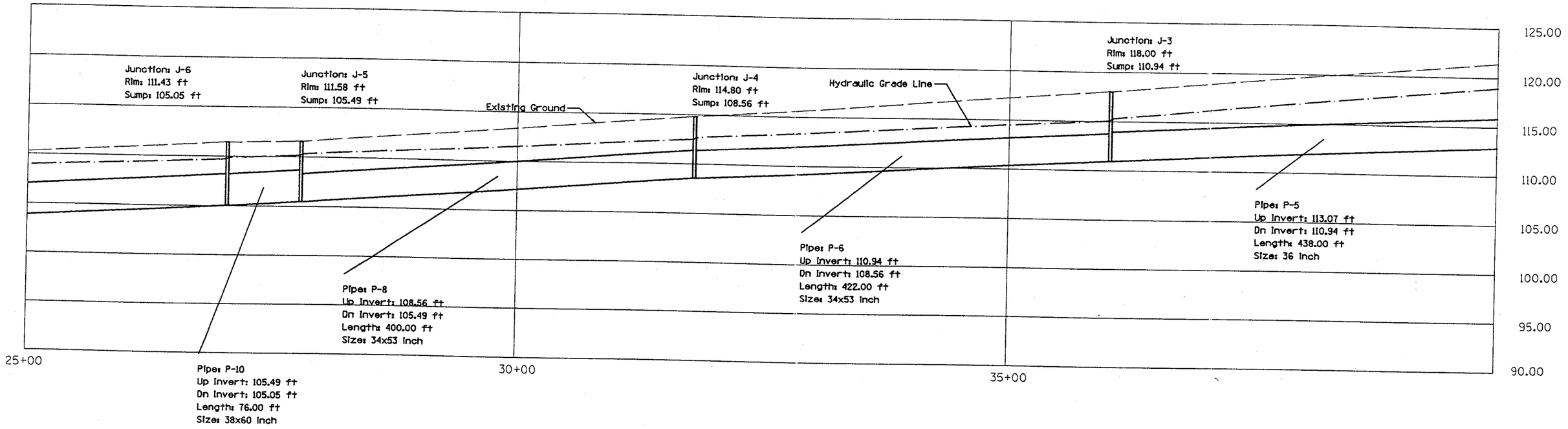

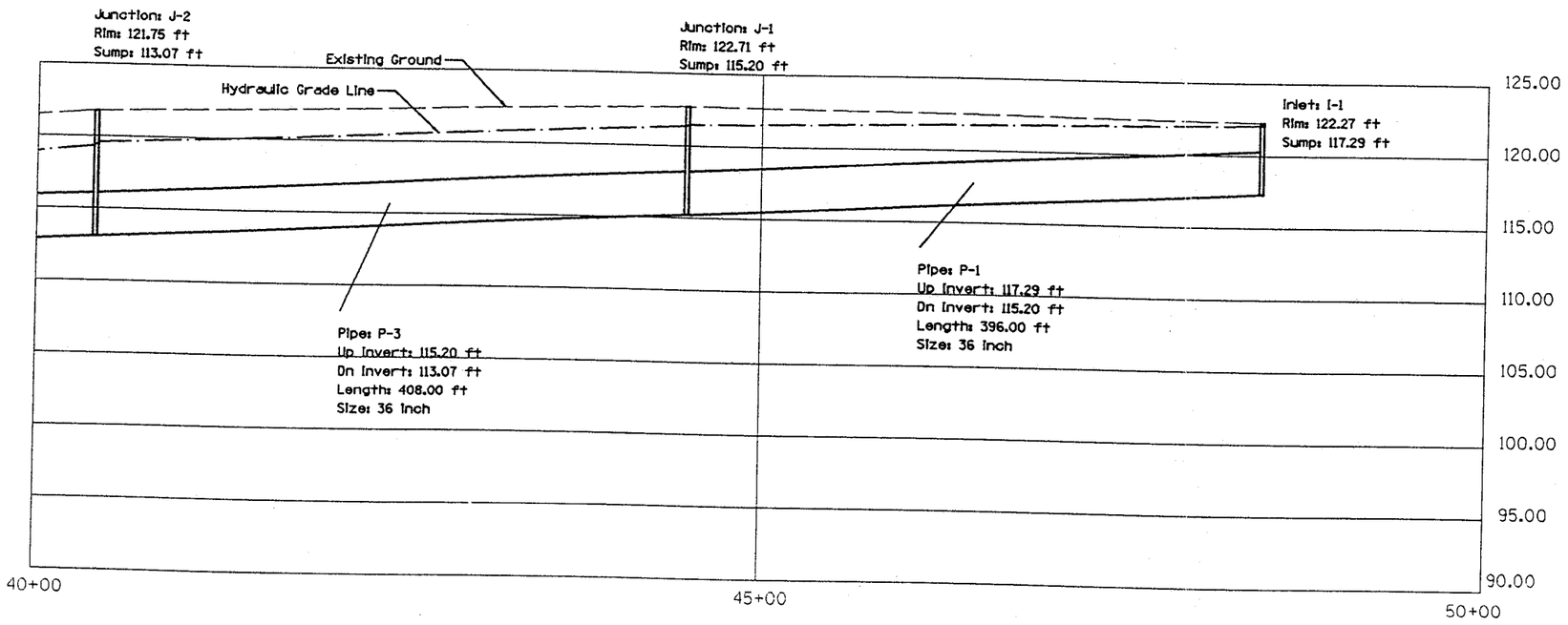

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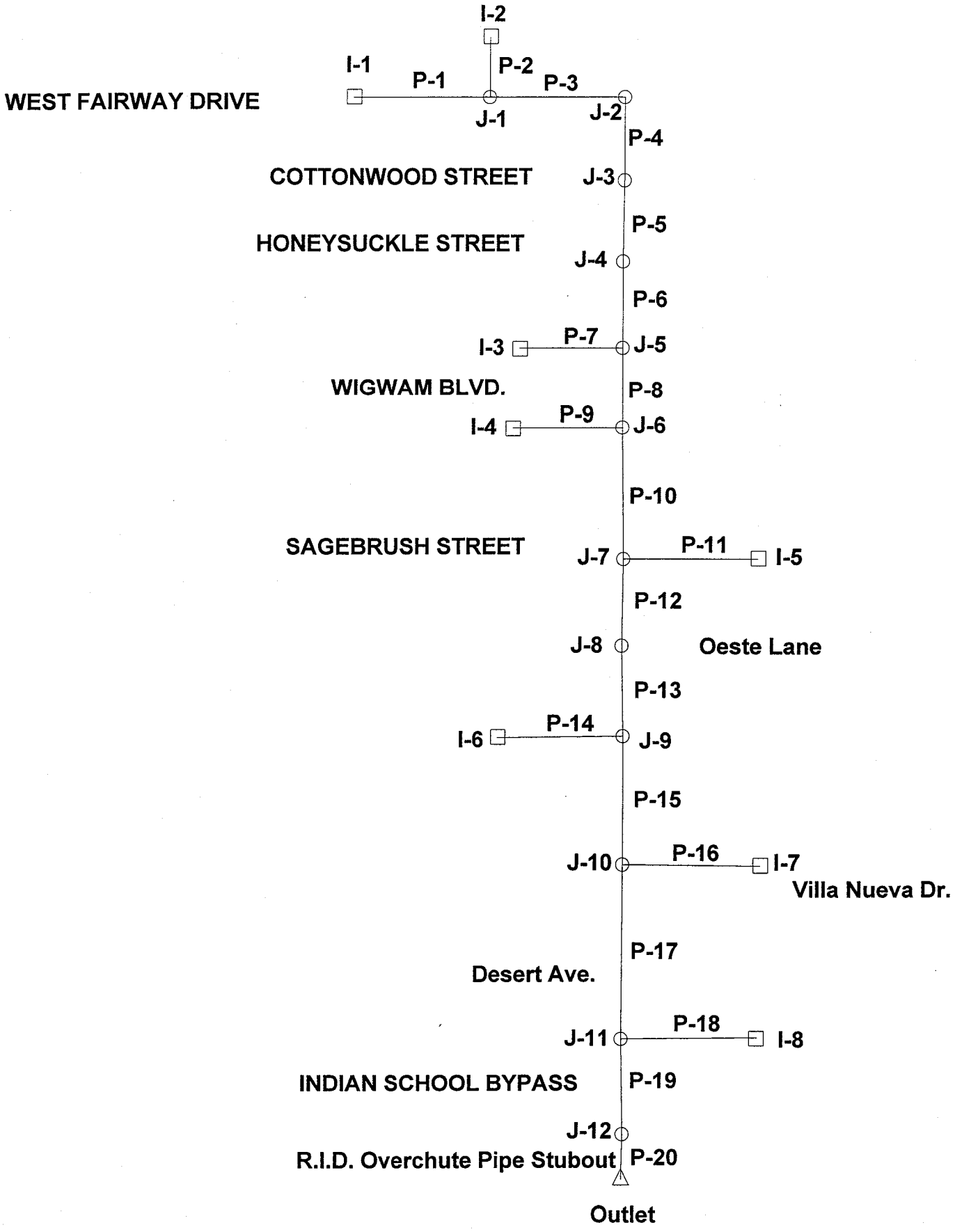
STORM DRAIN PROFILES

FILE: A1LITCH.STM SHT 2/ 2



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Combined Pipe/Node Report

Pipe	Upstream Node	Downstream Node	Upstream Ground Elevation (ft)	Upstream HGL (ft)	Downstream Ground Elevation (ft)	Downstream HGL (ft)	Upstream Invert Elevation (ft)	Downstream Invert Elevation (ft)	Constructed Slope (ft/ft)	Length (ft)	Section Size	Discharge (cfs)	Average Velocity (ft/s)	Pipe
P-18	I-8	J-11	97.06	96.58	97.06	96.57	93.06	91.33	0.069200	25.00	24 inch	5.00	1.59	P-18
P-16	I-7	J-10	100.30	99.95	100.30	99.94	96.30	94.30	0.080000	25.00	24 inch	5.00	1.59	P-16
P-11	I-5	J-7	107.55	106.32	107.55	106.31	103.55	101.11	0.081333	30.00	24 inch	5.00	1.59	P-11
P-9	I-4	J-6	111.43	109.00	111.43	108.98	107.43	105.05	0.059500	40.00	24 inch	10.00	3.49	P-9
P-7	I-3	J-5	111.58	109.97	111.58	109.80	107.58	105.49	0.052250	40.00	24 inch	15.00	4.77	P-7
P-2	I-2	J-1	122.71	120.67	122.71	120.51	118.71	115.20	0.140400	25.00	24 inch	18.00	5.74	P-2
P-1	I-1	J-1	122.27	122.11	122.71	120.51	117.29	115.20	0.005278	396.00	30 inch	26.00	5.30	P-1
P-3	J-1	J-2	122.71	120.26	121.75	115.57	115.20	113.07	0.005221	408.00	30 inch	44.00	8.96	P-3
P-4	J-2	J-3	121.75	115.40	118.00	113.32	113.07	110.94	0.004863	438.00	36 inch	44.00	7.40	P-4
P-5	J-3	J-4	118.00	113.12	114.80	111.65	110.94	108.56	0.005640	422.00	36 inch	44.00	7.11	P-5
P-6	J-4	J-5	114.80	111.53	111.58	109.80	108.56	105.49	0.007675	400.00	36 inch	44.00	6.23	P-6
P-8	J-5	J-6	111.58	109.58	111.43	108.98	105.49	105.05	0.005789	76.00	36 inch	59.00	8.35	P-8
P-10	J-6	J-7	111.43	108.84	107.55	106.31	105.05	101.11	0.005803	679.00	34x53 inch	69.00	6.76	P-10
P-12	J-7	J-8	107.55	106.15	105.10	104.22	101.10	98.77	0.005178	450.00	34x53 inch	74.00	7.25	P-12
P-13	J-8	J-9	105.10	104.05	102.50	102.08	98.77	96.38	0.005196	460.00	34x53 inch	74.00	7.25	P-13
P-14	I-6	J-9	102.50	102.09	102.50	102.08	98.50	96.38	0.084800	25.00	24 inch	5.00	1.59	P-14
P-15	J-9	J-10	102.50	101.89	100.30	99.94	96.38	94.30	0.005200	400.00	34x53 inch	79.00	7.75	P-15
P-17	J-10	J-11	100.30	99.73	97.06	96.57	94.30	91.33	0.005201	571.00	34x53 inch	84.00	8.24	P-17
P-19	J-11	J-12	97.06	96.51	96.72	96.33	91.33	90.74	0.005175	114.00	34x53 inch	89.00	4.36	P-19
P-20	J-12	Outlet	96.72	96.31	96.29	96.29	90.74	90.29	0.015000	30.00	38x60 inch	89.00	3.45	P-20

SHEET NO. 19

ASL Sierra Consulting Engineers, Inc.
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```
------------------ Beginning Calculation Cycle ------------------
Discharge: 5.00 cfs  at node I-6
Discharge: 26.00 cfs  at node I-1
Discharge: 18.00 cfs  at node I-2
Discharge: 44.00 cfs  at node J-1
Discharge: 44.00 cfs  at node J-2
Discharge: 44.00 cfs  at node J-3
Discharge: 44.00 cfs  at node J-4
Discharge: 15.00 cfs  at node I-3
Discharge: 59.00 cfs  at node J-5
Discharge: 10.00 cfs  at node I-4
Discharge: 69.00 cfs  at node J-6
Discharge: 5.00 cfs  at node I-5
Discharge: 74.00 cfs  at node J-7
Discharge: 74.00 cfs  at node J-8
Discharge: 79.00 cfs  at node J-9
Discharge: 5.00 cfs  at node I-7
Discharge: 84.00 cfs  at node J-10
Discharge: 5.00 cfs  at node I-8
Discharge: 89.00 cfs  at node J-11
Discharge: 89.00 cfs  at node J-12
Discharge: 89.00 cfs  at node Outlet
Beginning iteration 1
Discharge: 5.00 cfs  at node I-6
Discharge: 26.00 cfs  at node I-1
Discharge: 18.00 cfs  at node I-2
Discharge: 44.00 cfs  at node J-1
Discharge: 44.00 cfs  at node J-2
Discharge: 44.00 cfs  at node J-3
Discharge: 44.00 cfs  at node J-4
Discharge: 15.00 cfs  at node I-3
Discharge: 59.00 cfs  at node J-5
Discharge: 10.00 cfs  at node I-4
Discharge: 69.00 cfs  at node J-6
Discharge: 5.00 cfs  at node I-5
Discharge: 74.00 cfs  at node J-7
Discharge: 74.00 cfs  at node J-8
Discharge: 79.00 cfs  at node J-9
Discharge: 5.00 cfs  at node I-7
Discharge: 84.00 cfs  at node J-10
Discharge: 5.00 cfs  at node I-8
Discharge: 89.00 cfs  at node J-11
Discharge: 89.00 cfs  at node J-12
Discharge: 89.00 cfs  at node Outlet
Discharge Convergence Achieved in 1 iterations: relative error:  0.0
Warning: No Duration data exists in IDF Table
Information: Outlet Known flow propagated from upstream junctions.
Information: P-20 Surcharged condition
Information: J-12 Known flow propagated from upstream junctions.
Information: P-19 Surcharged condition
Information: J-11 Known flow propagated from upstream junctions.
Information: P-17 Surcharged condition
Information: P-18 Surcharged condition
Information: J-10 Known flow propagated from upstream junctions.
Information: P-15 Surcharged condition
Information: P-16 Surcharged condition
Information: J-9 Known flow propagated from upstream junctions.
Information: P-14 Surcharged condition
Information: P-13 Surcharged condition
Information: J-8 Known flow propagated from upstream junctions.
Information: P-12 Surcharged condition
Information: J-7 Known flow propagated from upstream junctions.
Information: P-10 Surcharged condition
Information: P-11 Surcharged condition
Information: J-6 Known flow propagated from upstream junctions.
Information: P-8 Surcharged condition
Information: J-5 Known flow propagated from upstream junctions.
Information: P-7 Surcharged condition
Information: J-4 Known flow propagated from upstream junctions.
```

Information: J-3 Known flow propagated from upstream junctions.
Information: J-2 Known flow propagated from upstream junctions.
Information: J-1 Known flow propagated from upstream junctions.
Information: P-1 Surcharged condition
---------- Calculations Complete ----------

** Analysis Options **
Friction method: Manning's Formula
HGL Convergence Test: 0.001000
Maximum Network Traversals: 5
Number of Flow Profile Steps: 5
Discharge Convergence Test: 0.001000
Maximum Design Passes: 3

---------- Network Quick View ----------

				Hydraulic Grade	
Label	Length	Size	Discharge	Upstream	Downstream
P-1	396.00	30 inch	26.00	122.11	120.51
P-3	408.00	30 inch	44.00	120.26	115.57
P-2	25.00	24 inch	18.00	120.67	120.51
P-6	400.00	36 inch	44.00	111.53	109.80
P-8	76.00	36 inch	59.00	109.58	108.98
P-7	40.00	24 inch	15.00	109.97	109.80
P-9	40.00	24 inch	10.00	109.00	108.98
P-10	679.00	34x53 inch	69.00	108.84	106.31
P-15	400.00	34x53 inch	79.00	101.89	99.94
P-17	571.00	34x53 inch	84.00	99.73	96.57
P-11	30.00	24 inch	5.00	106.32	106.31
P-14	25.00	24 inch	5.00	102.09	102.08
P-16	25.00	24 inch	5.00	99.95	99.94
P-4	438.00	36 inch	44.00	115.40	113.32
P-5	422.00	36 inch	44.00	113.12	111.65
P-12	450.00	34x53 inch	74.00	106.15	104.22
P-13	460.00	34x53 inch	74.00	104.05	102.08
P-19	114.00	34x53 inch	89.00	96.51	96.33
P-20	30.00	38x60 inch	89.00	96.31	96.29
P-18	25.00	24 inch	5.00	96.58	96.57

		Elevations		
Label	Discharge	Ground	Upstream HGL	Downstream HGL
I-1	26.00	122.27	122.19	122.11
J-1	44.00	122.71	120.51	120.26
J-2	44.00	121.75	115.57	115.40
I-2	18.00	122.71	120.92	120.67
J-4	44.00	114.80	111.65	111.53
J-5	59.00	111.58	109.80	109.58
J-6	69.00	111.43	108.98	108.84
I-3	15.00	111.58	110.15	109.97
I-4	10.00	111.43	109.11	109.00
J-7	74.00	107.55	106.31	106.15
J-9	79.00	102.50	102.08	101.89
J-10	84.00	100.30	99.94	99.73
Outlet	89.00	96.29	96.29	96.29
J-11	89.00	97.06	96.57	96.51
I-5	5.00	107.55	106.34	106.32
I-6	5.00	102.50	102.11	102.09
I-7	5.00	100.30	99.97	99.95
J-3	44.00	118.00	113.32	113.12
J-8	74.00	105.10	104.22	104.05
J-12	89.00	96.72	96.33	96.31

		Elevations		
Label	Discharge	Ground	Upstream HGL	Downstream HGL
I-8	5.00	97.06	96.58	96.58

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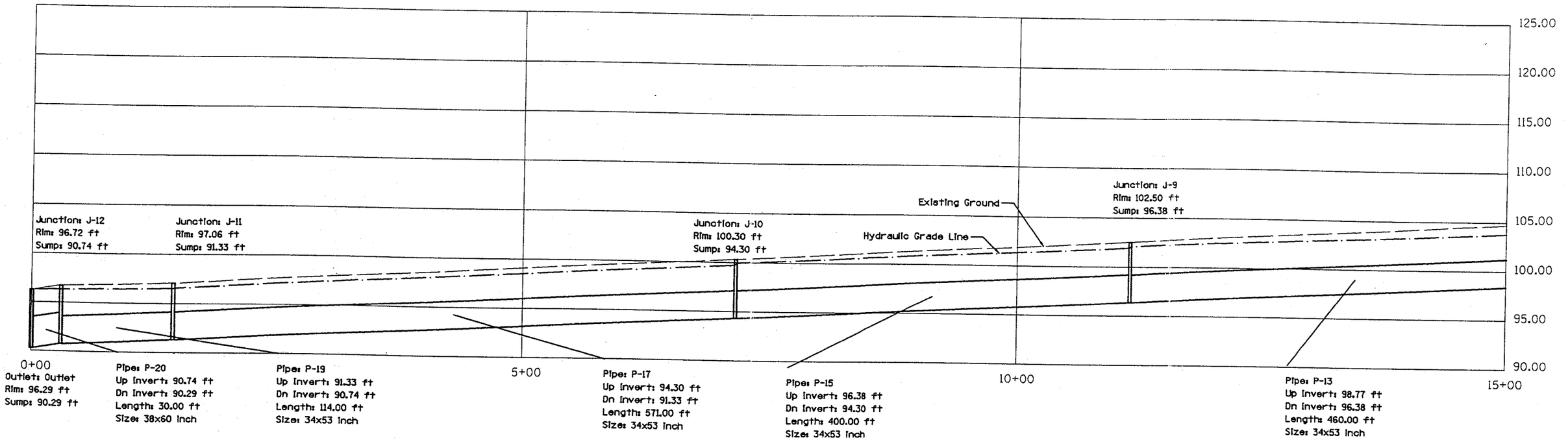

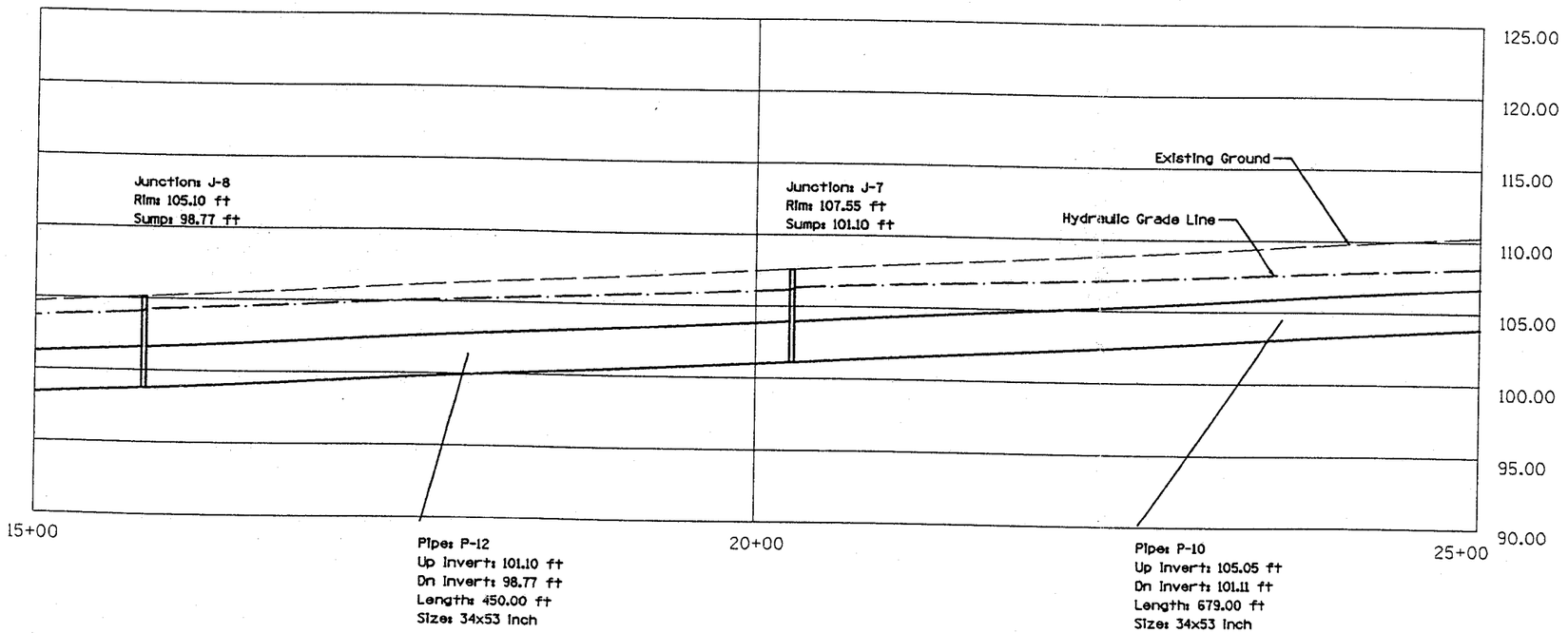

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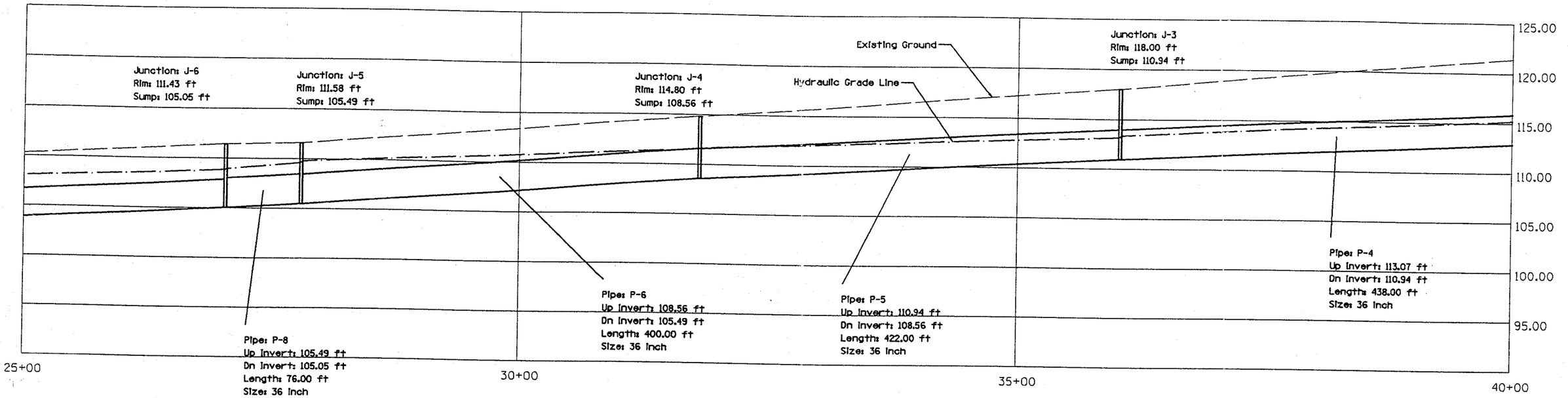
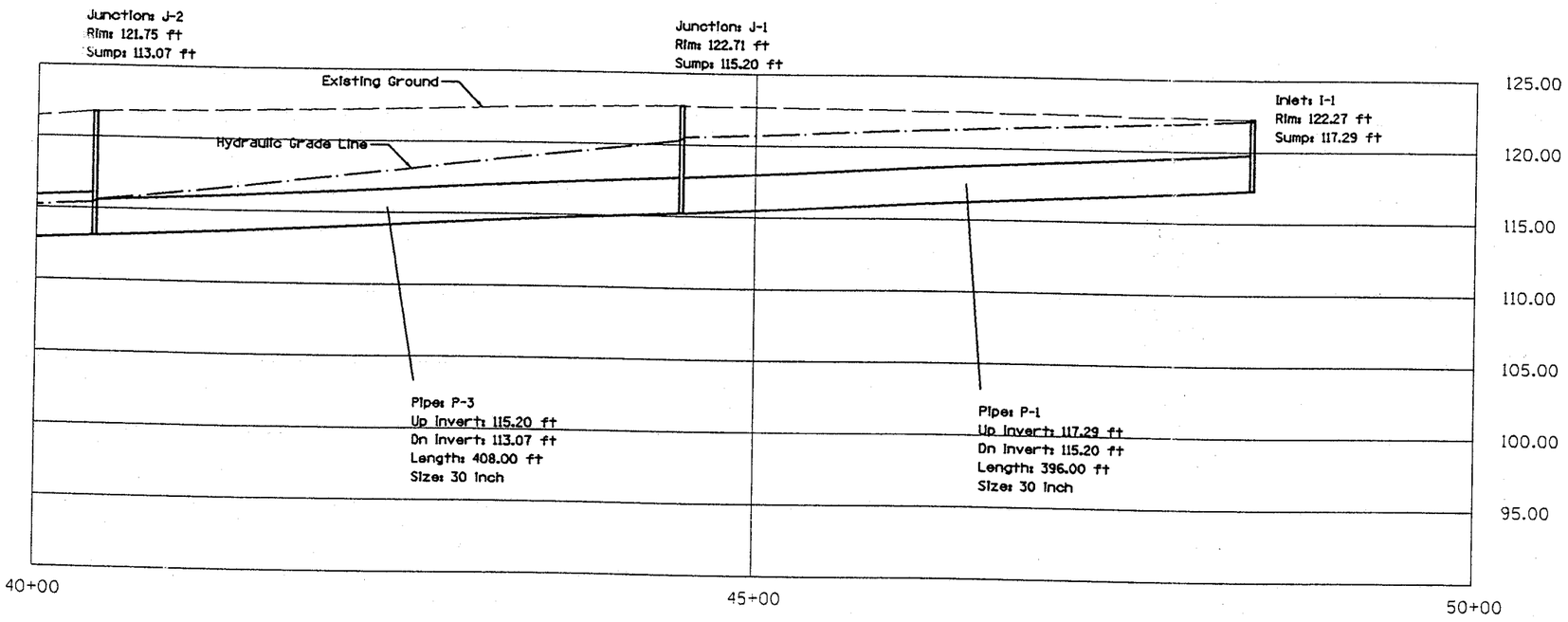
STORM DRAIN PROFILES

FILE: A2LITCH.STM SHT 1/ 2





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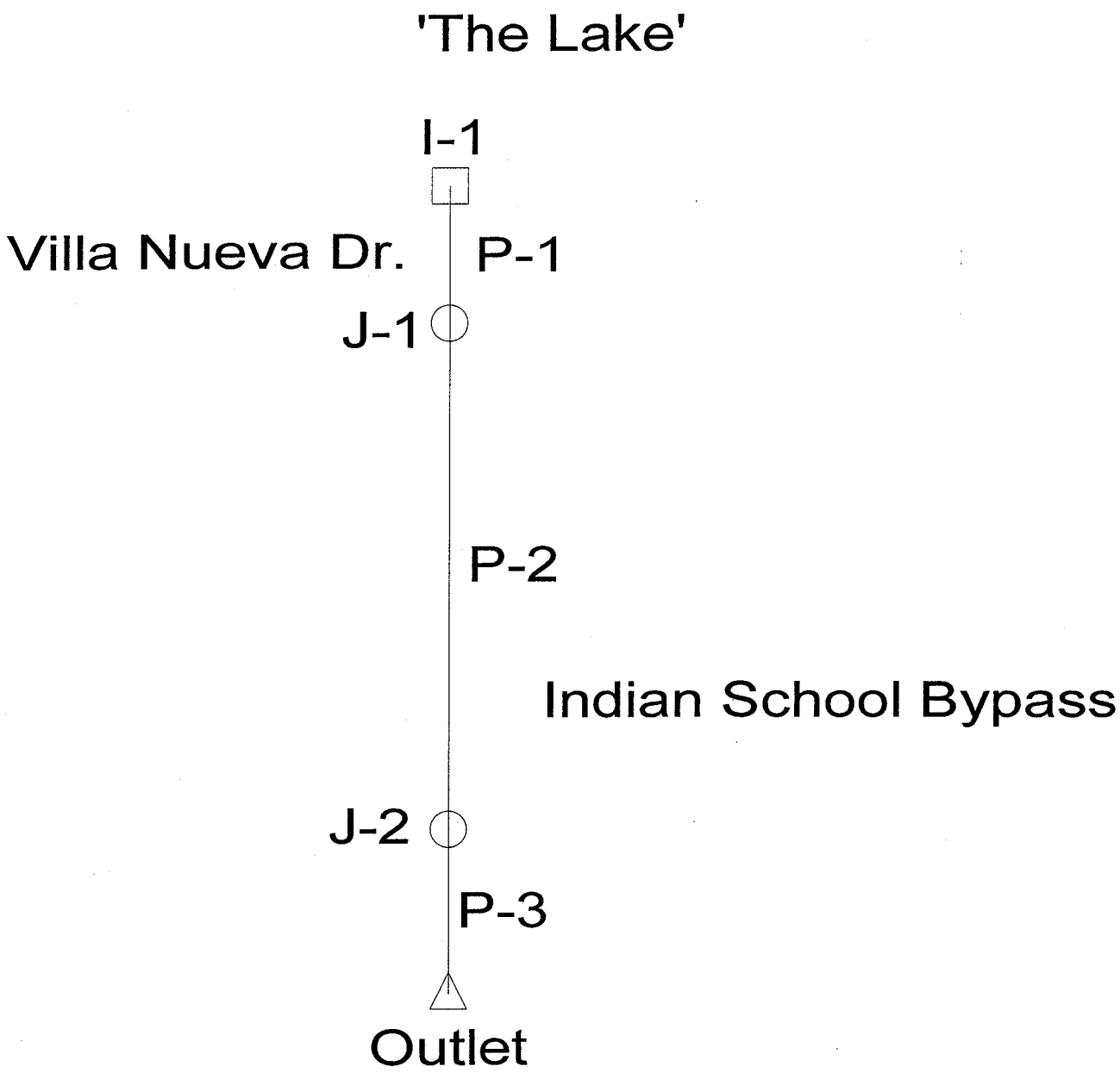
STORM DRAIN PROFILES

FILE: A2LITCH.STM SHT 2/ 2



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Combined Pipe/Node Report

Pipe	Upstream Node	Downstream Node	Upstream Ground Elevation (ft)	Upstream HGL (ft)	Downstream Ground Elevation (ft)	Downstream HGL (ft)	Upstream Invert Elevation (ft)	Downstream Invert Elevation (ft)	Constructed Slope (ft/ft)	Length (ft)	Section Size	Discharge (cfs)	Average Velocity (ft/s)	Pipe
P-1	I-1	J-1	99.90	99.77	100.00	99.21	95.40	94.65	0.005357	140.00	34x53 inch	71.00	6.96	P-1
P-2	J-1	J-2	100.00	98.84	96.22	96.29	94.65	90.74	0.006062	645.00	34x53 inch	71.00	6.96	P-2
P-3	J-2	Outlet	96.22	96.30	96.50	96.29	90.74	90.29	0.015000	30.00	38x60 inch	71.00	1.83	P-3

SHEET NO. 25

ASL Sierra Consulting Engineers, Inc.
37 Brookside Road Waterbury, CT 06708 USA (203) 755-1666

```
------------------ Beginning Calculation Cycle ------------------
Discharge: 71.00 cfs  at node I-1
Discharge: 71.00 cfs  at node J-1
Discharge: 71.00 cfs  at node J-2
Discharge: 71.00 cfs  at node Outlet
Beginning iteration 1
Discharge: 71.00 cfs  at node I-1
Discharge: 71.00 cfs  at node J-1
Discharge: 71.00 cfs  at node J-2
Discharge: 71.00 cfs  at node Outlet
Discharge Convergence Achieved in 1 iterations: relative error:  0.0
** Problem: Flooding in system
Warning: No Duration data exists in IDF Table
Information: Outlet Known flow propagated from upstream junctions.
Information: P-3 Surcharged condition
Information: J-2 The hydraulic grade exceeds the Rim/Ground elevation
Information: J-2 Flooding condition.
Information: J-2 Known flow propagated from upstream junctions.
Information: P-2 Surcharged condition
Information: J-1 Known flow propagated from upstream junctions.
Information: P-1 Surcharged condition
--------------------- Calculations Complete ---------------------

** Analysis Options **
Friction method:  Manning's Formula
HGL Convergence Test:  0.001000
Maximum Network Traversals:  5
Number of Flow Profile Steps:  5
Discharge Convergence Test:  0.001000
Maximum Design Passes:  3


----------------- Network Quick View ------------------------
```

				Hydraulic Grade	
Label	Length	Size	Discharge	Upstream	Downstream
P-3	30.00	38x60 inch	71.00	96.30	96.29
P-1	140.00	34x53 inch	71.00	99.77	99.21
P-2	645.00	34x53 inch	71.00	98.84	96.29

		Elevations		
Label	Discharge	Ground	Upstream HGL	Downstream HGL
I-1	71.00	99.90	99.77	99.77
J-2	71.00	96.22	96.29	96.29
Outlet	71.00	96.50	96.29	96.29
J-1	71.00	100.00	99.21	98.84

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Elapsed: 0 minute(s) 1 second(s)
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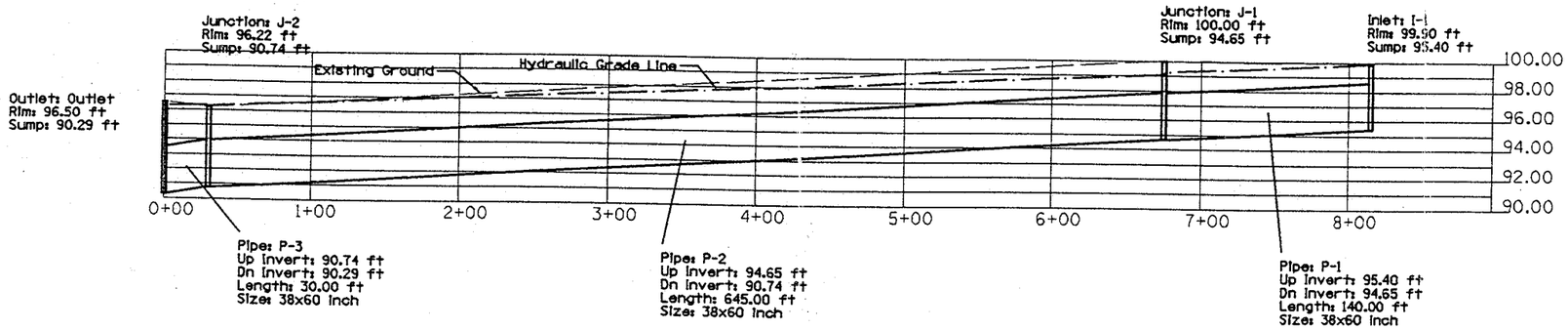

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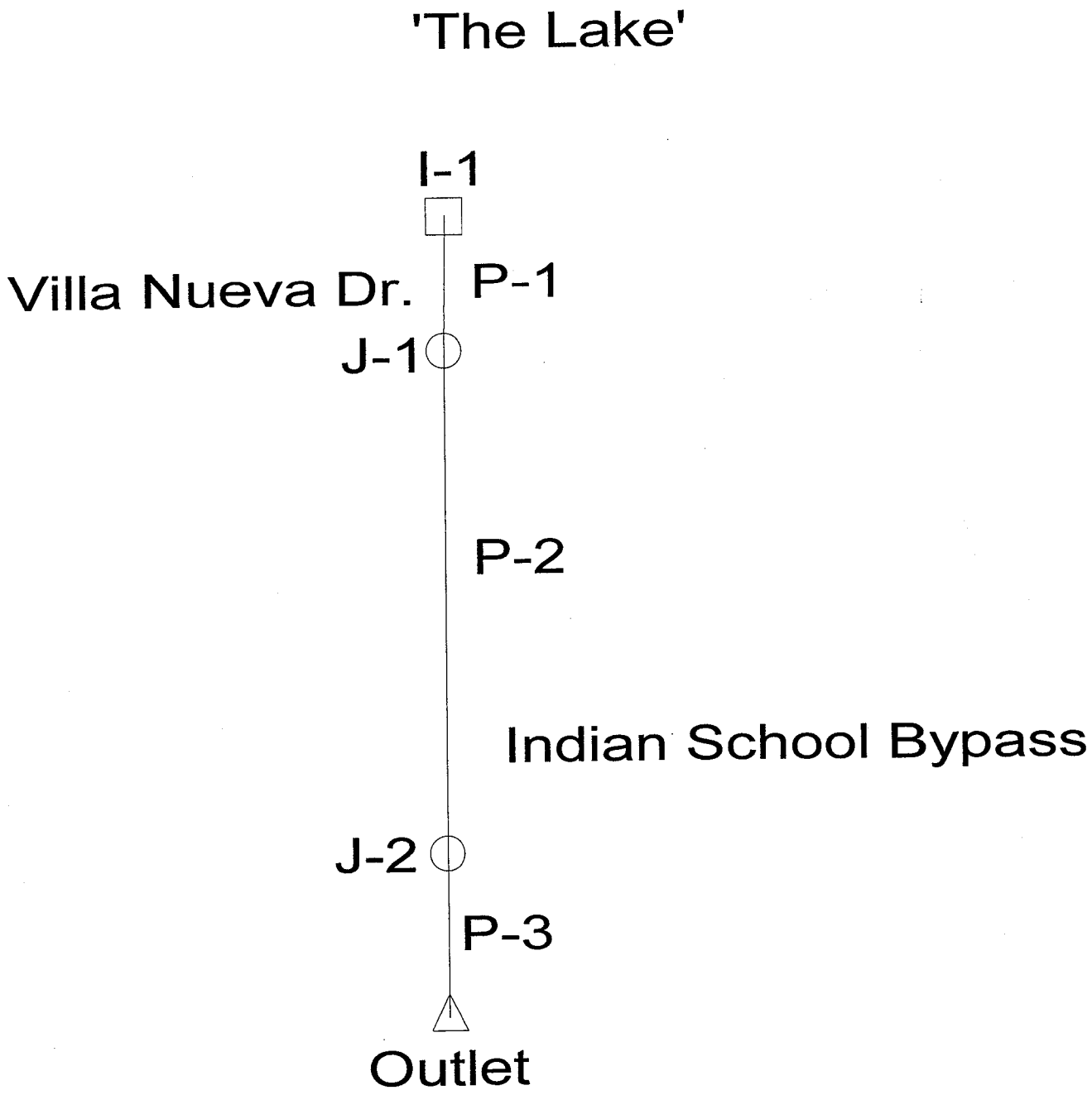
STORM DRAIN PROFILES

FILE: A1LAKE.STM SHT 1/1



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37 Brookside Road Waterbury, CT 06708 USA (203) 755-1666

Combined Pipe/Node Report

Pipe	Upstream Node	Downstream Node	Upstream Ground Elevation (ft)	Upstream HGL (ft)	Downstream Ground Elevation (ft)	Downstream HGL (ft)	Upstream Invert Elevation (ft)	Downstream Invert Elevation (ft)	Constructed Slope (ft/ft)	Length (ft)	Section Size	Discharge (cfs)	Average Velocity (ft/s)	Pipe
P-1	I-1	J-1	99.90	99.84	100.00	99.24	95.40	94.65	0.005357	140.00	38x60 inch	101.00	7.83	P-1
P-2	J-1	J-2	100.00	99.05	96.22	96.29	94.65	90.74	0.006062	645.00	38x60 inch	101.00	7.83	P-2
P-3	J-2	Outlet	96.22	96.30	96.50	96.29	90.74	90.29	0.015000	30.00	38x60 inch	101.00	2.61	P-3

SHEET NO. 29

ASL Sierra Consulting Engineers, Inc.
37 Brookside Road Waterbury, CT 06708 USA (203) 755-1666

```
------------------ Beginning Calculation Cycle ------------------
Discharge: 101.00 cfs  at node I-1
Discharge: 101.00 cfs  at node J-1
Discharge: 101.00 cfs  at node J-2
Discharge: 101.00 cfs  at node Outlet
Beginning iteration 1
Discharge: 101.00 cfs  at node I-1
Discharge: 101.00 cfs  at node J-1
Discharge: 101.00 cfs  at node J-2
Discharge: 101.00 cfs  at node Outlet
Discharge Convergence Achieved in 1 iterations: relative error:  0.0
** Problem: Flooding in system
Warning: No Duration data exists in IDF Table
Information: Outlet Known flow propagated from upstream junctions.
Information: P-3 Surcharged condition
Information: J-2 The hydraulic grade exceeds the Rim/Ground elevation
Information: J-2 Flooding condition.
Information: J-2 Known flow propagated from upstream junctions.
Information: P-2 Surcharged condition
Information: J-1 Known flow propagated from upstream junctions.
Information: P-1 Surcharged condition
--------------------- Calculations Complete ----------------------

** Analysis Options **
Friction method:  Manning's Formula
HGL Convergence Test:  0.001000
Maximum Network Traversals:  5
Number of Flow Profile Steps:  5
Discharge Convergence Test:  0.001000
Maximum Design Passes:  3


 ----------------- Network Quick View  ------------------------
```

				Hydraulic Grade	
Label	Length	Size	Discharge	Upstream	Downstream
P-3	30.00	38x60 inch	101.00	96.30	96.29
P-1	140.00	38x60 inch	101.00	99.84	99.24
P-2	645.00	38x60 inch	101.00	99.05	96.29

		Elevations		
Label	Discharge	Ground	Upstream HGL	Downstream HGL
I-1	101.00	99.90	99.84	99.84
J-2	101.00	96.22	96.29	96.29
Outlet	101.00	96.50	96.29	96.29
J-1	101.00	100.00	99.24	99.05

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Elapsed: 0 minute(s) 1 second(s)
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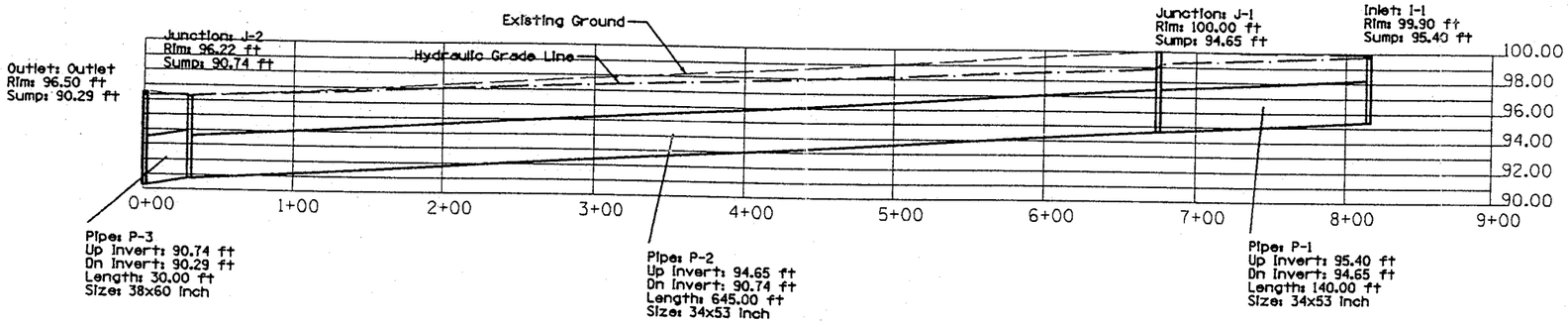

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STORM DRAIN PROFILES

FILE: A2LAKE.STM SHT 1/ 1

APPENDIX IV

Detailed Engineers Estimates

ENGINEERS ESTIMATE
ALTERNATE NO. 1 - PHASE I-V

LITCHFIELD ROAD AND NEOLIN AVE.
DRAINAGE IMPROVEMENTS

12-Feb-98

PHASE I - FROM THE RID OVERCHUTE THROUGH LAKE TO NEOLIN AND SAGEBRUSH AND 700 FEET OF LITCHFIELD ROAD BEGINNING AT THE RID OVERCHUTE

ITEM NO.	DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
1	PAVEMENT REMOVAL	SY	1,740	$2.00	$3,480.00
2	PAVEMENT REPLACEMENT	SY	1,740	$15.00	$26,100.00
3	38" x 60" ELLIPTICAL RCP (W/ EX. AND BACKFILL)	LF	2,253	$115.00	$259,095.00
4	34" x 53" ELLIPTICAL RCP (W/ EX. AND BACKFILL)	LF	1,013	$95.00	$96,235.00
5	24" RGRCP (W/EX. AND BACKFILL)	LF	232	$55.00	$12,760.00
6	STORM DRAIN MANHOLE	EA	9	$3,500.00	$31,500.00
7	CURB OPENING INLET	EA	8	$3,000.00	$24,000.00
8	OUTLET HEADWALL INTO 'THE LAKE'	EA	1	$3,000.00	$3,000.00
9	WEIR STRUCTURE (FOR 'THE LAKE')	EA	2	$3,500.00	$7,000.00
10	EXISTING CART PATH REMOVAL	SY	1,300	$3.00	$3,900.00
11	CART PATH/ SWALE (6" CONCRETE)	SY	1,450	$35.00	$50,750.00
12	6" CURB AND GUTTER	LF	480	$15.00	$7,200.00
13	WATERLINE VERTICAL RELOCATION	EA	4	$2,000.00	$8,000.00
14	SEWER CROSSING	EA	2	$2,000.00	$4,000.00
15	UTILITY RELOCATIONS	LS	1	$5,000.00	$5,000.00
16	MISCELLANEOUS REMOVALS	LS	1	$10,000.00	$10,000.00
17	CONSTRUCTION ENGINEERING	LS	1	$55,200.00	$55,200.00
18	CONTINGENCIES	LS	1	$55,200.00	$55,200.00

PHASE I TOTAL **$662,420.00**

PHASE IIA - NEOLIN AVE. FROM SAGEBRUSH ST. TO WIGWAM BLVD.

NO.	DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
1	PAVEMENT REMOVAL	SY	950	$2.00	$1,900.00
2	PAVEMENT REPLACEMENT	SY	950	$15.00	$14,250.00
3	34" x 53" ELLIPTICAL RCP (W/ EX. AND BACKFILL)	LF	723	$95.00	$68,685.00
4	24" RGRCP (W/EX. AND BACKFILL)	LF	412	$55.00	$22,660.00
5	STORM DRAIN MANHOLE	EA	3	$3,500.00	$10,500.00
6	CURB OPENING INLET	EA	8	$3,000.00	$24,000.00
7	WATERLINE VERTICAL RELOCATION	EA	2	$2,000.00	$4,000.00
8	SEWER CROSSING	EA	1	$2,000.00	$2,000.00
9	UTILITY RELOCATIONS	LS	1	$3,000.00	$3,000.00
10	MISCELLANEOUS REMOVALS	LS	1	$3,000.00	$3,000.00
11	CONSTRUCTION ENGINEERING	LS	1	$15,400.00	$15,400.00
12	CONTINGENCIES	LS	1	$15,400.00	$15,400.00

PHASE IIA TOTAL **$184,795.00**

PHASE IIB - LITCHFIELD ROAD FROM VILLA NUEVA DR. TO SAGEBRUSH ST.

NO.	DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
1	PAVEMENT REMOVAL	SY	1,330	$2.00	$2,660.00
2	PAVEMENT REPLACEMENT	SY	1,330	$15.00	$19,950.00
3	38" x60" ELLIPTICAL RCP (W/ EX. AND BACKFILL)	LF	1,250	$115.00	$143,750.00
4	24" RGRCP (W/EX. AND BACKFILL)	LF	125	$55.00	$6,875.00
5	STORM DRAIN MANHOLE	EA	3	$3,500.00	$10,500.00
6	CURB OPENING INLET	EA	4	$3,000.00	$12,000.00
7	WATERLINE VERTICAL RELOCATION	EA	1	$2,000.00	$2,000.00
8	SEWER CROSSING	EA	2	$2,000.00	$4,000.00
9	UTILITY RELOCATIONS	LS	1	$3,000.00	$3,000.00
10	MISCELLANEOUS REMOVALS	LS	1	$3,000.00	$3,000.00
11	CONSTRUCTION ENGINEERING	LS	1	$20,800.00	$20,800.00
12	CONTINGENCIES	LS	1	$20,800.00	$20,800.00

PHASE IIB TOTAL **$249,335.00**

COMBINED PHASE IIA & IIB TOTAL **$434,130.00**

PHASE III - LITCHFIELD ROAD FROM SAGEBRUSH ST. TO HONEYSUCKLE ST.

ITEM NO.	DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
1	PAVEMENT REMOVAL	SY	1,320	$2.00	$2,640.00
2	PAVEMENT REPLACEMENT	SY	1,320	$15.00	$19,800.00
3	38" x 60" ELLIPTICALRCP (W/ EX. AND BACKFILL)	LF	750	$115.00	$86,250.00
4	34" x 53" ELLIPTICAL RCP (W/ EX. AND BACKFILL)	LF	410	$95.00	$38,950.00
5	24" RGRCP (W/EX. AND BACKFILL)	LF	280	$55.00	$15,400.00
6	STORM DRAIN MANHOLE	EA	3	$3,500.00	$10,500.00
7	CURB OPENING INLET	EA	3	$3,000.00	$9,000.00
8	WATERLINE VERTICAL RELOCATION	EA	5	$2,000.00	$10,000.00
9	SEWER CROSSING	EA	3	$2,000.00	$6,000.00
10	UTILITY RELOCATIONS	LS	1	$3,000.00	$3,000.00
11	MISCELLANEOUS REMOVALS	LS	1	$3,000.00	$3,000.00
12	CONSTRUCTION ENGINEERING	LS	1	$20,500.00	$20,500.00
13	CONTINGENCIES	LS	1	$20,500.00	$20,500.00

PHASE III TOTAL **$245,540.00**

PHASE IV - LITCHFIELD RD. FROM HONEYSUCKLE ST. TO FAIRWAY DRIVE AND FAIRWAY DRIVE TO LA LOMA AVE

ITEM NO.	DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
1	PAVEMENT REMOVAL	SY	1,050	$2.00	$2,100.00
2	PAVEMENT REPLACEMENT	SY	1,050	$15.00	$15,750.00
4	34" x 53" ELLIPTICAL RCP (W/ EX. AND BACKFILL)	LF	404	$95.00	$38,380.00
3	36" RGRCP (W/EX. AND BACKFILL)	LF	1,096	$70.00	$76,720.00
4	24" RGRCP (W/EX. AND BACKFILL)	LF	400	$55.00	$22,000.00
5	STORM DRAIN MANHOLE	EA	4	$3,500.00	$14,000.00
6	CURB OPENING INLET	EA	8	$3,000.00	$24,000.00
8	WATERLINE VERTICAL RELOCATION	EA	5	$2,000.00	$10,000.00
9	SEWER CROSSING	EA	1	$2,000.00	$2,000.00
7	UTILITY RELOCATIONS	LS	1	$3,000.00	$3,000.00
8	MISCELLANEOUS REMOVALS	LS	1	$2,000.00	$2,000.00
12	CONSTRUCTION ENGINEERING	LS	1	$21,000.00	$21,000.00
9	CONTINGENCIES	LS	1	$21,000.00	$21,000.00

PHASE IV TOTAL **$251,950.00**

PHASE V - NEOLIN AVE. FROM WIGWAM BLVD. TO THE AIRLINE CANAL (W/ CHANNEL ON THE GOLF COURSE)

ITEM NO.	DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
1	PAVEMENT REMOVAL	SY	960	$2.00	$1,920.00
2	PAVEMENT REPLACEMENT	SY	960	$15.00	$14,400.00
3	36" RGRCP (W/EX. AND BACKFILL)	LF	1,207	$70.00	$84,490.00
4	24" RGRCP (W/EX. AND BACKFILL)	LF	32	$55.00	$1,760.00
5	STORM DRAIN MANHOLE	EA	3	$3,500.00	$10,500.00
6	CURB OPENING INLET	EA	2	$3,000.00	$6,000.00
7	CONSTRUCT CHANNEL (EXCAVATION & GRADING)	CY	1,200	$2.00	$2,400.00
7	INSTALL GRASS IN CHANNEL	SY	4,700	$3.00	$14,100.00
8	WATERLINE VERTICAL RELOCATION	EA	3	$2,000.00	$6,000.00
9	SEWER CROSSING	EA	3	$2,000.00	$6,000.00
8	UTILITY RELOCATIONS	LS	1	$3,000.00	$3,000.00
9	MISCELLANEOUS REMOVALS	LS	1	$3,000.00	$3,000.00
12	CONSTRUCTION ENGINEERING	LS	1	$15,400.00	$15,400.00
10	CONTINGENCIES	LS	1	$15,400.00	$15,400.00
				PHASE V TOTAL	$184,370.00

CONSTRUCTION TOTAL	$1,778,410.00
PREDESIRN STUDY	$40,000.00
PUBLIC INVOLVEMENT	$15,000.00
ENGINEERING	$134,740.00
PROJECT GRAND TOTAL	$1,968,150.00

ENGINEERS ESTIMATE
ALTERNATE NO. 2 - PHASE I - V

LITCHFIELD ROAD AND NEOLIN AVE
DRAINAGE IMPROVEMENTS

12-Feb-98

PHASE I - FROM THE RID OVERCHUTE THROUGH LAKE TO NEOLIN AND SAGEBRUSH AND 700 FEET OF LITCHFIELD ROAD BEGINNING AT THE RID OVERCHUTE

ITEM NO.	DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
1	PAVEMENT REMOVAL	SY	4,590	$2.00	$9,180.00
2	PAVEMENT REPLACEMENT	SY	4,590	$15.00	$68,850.00
3	34" x 53" ELLIPTICAL RCP (W/ EX. AND BACKFILL)	LF	3,298	$95.00	$313,310.00
4	24" RGRCP (W/EX. AND BACKFILL)	LF	232	$55.00	$12,760.00
5	STORM DRAIN MANHOLE	EA	9	$3,500.00	$31,500.00
6	CURB OPENING INLET	EA	8	$3,000.00	$24,000.00
7	OUTLET HEADWALL INTO 'THE LAKE'	EA	1	$3,000.00	$3,000.00
8	WEIR STRUCTURE (FOR 'THE LAKE')	EA	2	$3,500.00	$7,000.00
9	EXISTING CART PATH REMOVAL	SY	1,300	$3.00	$3,900.00
10	CART PATH/ SWALE (6" CONCRETE)	SY	1,450	$35.00	$50,750.00
11	6" CURB AND GUTTER	LF	1,265	$15.00	$18,975.00
12	WATERLINE VERTICAL RELOCATION	EA	4	$2,000.00	$8,000.00
13	SEWER CROSSING	EA	2	$2,000.00	$4,000.00
14	UTILITY RELOCATIONS	LS	1	$5,000.00	$5,000.00
15	MISCELLANEOUS REMOVALS	LS	1	$10,000.00	$10,000.00
16	CONSTRUCTION ENGINEERING	LS	1	$57,000.00	$57,000.00
17	CONTINGENCIES	LS	1	$57,000.00	$57,000.00

PHASE I TOTAL **$684,225.00**

PHASE IIA - NEOLIN AVE. FROM SAGEBRUSH ST. TO WIGWAM BLVD.

NO.	DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
1	PAVEMENT REMOVAL	SY	3,600	$2.00	$7,200.00
2	PAVEMENT REPLACEMENT	SY	3,600	$15.00	$54,000.00
3	34" x 53" ELLIPTICAL RCP (W/ EX. AND BACKFILL)	LF	340	$95.00	$32,300.00
4	36" RGRCP (W/EX. AND BACKFILL)	LF	242	$70.00	$16,940.00
5	30" RGRCP (W/EX. AND BACKFILL)	LF	132	$60.00	$7,920.00
6	24" RGRCP (W/EX. AND BACKFILL)	LF	412	$55.00	$22,660.00
7	STORM DRAIN MANHOLE	EA	3	$3,500.00	$10,500.00
8	CURB OPENING INLET	EA	8	$3,000.00	$24,000.00
9	WATERLINE VERTICAL RELOCATION	EA	2	$2,000.00	$4,000.00
10	SEWER CROSSING	EA	1	$2,000.00	$2,000.00
11	UTILITY RELOCATIONS	LS	1	$3,000.00	$3,000.00
12	MISCELLANEOUS REMOVALS	LS	1	$3,000.00	$3,000.00
13	CONSTRUCTION ENGINEERING	LS	1	$18,800.00	$18,800.00
14	CONTINGENCIES	LS	1	$18,800.00	$18,800.00

PHASE IIA TOTAL **$225,120.00**

PHASE IIB - LITCHFIELD ROAD FROM VILLA NUEVA DR. TO SAGEBRUSH ST.

NO.	DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
1	PAVEMENT REMOVAL	SY	4,760	$2.00	$9,520.00
2	PAVEMENT REPLACEMENT	SY	4,760	$15.00	$71,400.00
3	6" CURB AND GUTTER	LF	450	$15.00	$6,750.00
4	34" x 53" ELLIPTICAL RCP (W/ EX. AND BACKFILL)	LF	1,250	$95.00	$118,750.00
5	24" RGRCP (W/EX. AND BACKFILL)	LF	125	$55.00	$6,875.00
6	STORM DRAIN MANHOLE	EA	3	$3,500.00	$10,500.00
7	CURB OPENING INLET	EA	4	$3,000.00	$12,000.00
8	WATERLINE VERTICAL RELOCATION	EA	1	$2,000.00	$2,000.00
9	SEWER CROSSING	EA	2	$2,000.00	$4,000.00
10	UTILITY RELOCATIONS	LS	1	$3,000.00	$3,000.00
11	MISCELLANEOUS REMOVALS	LS	1	$3,000.00	$3,000.00
12	CONSTRUCTION ENGINEERING	LS	1	$24,800.00	$24,800.00
13	CONTINGENCIES	LS	1	$24,800.00	$24,800.00

PHASE IIB TOTAL **$297,395.00**

COMBINED PHASE IIA & IIB TOTAL **$522,515.00**

PHASE III - LITCHFIELD ROAD FROM SAGEBRUSH ST. TO HONEYSUCKLE ST.

ITEM NO.	DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
1	PAVEMENT REMOVAL	SY	6,540	$2.00	$13,080.00
2	PAVEMENT REPLACEMENT	SY	6,540	$15.00	$98,100.00
3	6" CURB AND GUTTER	LF	600	$15.00	$9,000.00
4	34" x 53" ELLIPTICAL RCP (W/ EX. AND BACKFILL)	LF	631	$95.00	$59,945.00
5	36 RGRCP (W/ EX. AND BACKFILL)	LF	529	$70.00	$37,030.00
6	24" RGRCP (W/EX. AND BACKFILL)	LF	280	$55.00	$15,400.00
7	STORM DRAIN MANHOLE	EA	3	$3,500.00	$10,500.00
8	CURB OPENING INLET	EA	3	$3,000.00	$9,000.00
9	WATERLINE VERTICAL RELOCATION	EA	5	$2,000.00	$10,000.00
10	SEWER CROSSING	EA	3	$2,000.00	$6,000.00
11	UTILITY RELOCATIONS	LS	1	$3,000.00	$3,000.00
12	MISCELLANEOUS REMOVALS	LS	1	$3,000.00	$3,000.00
13	CONSTRUCTION ENGINEERING	LS	1	$27,400.00	$27,400.00
14	CONTINGENCIES	LS	1	$27,400.00	$27,400.00

PHASE III TOTAL **$328,855.00**

PHASE IV - LITCHFIELD RD. FROM HONEYSUCKLE ST. TO FAIRWAY DRIVE AND FAIRWAY DRIVE TO LA LOMA AVE

ITEM NO.	DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
1	PAVEMENT REMOVAL	SY	970	$2.00	$1,940.00
2	PAVEMENT REPLACEMENT	SY	970	$15.00	$14,550.00
3	36 RGRCP (W/ EX. AND BACKFILL)	LF	404	$70.00	$28,280.00
4	30" RGRCP (W/EX. AND BACKFILL)	LF	1,096	$60.00	$65,760.00
5	24" RGRCP (W/EX. AND BACKFILL)	LF	400	$55.00	$22,000.00
6	STORM DRAIN MANHOLE	EA	4	$3,500.00	$14,000.00
7	CURB OPENING INLET	EA	8	$3,000.00	$24,000.00
8	WATERLINE VERTICAL RELOCATION	EA	5	$2,000.00	$10,000.00
9	SEWER CROSSING	EA	1	$2,000.00	$2,000.00
10	UTILITY RELOCATIONS	LS	1	$3,000.00	$3,000.00
11	MISCELLANEOUS REMOVALS	LS	1	$2,000.00	$2,000.00
12	CONSTRUCTION ENGINEERING	LS	1	$18,800.00	$18,800.00
13	CONTINGENCIES	LS	1	$18,800.00	$18,800.00

PHASE IV TOTAL **$225,130.00**

PHASE V - NEOLIN AVE. FROM WIGWAM BLVD. TO THE AIRLINE CANAL (W/ CHANNEL ON THE GOLF COURSE)

ITEM NO.	DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
1	PAVEMENT REMOVAL	SY	5,200	$2.00	$10,400.00
2	PAVEMENT REPLACEMENT	SY	5,200	$15.00	$78,000.00
3	6" CURB AND GUTTER	LF	2,500	$15.00	$37,500.00
4	CONSTRUCT CHANNEL (EXCAVATION & GRADING)	CY	1,200	$2.00	$2,400.00
5	INSTALL GRASS IN CHANNEL	SY	4,700	$3.00	$14,100.00
6	UTILITY RELOCATIONS	LS	1	$3,000.00	$3,000.00
7	MISCELLANEOUS REMOVALS	LS	1	$3,000.00	$3,000.00
8	CONSTRUCTION ENGINEERING	LS	1	$14,800.00	$14,800.00
9	CONTINGENCIES	LS	1	$14,800.00	$14,800.00
			PHASE V TOTAL		$178,000.00

CONSTRUCTION TOTAL	$1,938,725.00
PREDESIRN STUDY	$40,000.00
PUBLIC INVOLVEMENT	$15,000.00
ENGINEERING	$134,740.00
PROJECT GRAND TOTAL	$2,128,465.00

ENGINEERS ESTIMATE
ALTERNATE NO. 1 - COMBINED

LITCHFIELD ROAD AND NEOLIN AVE
DRAINAGE IMPROVEMENTS

12-Feb-98

NEOLIN AVE. ALTERNATE 1

ITEM NO.	DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
1	PAVEMENT REMOVAL	SY	2,770	$2.00	$5,540.00
2	PAVEMENT REPLACEMENT	SY	2,770	$15.00	$41,550.00
3	34" x 53" ELLIPTICAL RCP (W/ EX. AND BACKFILL)	LF	1,736	$95.00	$164,920.00
4	36" RGRCP (W/ EX. AND BACKFILL)	LF	1,207	$70.00	$84,490.00
5	24" RGRCP (W/ EX. AND BACKFILL)	LF	576	$55.00	$31,680.00
6	STORM DRAIN MANHOLE	EA	8	$3,500.00	$28,000.00
7	CURB OPENING INLET	EA	14	$3,000.00	$42,000.00
8	OUTLET HEADWALL INTO 'THE LAKE'	EA	1	$3,000.00	$3,000.00
9	EXISTING CART PATH REMOVAL	SY	1,300	$3.00	$3,900.00
10	CART PATH/ SWALE (6" CONCRETE)	SY	1,450	$35.00	$50,750.00
11	6" CURB AND GUTTER	LF	480	$15.00	$7,200.00
12	CONSTRUCT CHANNEL (EXCAVATION & GRADING)	CY	1,200	$2.00	$2,400.00
13	INSTALL GRASS IN CHANNEL	SY	4,700	$3.00	$14,100.00
14	WATERLINE VERTICAL RELOCATION	EA	8	$2,000.00	$16,000.00
15	SEWER CROSSING	EA	5	$2,000.00	$10,000.00
16	UTILITY RELOCATIONS	LS	1	$8,000.00	$8,000.00
17	MISCELLANEOUS REMOVALS	LS	1	$10,000.00	$10,000.00
18	CONSTRUCTION ENGINEERING 10%	LS	1	$52,400.00	$52,400.00
19	CONTINGENCIES 10%	LS	1	$52,400.00	$52,400.00

NEOLIN AVE. TOTAL **$628,330.00**

LITCHFIELD RD. ALTERNATE 1

ITEM NO.	DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
1	PAVEMENT REMOVAL	SY	4,450	$2.00	$8,900.00
2	PAVEMENT REPLACEMENT	SY	4,450	$15.00	$66,750.00
3	38" x 60" ELLIPTICAL RCP (W/ EX. AND BACKFILL)	LF	2,683	$115.00	$308,545.00
3	34" x 53" ELLIPTICAL RCP (W/ EX. AND BACKFILL)	LF	814	$95.00	$77,330.00
4	36" RGRCP (W/ EX. AND BACKFILL)	LF	1,096	$70.00	$76,720.00
5	24" RGRCP (W/ EX. AND BACKFILL)	LF	905	$55.00	$49,775.00
6	STORM DRAIN MANHOLE	EA	13	$3,500.00	$45,500.00
7	CURB OPENING INLET	EA	19	$3,000.00	$57,000.00
8	WATERLINE VERTICAL RELOCATION	EA	12	$2,000.00	$24,000.00
9	SEWER CROSSING	EA	7	$2,000.00	$14,000.00
10	UTILITY RELOCATIONS	LS	1	$8,000.00	$8,000.00
11	MISCELLANEOUS REMOVALS	LS	1	$10,000.00	$10,000.00
12	CONSTRUCTION ENGINEERING 10%	LS	1	$74,700.00	$74,700.00
13	CONTINGENCIES 10%	LS	1	$74,700.00	$74,700.00

LITCHFIELD RD. TOTAL **$895,920.00**

THE LAKE' OUTLET - ALTERNATE 1

ITEM NO.	DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
1	PAVEMENT REMOVAL	SY	130	$2.00	$260.00
2	PAVEMENT REPLACEMENT	SY	130	$15.00	$1,950.00
3	38" x 60" ELLIPTICAL RCP (W/ EX. AND BACKFILL)	LF	1,570	$115.00	$180,550.00
4	STORM DRAIN MANHOLE	EA	4	$3,500.00	$14,000.00
5	WEIR STRUCTURE (FOR 'THE LAKE')	EA	2	$3,500.00	$7,000.00
6	UTILITY RELOCATIONS	LS	1	$4,000.00	$4,000.00
7	MISCELLANEOUS REMOVALS	LS	1	$4,000.00	$4,000.00
8	CONSTRUCTION ENGINEERING 10%	LS	1	$21,200.00	$21,200.00
9	CONTINGENCIES 10%	LS	1	$21,200.00	$21,200.00

LITCHFIELD R $254,160.00

CONSTRUCTION TOTAL	**1,778,410.00**
PREDESIGN STUDY	**40,000.00**
PUBLIC INVOLVEMENT	**15,000.00**
ENGINEERING	**134,740.00**
PROJECT GRAND TOTAL	**1,968,150.00**

ENGINEERS ESTIMATE
ALTERNATE NO. 2 - COMBINED

LITCHFIELD ROAD AND NEOLIN AVE
DRAINAGE IMPROVEMENTS

12-Feb-98

NEOLIN AVE. ALTERNATE 2

ITEM NO.	DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
1	PAVEMENT REMOVAL	SY	9,660	$2.00	$19,320.00
2	PAVEMENT REPLACEMENT	SY	9,660	$15.00	$144,900.00
3	34" x 53" ELLIPTICAL RCP (W/ EX. AND BACKFILL)	LF	1,353	$95.00	$128,535.00
4	36" RGRCP (W/ EX. AND BACKFILL)	LF	242	$70.00	$16,940.00
4	30" RGRCP (W/ EX. AND BACKFILL)	LF	132	$60.00	$7,920.00
5	24" RGRCP (W/ EX. AND BACKFILL)	LF	544	$55.00	$29,920.00
6	STORM DRAIN MANHOLE	EA	5	$3,500.00	$17,500.00
7	CURB OPENING INLET	EA	12	$3,000.00	$36,000.00
8	OUTLET HEADWALL INTO 'THE LAKE'	EA	1	$3,000.00	$3,000.00
9	EXISTING CART PATH REMOVAL	SY	1,300	$3.00	$3,900.00
10	CART PATH/ SWALE (6" CONCRETE)	SY	1,450	$35.00	$50,750.00
11	6" CURB AND GUTTER	LF	2,980	$15.00	$44,700.00
12	CONSTRUCT CHANNEL (EXCAVATION & GRADING)	CY	1,200	$2.00	$2,400.00
13	INSTALL GRASS IN CHANNEL	SY	4,700	$3.00	$14,100.00
14	WATERLINE VERTICAL RELOCATION	EA	5	$2,000.00	$10,000.00
15	SEWER CROSSING	EA	2	$2,000.00	$4,000.00
16	UTILITY RELOCATIONS	LS	1	$8,000.00	$8,000.00
17	MISCELLANEOUS REMOVALS	LS	1	$10,000.00	$10,000.00
18	CONSTRUCTION ENGINEERING	LS	1	$55,200.00	$55,200.00
19	CONTINGENCIES	LS	1	$55,200.00	$55,200.00

NEOLIN AVE. TOTAL **$662,285.00**

LITCHFIELD RD. ALTERNATE 2

ITEM NO.	DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
1	PAVEMENT REMOVAL	SY	13,000	$2.00	$26,000.00
2	PAVEMENT REPLACEMENT	SY	13,000	$15.00	$195,000.00
3	6" CURB AND GUTTER	LF	1,050	$15.00	$15,750.00
3	34" x 53" ELLIPTICAL RCP (W/ EX. AND BACKFILL)	LF	2,596	$95.00	$246,620.00
3	36" RGRCP (W/ EX. AND BACKFILL)	LF	933	$70.00	$65,310.00
4	30" RGRCP (W/ EX. AND BACKFILL)	LF	1,096	$60.00	$65,760.00
5	24" RGRCP (W/ EX. AND BACKFILL)	LF	905	$55.00	$49,775.00
6	STORM DRAIN MANHOLE	EA	13	$3,500.00	$45,500.00
7	CURB OPENING INLET	EA	19	$3,000.00	$57,000.00
8	WATERLINE VERTICAL RELOCATION	EA	12	$2,000.00	$24,000.00
9	SEWER CROSSING	EA	7	$2,000.00	$14,000.00
10	UTILITY RELOCATIONS	LS	1	$8,000.00	$8,000.00
11	MISCELLANEOUS REMOVALS	LS	1	$10,000.00	$10,000.00
12	CONSTRUCTION ENGINEERING	LS	1	$82,300.00	$82,300.00
13	CONTINGENCIES	LS	1	$82,300.00	$82,300.00

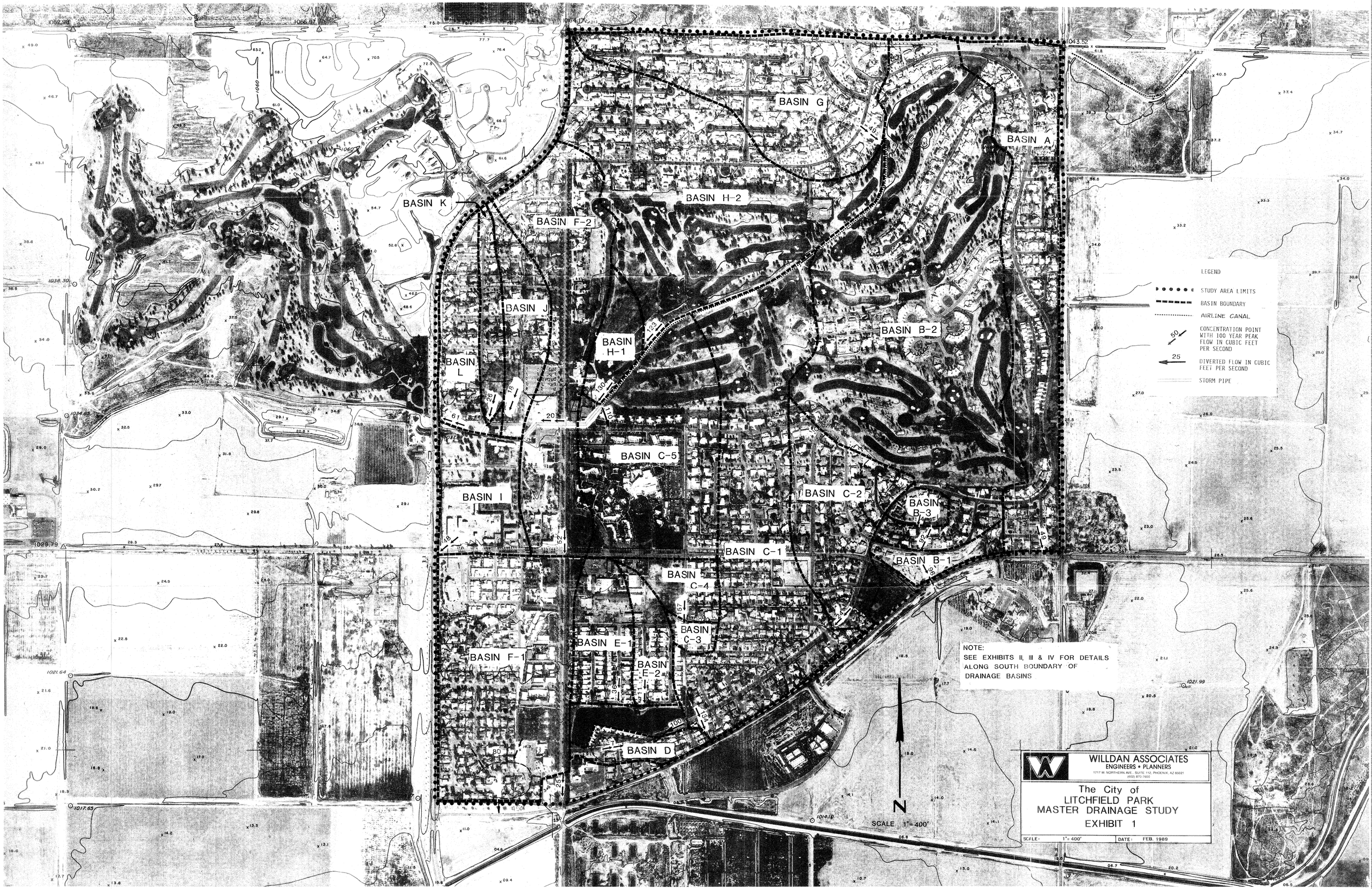
LITCHFIELD RD. TOTAL **$987,315.00**

THE LAKE' OUTLET - ALTERNATE 2

ITEM NO.	DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
1	PAVEMENT REMOVAL	SY	3,000	$2.00	$6,000.00
2	PAVEMENT REPLACEMENT	SY	3,000	$15.00	$45,000.00
3	6" CURB AND GUTTER	LF	785	$15.00	$11,775.00
4	34" x 53" ELLIPTICAL RCP (W/ EX. AND BACKFILL)	LF	1,570	$95.00	$149,150.00
5	STORM DRAIN MANHOLE	EA	4	$3,500.00	$14,000.00
6	WEIR STRUCTURE (FOR 'THE LAKE')	EA	2	$3,500.00	$7,000.00
7	UTILITY RELOCATIONS	LS	1	$4,000.00	$4,000.00
8	MISCELLANEOUS REMOVALS	LS	1	$4,000.00	$4,000.00
9	CONSTRUCTION ENGINEERING	LS	1	$24,100.00	$24,100.00
10	CONTINGENCIES	LS	1	$24,100.00	$24,100.00

LITCHFIELD RD. TOTAL **$289,125.00**

CONSTRUCTION TOTAL	**1,938,725.00**
PREDESIGN STUDY	**40,000.00**
PUBLIC INVOLVEMENT	**15,000.00**
ENGINEERING	**134,740.00**
PROJECT GRAND TOTAL	**2,128,465.00**

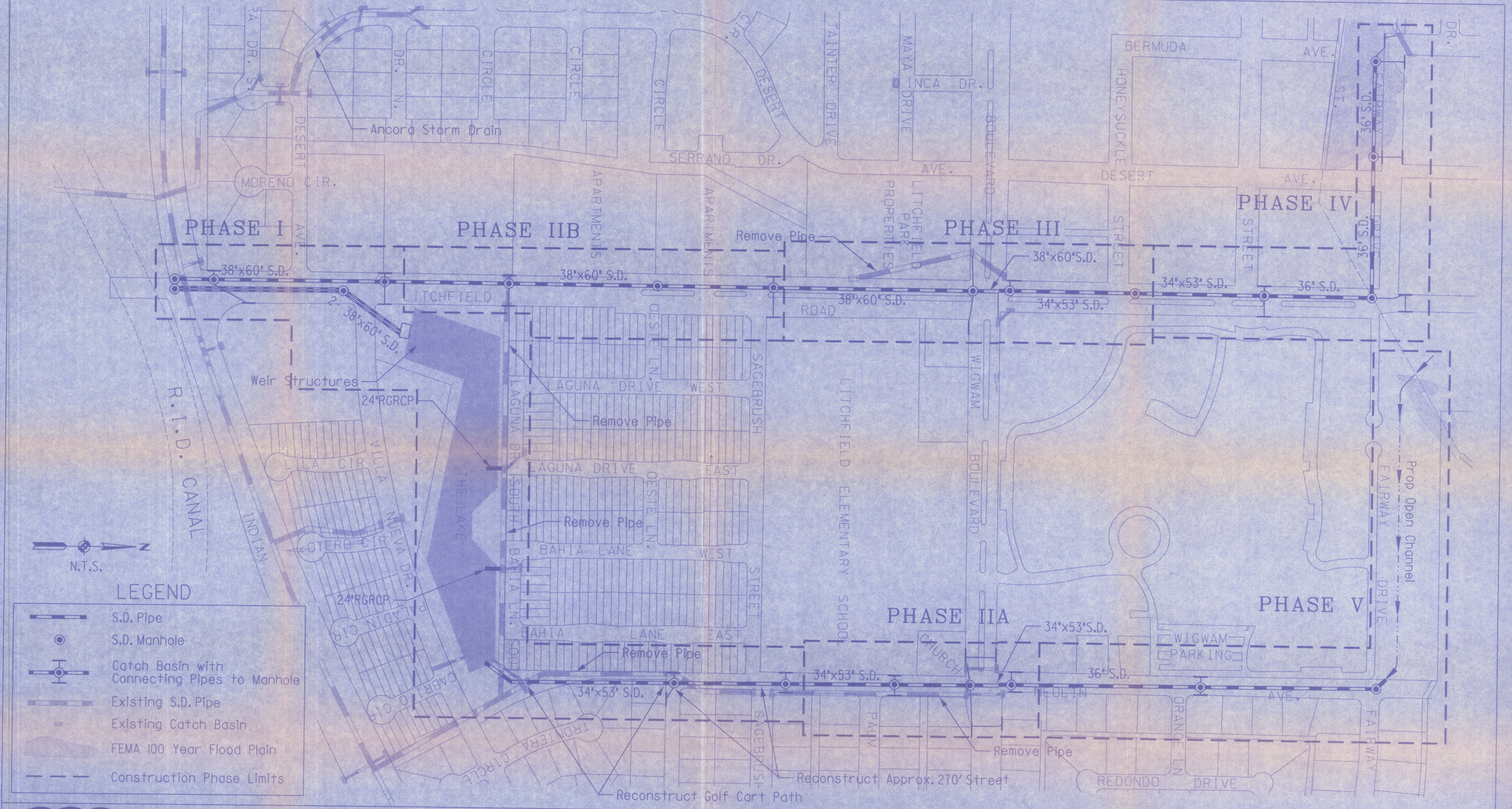


WILLDAN ASSOCIATES
ENGINEERS • PLANNERS
1717 W. NORTHERN AVE., SUITE 112, PHOENIX, AZ 85021
(602) 870-7600

The City of LITCHFIELD PARK MASTER DRAINAGE STUDY

EXHIBIT 1

SCALE: 1"= 400' | DATE: FEB. 1989



CITY OF LITCHFIELD PARK

LITCHFIELD ROAD AND NEOLIN AVENUE
DRAINAGE IMPROVEMENTS

EXHIBIT NO. 2
PROPOSED STORM DRAIN LOCATIONS
(Litchfield Rd. Alt. No. 1, Neolin Ave. Alt. No. 1, Lake Outlet Alt. No. 1)