U.S. ARMY CORPS OF ENGINEERS
NEW ORLEANS DISTRICT

DESIGN MEMORANDUM

JEFFERSON PARISH

SOUTHEAST LOUISIANA DRAINAGE PROJECT
JEFFERSON PARISH
RAILROAD CANAL
AVENUE B TO THE KEYHOLE CANAL

February 1998

URS Greiner
Metairie, Louisiana

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URS Greiner

February 26, 1998

Mr. Russell J. Young, Jr., P.E. CELMN-ED-DL
Civil Engineer, Levees Section
Post Office Box 60267
New Orleans, Louisiana 70160-0267

RE: **Southeast Louisiana Drainage Projects**
Railroad Canal from Avenue B to the Keyhole Canal
USACE No. DACW29-97-D-0031
URSG Project No. 04-46269.00

Dear Mr. Young:

Please find attached two final copies of our design report for your review and comment. The report includes final revisions based upon the USACE's final hydraulic model run as requested.

Also, by copy of this letter we are forwarding two copies of same report to Mr. Don Hull of Jefferson Parish for the local sponsors review and comment.

In addition, we have also attached to this submittal a letter and permit application to the Union Pacific Railroad. We are at this time requesting comments, if any, from the USACE and Jefferson Parish prior to submitting the material to the railroad.

Please note that it is our understanding that Jefferson Parish after receipt of the above documents will distribute the documents and schedule a meeting with the USACE, The City of Westwego and various departments at Jefferson Parish interested in the project. URSG will follow up with the Parish within a few days to confirm the exact time and date of this meeting.

Should you require any additional information, or have any questions, please don't hesitate to contact us.

Sincerely,

URS Greiner, Inc.

Michael D. Patorno, P.E.
Project Manger

cc: Mr. Don Hull, Program Director, Capital Drainage Program (w/enclosures)

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EXECUTIVE SUMMARY

[1]Original Draft

The Railroad Canal, parallel to 4th St. in the City of Westwego, Jefferson Parish LA, is mostly an open earthen ditch running about 2100 feet from Ave. B to its confluence with the Keyhole Canal. The Keyhole Canal flows south to an eventual outfall into Bayou Segnette at the Westwego Pumping Station. The Railroad Canal services an area composed of residential, commercial and industrial facilities between the Mississippi River and the railroad tracks. According to a U.S. Army Corps of Engineers (USACE) hydraulic model study of the canal, 10-year design flows are: 70 cfs (upper end) to 250 cfs (lower end, head of Keyhole Canal).

The current configuration of the canal consists of approximately 890 linear feet of earthen section followed by approximately 390 linear feet of 60" reinforced concrete pipe in parallel with a 48" RCP. Both of these culverts cross beneath a railroad spur which services local industry in the area. Beyond these culverts, approximately 460 linear feet of earthen canal section exists followed by a single 60" reinforced concrete culvert approximately 150 feet long crossing another railroad spur. Another approximately 270 linear feet of earthen canal section extends beyond this culvert to the head of Keyhole Canal. At that point, the canal is joined by another railroad ditch flowing from the west. Some 30 feet south of this confluence point, Keyhole Canal crosses under two railroad trestles. About 60 feet downstream of the second trestle, flow enters an 11' wide x 6.8' high reinforced concrete box culvert. See Appendix F for site photos, Appendix H for plans and Figure 1 for overview of project.

The development surrounding the Railroad Canal restricts improvements to the canal. Just south of the canal a dual set of railroad tracks limits expansion of the canal to the south. To the north of the canal residential, commercial and industrial properties also limit expansion of the canal. It is anticipated, and shown in the real estate section of this report, that property from the railroad and surrounding property owners will need to be acquired to improve the canal. Currently only one section of the Railroad Canal is entirely within dedicated drainage servitude. ← where Keyhole Canal crosses under the RR trestles

Planned improvements to the Railroad Canal are in part based upon the Corps of Engineer's May 1996 South East Louisiana (SELA) Study and a more recent hydraulic model also done by the USACE. The purpose of these improvements is to ease current flooding problems which exist in this area of Jefferson Parish. The scope of this project and the purpose of this report were to examine previous studies done for the area using the USACE's Hydraulic Model as a design basis for improvements and determine if a more cost effective canal section could be used, prior to commencing with the plans and specifications phase of this project. As required by the scope of this

[1]The following is adopted from the Draft Design Memorandum and reflects the Draft Plan. The Revised Plan is presented in the section titled "USACE Review", following.

project a more economical consideration warranting review was an open concrete lined channel similar to that suggested in the SELA study. However, slope instabilities and soil wedge failures based on geotechnical analyses, done as part of this report, required that the recommended sections for the canal improvements consist of a combination of concrete flumes ("U" channel), concrete box sections and culverts.

Finally, as part of this project and prior to the commencement of the plans and specifications phase of this project, the USACE hydraulics section utilized the recommendations and information contained in the Draft Report to update their model and verify hydraulically that the recommended sections perform in accordance with their criteria for limiting flooding to the area. The 10-year design storm, as required by Jefferson Parish, was used as a basis for the USACE's model. Further, checks of the recommended sections performance utilizing 100 year flows was also provided by the USACE Hydraulics Section during their review.

USACE REVIEW:

After a thorough review by the Corps of Engineers of the Draft Plan of the proposed canal improvements, it was determined that certain changes should be made based on the following conditions:

1. Existing field conditions found through detailed topographic surveys were in some cases very different than conditions assumed for the original SELA Plan and original Hydraulic Model. Therefore, the hydraulic model was redone to evaluate these conditions. The revised hydraulic model also considered circular culverts since these were more geotechnically stable and not subject to the same unbalanced forces as that of the open flumes. Therefore, less lands need to be acquired.

2. Insitu soil conditions discovered during a detailed geotechnical analysis performed as part of this scope of work was found to be substantially different from that assumed for the original SELA Plan.

Following is a brief description of the Revised Plan and the major hydraulic, geotechnical and economic reasons for the revisions from the Draft Plan. The same information is contained in a more concise form in Figure 1. Circular pipes will not be subject to the same unbalanced soil forces as are rectangular boxes and flumes. The Revised Plan is to install double 60" diameter reinforced concrete pipes from Avenue B to the confluence with the 42" RCP and the 48" CMP at station 6+80 and install double 72" diameter RCP's from there to the first railroad spur. This was done because geotechnical considerations required the acquisition of land to the north when boxes on flumes were proposed. The analysis leading to the Revised Plan also indicated that additional capacity would be needed under the first spur. Therefore, an additional 60" diameter pipe will be installed in parallel with the existing 60" and 48" pipes under this spur. The originally planned 14' x 6' RC flume section

just downstream of the proposed 60" pipe would be retained to the second railroad spur. The analysis leading to the Revised Plan showed that two 72" pipes would be needed downstream of the second railroad spur, in lieu of two 84" pipes. The Revised Plan, is therefore, to install two 72" diameter pipes parallel with the existing 60" diameter pipe under the second railroad spur. The originally proposed 14' x 6' flume downstream of the second railroad spur to the head of Keyhole Canal would be retained in the Revised Plan. A reinforced concrete box section would be installed under the first railroad trestle, as in the original plan, but it will be a 10' wide by 8' high standard RC box section. The cross sectional areas of this box is a little more than the originally planned box; however, the expense should be less, since the standard size box. The existing earthen channel will be retained under the second (concrete) railroad bridge to the existing 11' x 6.8' RC box culvert.

The Original SELA Plan and the Draft Plan are presented for reference only in Appendix B and Figure 1, respectively. The Revised Plan incorporates the results of soils analysis, feasibility analysis and cost analysis and represents the most desirable plan proposed to date.

Figure 1, found on page 4, is a summary of the recommendations included in the original draft report (the Draft Plan) compared with the Revised Plan, which is the recommended alternative of the subject report.

There is no page 4 in the report.

SOUTHEAST LOUISIANA DRAINAGE PROJECT
JEFFERSON PARISH
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1. STUDIES AND REPORTS

There have been several previous studies and a more recent model, which examined the Railroad Canal area. They are as follows:

Master Drainage Plan: This was a 1981 study commissioned by Jefferson Parish.

SELA(South East Louisiana) Plan: A USACE Technical Report for Southeast Louisiana Projects in Jefferson Parish dated May 1996.

Hydraulic Model: A hydraulic model of the Railroad Canal with recommended channel sections for the improvements to the canal. This model was updated concurrently with this report based on more detailed survey and geotechnical information and data obtained as part of this project.

2. PURPOSE

This report presents the design and cost estimates for the proposed Railroad Canal improvements and will serve as the basis for the preparation of construction plans and specifications.

3. PROJECT DESCRIPTION

The subject project is located parallel and north of 4th street (LA 18) in the City of Westwego, Jefferson Parish La, between Avenue B and the Keyhole Canal, including portions of the Keyhole Canal. Currently, this area of Westwego along the corridor of the Railroad Canal has flooding problems. As a result of these problems, improvements to this canal are proposed. The improvements are divided into eight separate sections similar to that described in the SELA Plan and mostly continued in the USACE's Hydraulic Model. However, some of the lengths have been adjusted to meet existing field conditions as determined during the topographic survey for this project.

The proposed improvements are to consist of approximately 509 linear feet of double 60" RCP (SECTION 1), followed by some 130 linear feet of double 60" RCP (SECTION 2) followed by approximately 255 linear feet of double 72" RCP (SECTION 3), east to an existing culverted section within the canal and under a railroad spur which serves industry in the area. This culverted section (SECTION 4) consists of an existing 48" RCP, with two 54" CMP end pieces and an existing 60" RCP. The total end area for this section is 32.2 square feet, which does not adequately carry the required 10 year flow. Therefore, an additional 60" diameter steel pipe will be jack and bored at this location to parallel the existing lines, giving this section a new total end area of 51.8 square feet. In addition, the end portions of the 48" RCP which are 54" CMP will be removed and replaced because they have settled resulting in slopes in the wrong direction or slopes that are too great and increase losses in the system. Beyond these culverts exist a second culverted section some 400 feet away

consisting of a 60" RCP with an end area of 19.6 square feet (SECTION 6). Between both of these culverted sections exist an open earthen canal section. Proposed improvements at this location will consist of a 6' deep by 14' wide "U" section (SECTION 5). In Section 6, it is planned to add two parallel 72" diameter pipes to the existing 60" RCP for a total end area of 76.2 square feet. Beyond this section, and at the confluence of the Railroad Canal with the Keyhole Canal, it is planned that a 6' deep by 14' wide "U" section will be constructed (SECTION 7). Beyond this confluence and 90' north of an existing 11' by 6.8' box culvert with an end area of 74.8 square feet, it is planned to construct a 8' deep by 10' wide box culvert with an end area of 80 square feet (SECTION 8) which will transverse under an existing wood railroad trestle. At a second, concrete railroad bridge, just south of the wood trestle, the existing earthen section will not be altered in any way. This section is proposed in lieu of extending the box culvert under the second bridge, because of the anticipated cost of such an undertaking and the existing adequacy of the channel to handle the projected flows. It is anticipated that the first bridge will not have to be demolished to construct the box culvert, but substantial estimated costs were added to the cost of construction as "extra cost for sheeting being jacked under the railroad bridge". These improvements and their selection criteria are described in following sections. The issues of hydraulics, geotechnical analyses and economics are addressed for each section. Design Plans showing these improvements are contained in the attached Appendix H for reference.

4. SURVEYS

A preliminary topographical survey was performed for the SELA plan in May, 1996. Excerpts from this survey and information from the SELA study are provided in Appendix B for reference. This original survey was also used as the basis for the USACE's original Hydraulic Model.

As part of this project, and to verify items discovered during the preliminary survey performed for the SELA Plan, a full topographic survey was performed. The survey included full topographic features with elevations and cross sections taken at each drainage structure and at 100 foot intervals along the project base line. The base line runs west to east and parallels the canal, about 30 feet north of the canal centerline. The topographic features and cross sections are included on the design plates attached in Appendix H for reference. All P.I. points along the survey baseline were monumented using USACE monuments attached to pipes driven into the ground. Each monument ties to 3 points for future recovery. The survey also included ties to all property corners and existing servitudes as well as established vertical control points. The information in this survey was utilized to update the USACE's hydraulic model concurrent with this project.

5. GEOTECHNICAL

5.1 General

As part of this project, soil analyses and slope stability calculations were performed and compiled into a geotechnical report attached in Appendix E.

To perform the analyses soil borings were taken along the corridor and parameters extrapolated. A strength line was determined for the slope stability of concrete lined channels using USACE criteria for factors-of-safety required for normal, dewatered and construction cases. Determinations for soil pressures, backfill and bedding requirements, and drainage of adjacent soils were also determined for flumed channel sections, construction sheeting and culvert sections. The criteria utilized in the design are as follows:

Slope Stability: (using LMVD Method of Planes)

Factory of Safety: 1.3- normal operating conditions (average low water level) & construction conditions.

Factor of Safety: 1.15- rapid drawdown conditions and dry or dewatered conditions.

Bearing Capacity: Factor of safety: 3.0

Dewatering: designs such that groundwater drawdown outside the construction easement is minimally affected.

Cantilever I-Wall and Braced Walls: Wall stability and required penetration are determined by the LMVD Method of Planes with a Factor of Safety applied to the soil parameters and analyzed for the below cases. For the friction angle, the F.S. is applied as follows:

$$\phi d = \frac{\tan^{-1} \tan \phi a}{\text{factor-of-safety}}$$

where: ϕa= available friction angle
ϕd= developed friction angle

The developed friction angle was determined using lateral earth pressure coefficients.

Q-Case-F.S. = 1.5 with static water at average water levels
1.3 with low water conditions
General: If the penetration to head ratio is less than 3:1, then increase it to 3:1

I-walls and braced walls retaining fill: In addition to above, analyze S-Case F.S. = 1.5 with static water levels.

5.2 Results of Geotechnical Analyses

Several different sections were analyzed geotechnically. As with all of the analyses, geotechnical, hydraulic, and cost, the entire canal was analyzed in eight different sections. These sections are as described in the original SELA Plan and for the most part continued in the hydraulic model. It was felt that using the same section designations would provide for easier comparisons on all fronts. The results of all geotechnical analyses are included and attached in Appendix E of this report. The following is a summary of the results of the geotechnical analyses by cross-section type and the associated section location.

5.2.1 Concrete Lined Open Channel.

Two different geometric layouts were analyzed for this type of cross-section. The first was based upon locating a new top of bank approximately 20 feet away from the centerline of the outside rail on the north side of the canal (i.e. at the same location as the existing top of bank) and determine stable slopes based upon the required factors-of-safety. As a result this section required a 6:1 side slope on the south side of the canal and a 2:1 slope on the north side. Assuming a minimum 4' wide bottom, and a 12 feet wide maintenance berm for Jefferson Parish, the northerly top of bank was required to be some 107 feet away from the outside rail on the north side. This placed the new canal section some 50 feet into private property at the western end of the canal and approximately 30-35 feet into industrial properties further east.

A second geometric layout was based on a section determined hydraulically to be equivalent to the section used in the Hydraulic Model. The section had 2:1 side slopes and an 8 foot bottom width. This section was analyzed to see how far away from the tracks it would have to be located to be stable and meet the required factors of safety. The results showed that the north top of bank would need to be located some 37 feet away from the existing north top of bank for the canal. This section also enveloped a major portion of the property from private owners and a large section of land from industry. The new south bank of this section was some 90 feet away from the most southern rail or some 40 feet into the 100 feet deep privately owned lots along the canal's corridor.

It should also be noted that the channels were assumed to be concrete lined to protect the channels from high velocities which will exist in the channel. See Appendix C for sample hydraulic calculations which demonstrate anticipated channel velocities.

5.2.2 Earthen Sections.

In an attempt to provide the most economical section, an earthen section was considered. The consideration was to leave the remaining canal section (i.e. canal bottom and south slope) as is and widen the canal to the north until it could hydraulically handle the design flows. This section however, as shown in the report attached in Appendix "E" is not stable. Offloading material from the Northern bank to allow the channel proper size for conveyance of 10 year flows causes problems with the existing northern bank by way of wedge failure. The only exception to the above was at the most southerly railroad bridge where the USACE determined that the existing channel could adequately carry the design flows and was geotechnically acceptable.

5.2.3 Concrete Lined Open Canal Section Below Bridges in Keyhole Canal.

The next section analyzed was a concrete lined section below the two existing railroad bridges. This section was approached by using a minimum 8 foot wide bottom required for hydraulics and sides sloped to reach the existing bridge abutments. This section was then analyzed to see what factors-of-safety exist. The resulting factor of safety was 0.82. This is unacceptable.

5.2.4 "U" Channel Sections.

The next cross-section analyzed was a "U" Channel. The "U" Channel, or Flume, as noted in the hydraulic model, varied in width from 12' to 14' in accordance with flows. Because it was desired to locate this section as close as possible to the existing canal, the wall heights were assumed to be extended to meet natural ground with minimal sloping of the section which might increase instability and require the section to be shifted further north. The analyses showed that for the 12' flume in Sections 1, 2 and 3, the flume centerline needed to be 39 feet from the edge of the railroad ballast toe. Copies of diagrams depicting these cross section locations are included in Appendix E for reference. In Sections 5 thru 7 the 14' wide flume had to be centered some 46' away from the edge of railroad ballast toe. Copies of diagrams depicting these cross section locations are also included in Appendix E for reference.

5.2.5 Concrete Box Culverts.

Concrete box culvert cross-sections were analyzed for three different locations. The first is in Section 1. The section near Avenue B was too close to the railroad track and required the use of a culvert for stability in lieu of a "U" channel. The second

is in Section 2, required where an existing building is too close to the existing canal. The third area was in the vicinity of the railroad bridges, Section 8. A culvert was the only structure in this area that provided factors-of-safety above 1.0. "U" channel sections were analyzed for these areas, but not included in the report since this then did not provide the desired factors-of-safety. It should be noted that all box culvert sections require some minimum height of backfill to achieve the minimum weight needed to resist uplift.

5.2.6 Culvert Sections.

Culverts were analyzed for use at Sections 1, 2, 6 and 8 as an alternative to box culverts. According to geotechnical reviews for the use of culvert sections in the range of 60" to 84" diameter pipes, few concerns exist for the stability of these sections, if properly installed, bedded and backfilled in accordance with the recommendations shown in the attached soils report found in Appendix E. It is also noted that 2-72" diameter steel pipes are to be jack and bored under the existing railroad spur in Section 6. Jacking and boring also meets with geotechnical approval pending installation in accordance with the recommendations of the attached geotechnical report. In addition, it should be noted that existing 48" and 60" diameter RCP's are to be left in place and utilized in Section 4, with the addition of an additional 60" RCP, which will be installed via boring and jacking under the railroad spur.

5.2.7 Bedding and Backfilling Requirements.

According to the soils report, bedding for the flumed ("U" channel) cross-sections includes 2 feet of crushed stone and a minimum of 4.5 feet of bedding above the bottom of the structure. Weep holes are required to be used with this system of bedding to allow free drainage from the structure to the surrounding water table which will help deter upheaval. Above the bedding, insitu soils may be used for backfill; however, muck material should be stockpiled and allowed to drain to avoid soft areas adjacent to the structure where maintenance vehicles might require access. Bedding for box culvert sections require 1 ½ feet of crushed stone beneath the structure only. Backfill, as allowed for the flumed section, may be insitu materials. It is also noted that a geotextile separator fabric should be installed and surround the bedding material for both the flume and box sections.

Bedding for pipe culverts, except at jack and bore locations, is required to be crushed stone 2 feet in depth and extend approximately 1 ½ feet beyond the walls of the pipe in both directions, except for double pipes, where one foot separation is required between the pipes and both sides of the pipes. Geotextile fabric should separate the

crushed stone bedding from both the subbase beneath and the structural sand backfill above. Compacted sand backfill should extend to the spring line of the pipes. Above that can be in-situ materials, provided they have been dried somewhat before applying.

5.2.8 Temporary Sheeting.

The use of steel interlocking sheet piles is anticipated to a minimum elevation of (-) 26 Cario Datum (CD) or sheets approximately 50 feet in length for the purposes of constructing the sections. It is also planned that these sheets will be required to be braced at the top to resist loads from the soil and the adjacent railroad.

5.2.9 Drainage of Railroad Ballast.

Based upon a review of the topographical survey information and site visits to the area, the railroad ballast stands at an elevation of approximately 27 (CD). However, the anticipated canal banks and enclosed sections throughout this project will vary from elevation 22 to 25 (CD). Therefore, no problems are anticipated for the drainage of the railroad ballast. The railroad bed (i.e. ballast area) is expected to drain freely into the proposed open canal sections or be able to be directed into the closed sections where inlets are to be placed.

6. HYDRAULICS

6.1 Methodology

The objective of this study is to select a more economical channel than that previously studied. Therefore, a comparison of hydraulically equivalent sections and a review of the economics of each section was conducted. The geotechnical criteria for side slope stability and drainage of adjacent soils were also considered. To accomplish this task the water surface elevations and areas of proposed sections were compared with those sections previously studied. Calculation spreadsheets containing these computations are presented in Appendix C. Please note that these spreadsheets represent very preliminary hydraulic calculations and are utilized only to determine an approximate water surface elevation, since none was provided. The sections used for comparison were from the SELA plan and the Hydraulic Model criteria required by the scope. In conducting this study, the Hydraulic Model was used as the standard. That is, proposed sections had to perform as well as, or better than, the Hydraulic Model. The results of this study were further analyzed by the USACE and the Hydraulic Model was revised accordingly and rerun. The resulting canal sections are shown in Appendix H.

 Skip to page 20

The report skips from page 11 (page 16 in pdf file) to page 20 (page 18 in pdf file).

Draft Section:
Section 14' x 6.8' Box Culvert

10 year Storm 255 CFS
Depth of Flow +-2.5 Ft.
Velocity 4.82 Ft./s
Approx Avg. WSE +/- 14.61

100 year Storm 395CFS
Depth of Flow +- 3.0 Ft.
Velocity 8.69 Ft./s
Approx Avg. WSE +/- 15.35

In summary, the above information is provided as a simple and quick basis for characterizing the flow (i.e. depth, velocity etc.) which were occurring at each section and to help develop an open channel section or pipe section that would perform similarly to the hydraulically modeled section. The above does not calculate or consider losses which in some cases may be sizeable. These losses and their associated rise in water surface elevation were considered and reviewed by the USACE in their updated model utilizing the recommendations in this report and confirmed the hydraulic adequacy of the proposed sections.

7 CHANNEL SECTION SELECTION AND ALTERNATIVES REVIEWED

7.1 General

In general channel selection was based on three separate criteria: geotechnical, hydraulics and cost. One of the first alternatives reviewed and a requirement of this project's scope was concrete lined open channels. In the case of this alternative, we were able to evaluate and size a channel hydraulically that would perform with similar depths and areas as that contained in the USACE's hydraulic model and at first glance may have seemed to be a cost effective section. However, it was shown geotechnically that an open channel section was very unstable and did not provide the required factors of safety at any location in this project unless the section was spaced a great distance away from the railroad and the existing canal. This proved to demonstrate several problems which we were unable to overcome. The first of which is that large portions of privately held land and portions of land owned by industry would have been needed to relocate the channel according to the geotechnical requirements. In short major lands would be taken away from those which the improvements are designed to protect. And in some cases, privately held lands may have required the purchase of the entire parcels. This is because in many municipalities the lots have to have a certain square footage by ordinance to build on them. If portions of this land are acquired and the remaining area does not meet the required areas for the ordinance then the land is deemed unbuildable. This possibility did exist since almost half of these privately owned lots would have been needed to relocate the canal in accordance with the geotechnical requirements.

The second problem was that with the new channel being offset so far from the existing channel, it would be impractical and hydraulically inefficient to move in and out between the existing alignment and the new alignment to connect to the existing culverts being left

in-place. The third, as an alternative to the second problem, would be to completely replace the existing pipes required by the model to be left in-place. This along with having to backfill the existing canal being relocated, obviously and drastically increases the cost of the project beyond what was originally anticipated and makes the use of an open concrete lined ditch impractical. Therefore, open concrete lined channels were not selected as a viable alternative for this project nor were cost estimates developed. Although, the SELA Plan which included some open channel sections was costed as a comparison to the recommended plan since it was the original basis for improvements in this area by the USACE.

In addition, earthen sections were also considered, but for the same reasons the concrete lined channels were not selected, earthen channels were not selected. Another consideration was maintaining the existing southern bank of the channel adjacent to the railroad, but widening the opposite bank to enlarge the channel hydraulically. This undermined the stability of the entire section. Also, without a concrete lining and high velocities, it is impossible to stop erosion and maintain an earthen channel.

Another alternative considered was the possibility of closing the entire canal in with multiple culvert sections. During the early stages of this project we discussed with the USACE this possibility. The USACE advised that this alternative would be considered and further evaluated during their final hydraulic model. As noted previously the USACE was to finalize their hydraulic model based upon the draft of this report and the final survey/geotechnical information gathered as part of the scope of this project. It is noted that based upon the final hydraulic model and geotechnical/economic factors, culverts were used where applicable.

A third alternative considered during this project was to modify the modeled "U" channels (flumed sections) to make them more cost efficient and to help the adjacent railroad ballast drain as required by the scope of work. However, as described in the geotechnical section, modifications to these sections to facilitate drainage of the adjacent railroad ballast is not required. The top of bank sits well below the existing tracks and weep holes are to be provided to allow the water table free drainage into the channel. Secondly, because of the geotechnical requirements for the location of this section and our trying to limit the impact on adjacent lands, the walls of these sections were not sloped, but extended from the inverts of the canal up to match existing surrounding grades (i.e. not sloped substantially from the wall to the existing top of bank). Therefore, flumed sections where recommended will be mostly unmodified and as shown in the requirements of the USACE's hydraulic model. The outstanding reason for this is to maintain a maximum concentrated weight to counteract uplift.

7.2 Recommended Alternative

The following is a summary of the recommended cross sections at each of the eight sections along the project area and the reasons they were recommended.

Section 1

This section of the canal will consist of some 509 linear feet of double 60" diameter culverts. The section required by the original hydraulic model (i.e. a 12' wide flume, "U" channel) was also considered hydraulically. However, in order to satisfy geotechnical stability criteria, (requiring certain distances from the railroad track) an open channel at this section would necessitate acquiring lands from private property owners. The "U" channel alternative at this location as well as the box culvert section also considered were either more costly because of land acquisition or outright more costly.

Section 2

This section of the canal crosses behind an existing building (Knights of Columbus Hall) . The building is approximately 3 feet away from the existing top of canal bank. A flume, "U" channel section was considered at this location; however, in order to meet the geometric requirements in the geotechnical report, the section and sheeting to construct the flume would be within 1 foot of the buildings foundation. It was deemed not practical to drive sheets this close to the foundation of this structure. The box section considered at this location was a 5' x 12' wide box culvert. This would have allowed the channel to be shifted closer to the railroad track and eliminate the problem of driving sheeting within a foot of the building's foundation. However, this alternative proved more costly than a multiple culvert section. The proposed section is 130' of double 60" RC pipe behind the Knights of Columbus Hall.

Section 3

This section of the canal is very much like Section 1 except that flows are greater. Therefore, a double 72" culvert section is recommended. The length is 255 feet.

Section 4

This section traverses a railroad spur and consist of an existing 60" RCP and 48" RCP. The model, according to the USACE and a recent update, utilizing the survey information acquired during this project, demonstrates that the existing pipes cannot transmit the required design flows. The recommended cross-section at this location is to leave the existing culverts in service, remove and replace the two 54" CMP ends and add a 60" diameter pipe

parallel to the existing lines by boring and jacking under the railroad spur. This should facilitate the transmitting of the required flows with minimal head loss according to the USACE's Hydraulic Section. This section is 391' long.

Section 5

This section will require the placement of a flumed section. Hydraulically according to the USACE's model the flume required is 14' wide because of the increased flow. The total length of this flume is 458'. Again, concrete lined sections were considered at this location, but were not used for the previously described reasons. Additionally, because of the amount of flow and the size required for multiple culverts or a large box section, the "U" channel proved more economic.

Section 6

Currently there exists a 60" RCP at this location. In accordance with the model, it was assumed that this pipe was 72" in diameter and an additional 72" diameter pipe would be added parallel to the first. However, during the course of the project it was determined that a minimum cross sectional area of 76 square feet would be required at this location. The reason for such a large area was to compensate for head losses occurring elsewhere in the system. This section of the channel is approximately 148' in length, where the only other location to decrease head losses substantially because of existing pipes is in section 4, which is some 400 feet in length. Therefore, it is much more cost effective to address the reduction in head losses at this section only 148 feet in length as opposed to changing 400 feet of pipe upstream. The recommended section is to keep the existing 60" diameter RCP and parallel it with 2-72" diameter pipes. It is planned to jack and bore both of these pipes at the spur crossing. However, the remaining areas beyond the spur will be installed by open excavation.

Section 7

Section 7 is very similar to section 5 and for the same reasons a 14' wide flume section is recommended at this location. This section is some 270' in length and will tie to the Western Railroad ditch and the Keyhole Canal via a transition flume section to the east and an earthen transition section to the south.

Section 8

Section 8 runs below two bridges which service the railroad. Geotechnically the only section that was stable at this location was a closed box culvert. A standard 10' x 8' R.C. box section will be used here. The cross sectional area is greater than that of the 11' x 6.8' box it will

flow into, but should prove economical since it is a standard size box. Because sheeting is required at this section to construct the improvements, the jacking of sheets under this bridge is also a cost in lieu of removing and replacing the bridges at this location. Beyond the first bridge, however, it has been confirmed that leaving the earthen channel in place is hydraulically feasible and geotechnically within criteria according to the USACE's model and the USACE's geotechnical section respectfully. The massive costs of improving the area under both railroad bridges and the obvious impact these improvements would have on rail service in the area was considered and the box followed by an earthen channel was found to be the best and most economical alternative.

8. METHOD OF CONSTRUCTION

It is anticipated, in accordance with the geotechnical report attached in Appendix E that all flume sections, jack and bore pits, and open cut culvert installation will be constructed within a cofferdam utilizing steel interlocking sheeting to a minimum depth of (-)26 (CD). It is also anticipated that the sheeting will be braced at the top until the section can be installed and backfilled to within some minimum distance from the tops of the sheets. It is also anticipated that steel sheets will be required at the box culvert location directly under the railroad bridge.

Dewatering of the cofferdam areas required along the entire project are anticipated to require temporary earthen dams upstream and downstream of all sections of the canal under construction. These dams would prevent normal or low water flows from entering the excavation; however, during imminent weather conditions the dams should be required to be removed, the excavation temporarily abandoned and required flows would be able to transverse through the areas under construction. A minimum dam elevation would be supplied by the local sponsor based upon historical data for the canal sections under construction.

9. ACCESS

Access for this project is by the West Bank Expressway to Avenue B in the City of Westwego. This site can also be accessed from the west at Avenue B or Avenues C and D from the north and south. Please note that temporary easements and access are shown on the rights-of-way drawings attached in Appendix H for reference.

10. LOCAL SPONSORS

The local sponsor for the project is The City of Westwego and Jefferson Parish. Their contact person is Mr. Donald Hull, P.E., Jefferson Parish Drainage Capital Improvements Program, 1221 Elmwood Park, Harahan, Louisiana. (504) 736-8750.

11. REAL ESTATE REQUIREMENTS

With the exception of one location, throughout this project, servitude and/or rights-of-way will be required for this project. Attached in Appendix H are design plates showing the required rights-of-way and the property owners who currently have title to the lands required. It is anticipated that where rights-of-ways do not exist, a right-of-entry during construction and permanent servitude or an agreement for permanently locating improvements along this corridor will have to be acquired by the local sponsor. The following is a list of property owners where lands will need to be acquired or permitted in the case of the railroad:

Land Owner:	Contact Person:	Address:	Phone No:
Union Pacific-Southern Pacific Railroad	Mary Hauschild	1800 Farnman St. Omaha, Nebraska 68102	404/997-3642
City of Westwego	Robert Utley City Superintendent	Lots 7-9 419 Avenue A Westwego, LA 70094	504-341-3424
ST Services	John Ridenhour Plant Manager	660 Labauve, Westwego, LA 70094	504/340-3000
Tri-Properties, Inc. c/o Port Cargo Services	Ronald Brower Operations Manager	5200 Coffee Drive New Orleans, LA	504/891-9494
Hydril Co.	Larry Pertuit Plant Manager	201 Klein Street Westwego, LA	504/371-1206

12. ENVIRONMENTAL IMPACTS

All of these improvements are to be accomplished along an existing established canal system. There are no anticipated negative environmental impacts due to these improvements. However, excavated material from the existing canal from elevation 9.5 and above will be required to be spoiled on site.

13. UTILITY RELOCATIONS

At several locations in this project there are electrical lines, and gas lines which will need to be relocated within the limits of the required rights-of-way for construction of the improvements. All of these known utilities and their disposition are shown on the right-of-way drawings (i.e. to be relocated or not to be disturbed). There are also, drainage structures and bridges owned by both the

local sponsors and the railroad. These utilities and structures are also shown along with their disposition in the right-of-way drawings.

Following is a list of all of the utility owners and their contacts:

Utility Owner:	Contact Person:	Address:	Phone No:
Union Pacific-Southern Pacific Railroad	Mary Hauschild	1800 Farnman Street Omaha, Nebraska 68102	404/994-3642
BellSouth	Mike Breaux	1010 Handcock St. Gretna, LA 70053	504/364-6800
Entergy Co.	Mike Stiebing	3734 Tulane Ave. New Orleans, LA	800/368-3749
LA Gas Co.	Mike Landry	123 Westbank Exp Harvey, LA 70058	504/456-9882
Cox Cable	Kaycee Sterling		504/734-7345 fax 736-0016
Jefferson Parish	Don Hull	1221 Elmwood Pk Harahan, LA 70123	504/736-6780

14. ESTIMATES OF COST

The cost of the selected alternative is estimated at $4,788,000, including a 20% contingency. Cost of lands are estimated at an additional $202,000. This cost does not include cost for lands owned by the railroad, as it is anticipated that this property will be by permit and not acquisition. However, a labor amount was included for their processing of the permit.

The original cost for the SELA plan was $1,100,000. In the early stages of the current study, this estimate was recalculated using the same unit prices but the total increased somewhat because of additional topographic information and some quantity changes. The refined cost estimated for the SELA plan is $1,641,976. See Appendix D for backup. This cost did not include any cost for land required to implement the plan. The cost of the SELA plan is less than the proposed plan but it is unacceptable because of existing geotechnical conditions and varying field conditions secured via a soils report and a detailed topographic survey of the area.

Costs for the alternatives utilizing open concrete lined channels were not developed because this alternative was not acceptable due to large areas of adjacent lands required, geotechnical and feasibility problems.

15. SCHEDULE FOR DESIGN AND CONSTRUCTION

Notice to Proceed with Design:	November 8, 1997
Final Report:	November 1997 - January 29, 1998
Plans and Specifications:	January 1998 - July 27, 1998
Advertisement:	August 1998 - September 1998
Award:	September 1998
Construction:	September 1998 - September 1999

16. RECOMMENDATIONS

It is recommended that the selected alternative in this report be utilized as a basis to develop plans and specifications required to accomplish the improvements to the Railroad Canal between the Keyhole Canal and Avenue B, including Keyhole Canal from the Railroad Canal to the existing 6.8 foot x 11 foot box culvert.

COST ESTIMATES

FOR

REVISED PLAN

REVISED COST SUMMARY			
SECTION	COST	CONTING'Y	TOTAL COS
1	$861,171	$172,234	$1,033,405
2	169,843	33,969	203,812
3	527,856	105,571	633,427
4	466,342	93,268	559,610
5	826,174	165,235	991,409
6	247,883	49,577	297,460
7	491,793	98,359	590,152
8	400,105	80,021	480,126
COST	3,991,167		
CONTING'Y		798,233	
TOTAL			4,789,400

RAILROAD CANAL

PROPOSED IMPROVEMENTS

2-60" - 509'

ITEM NO.	ITEM DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	Section 1 PRICE	20% CNTGNCY	PROJECT COST
1	Mobilization and Demobilization	1	LS	$50,000.00	50,000	$10,000	$60,000
2	Clearing and Grubbing	1	AC	$1,000.00	1,000	200	1,200
3	Sheeting	52000	SF	$11.00	572,000	114,400	686,400
4	Excavation	1345	CY	$3.00	4,035	807	4,842
5	Bedding	566	CY	$25.00	14,150	2,830	16,980
6	Filter Fabric	1923	SY	$2.00	3,846	769	4,615
7	2 - 60" Reinfoorced Concrete Pipe	1018	LF	$160.00	162,880	32,576	195,456
8	Sand	315	CY	$7.00	2,205	441	2,646
9	Backfill from excacvation	1345	CY	$3.00	4,035	807	4,842
10	Backfill from stockpile	1235	CY	$3.00	3,705	741	4,446
11	Utility Relocation	1	LS	$10,000.00	10,000	2,000	12,000
12	Drainage Line Modifications	1	LS	$4,000.00	4,000	800	4,800
13	Drainage Maintenance During Construction	1	LS	$10,000.00	10,000	2,000	12,000
14	Local Drainage	509	LF	$25.00	12,725	2,545	15,270
15	Safety Fencing	1040	LF	$6.00	6,240	1,248	7,488
16	Fertilizing and Seeding	1	AC	$350.00	350	70	420
	SUBTOTAL						$1,033,405
	Item Cost				$861,171		
	Contingencies					$172,234	
	Project Cost						$1,033,405

RAILROAD CANAL

PROPOSED IMPROVEMENTS

2-60" - 130'

ITEM NO.	ITEM DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	Section 2 PRICE	20% CNTGNCY	PROJECT COST
1	Mobilization and Demobilization	1	LS	$10,000.00	10,000	$2,000	$12,000
2	Clearing and Grubbing	1	AC	$1,000.00	1,000	200	1,200
3	Sheeting	8200	SF	$11.00	90,200	18,040	108,240
4	Excavation	273	CY	$3.00	819	164	983
5	Bedding	144	CY	$25.00	3,600	720	4,320
6	Filter Fabric	491	SY	$2.00	982	196	1,178
7	2 - 60" Reinfoorced Concrete Pipe	260	LF	$160.00	41,600	8,320	49,920
8	Sand	81	CY	$7.00	567	113	680
9	Backfill from excacvation	273	CY	$3.00	819	164	983
10	Backfill from stockpile	212	CY	$6.00	1,272	254	1,526
11	Utility Relocation	1	LS	$5,000.00	5,000	1,000	6,000
12	Drainage Line Modifications	1	LS	$4,400.00	4,400	880	5,280
13	Drainage Maintenance During Construction	1	LS	$5,000.00	5,000	1,000	6,000
14	Local drainage	130	LF	$25.00	3,250	650	3,900
15	Safety Fencing	164	LF	$6.00	984	197	1,181
16	Fertilizing and Seeding	1	AC	$350.00	350	70	420

SUBTOTAL			$203,812
Item Cost	$169,843		
Contingencies		$33,969	
Project Cost			$203,812

RAILROAD CANAL

PROPOSED IMPROVEMENTS

2-72" - 255'

ITEM NO.	ITEM DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	Section 3 PRICE	20% CNTGNCY	PROJECT COST
1	Mobilization and Demobilization	1	LS	$20,000.00	20,000	$4,000	$24,000
2	Clearing and Grubbing	1	AC	$1,000.00	1,000	200	1,200
3	Sheeting	29,300	SF	$11.00	322,300	64,460	386,760
4	Excavation	771	CY	$3.00	2,313	463	2,776
5	Bedding	340	CY	$25.00	8,500	1,700	10,200
6	Filter Fabric	1133	SY	$2.00	2,266	453	2,719
7	72" Reinfoorced Concrete Pipe	510	LF	$220.00	112,200	22,440	134,640
8	Sand	861	CY	$7.00	6,027	1,205	7,232
9	Backfill from excacvation	771	CY	$3.00	2,313	463	2,776
10	Backfill from stockpile	602	CY	$6.00	3,612	722	4,334
12	Drainage Line Modifications	1	LS	$17,000.00	17,000	3,400	20,400
13	Drainage Maintenance During Construction	1	LS	$20,000.00	20,000	4,000	24,000
14	Local Drainage	255	LF	$25.00	6,375	1,275	7,650
15	Safety Fencing	600	LF	$6.00	3,600	720	4,320
16	Fertilizing and Seeding	1	AC	$350.00	350	70	420
	SUBTOTAL						$633,427
	Item Cost				$527,856		
	Contingencies					$105,571	
	Project Cost						$633,427

RAILROAD CANAL

PROPOSED IMPROVEMENTS

1-60" RCP - 391', Including 120 Jack & Bore — Section 4

ITEM NO.	ITEM DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	PRICE	20% CNTGNCY	PROJECT COST
1	Mobilization and Demobilization	1	LS	$30,000.00	30,000	$6,000	$36,000
2	Clearing and Grubbing	1	AC	$1,000.00	1,000	200	1,200
3	Sheeting	27100	SF	$11.00	298,100	59,620	357,720
4	Excavation	1174	CY	$3.00	3,522	704	4,226
5	Bedding	181	CY	$25.00	4,525	905	5,430
6	Filter Fabric	662	SY	$2.00	1,324	265	1,589
7	60" Reinfoorced Concrete Pipe	391	LF	$160.00	62,560	12,512	75,072
8	Sand	152	CY	$7.00	1,064	213	1,277
9	Backfill from excacvation	603	CY	$3.00	1,809	362	2,171
10	Excavation to stockpile	571	CY	$3.00	1,713	343	2,056
11	Jack and Bore 60" Pipe	120	LF	$400.00	48,000	9,600	57,600
14	Drainage Maintenance During Construction	1	LS	$5,000.00	5,000	1,000	6,000
15	Local Drainage	271	LF	$25.00	6,775	1,355	8,130
16	Safety Fencing	100	LF	$6.00	600	120	720
17	Fertilizing and Seeding	1	AC	$350.00	350	70	420
	SUBTOTAL						$559,610
	Item Cost				$466,342		
	Contingencies					$93,268	
	Project Cost						$559,610

RAILROAD CANAL

PROPOSED IMPROVEMENTS

14' Flume - 458' | Section 6

ITEM NO.	ITEM DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	PRICE	20% CNTGNCY	PROJECT COST
1	Mobilization and Demobilization	1	LS	$65,000.00	65,000	$13,000	$78,000
2	Clearing and Grubbing	1	AC	$1,000.00	1,000	200	1,200
3	Cofferdam	45800	SF	$11.00	503,800	100,760	604,560
4	Excavation	3263	CY	$3.00	9,789	1,958	11,747
5	Backfill from Excavation	888	CY	$3.00	2,664	533	3,197
6	Excavation to Stockpile	1167	CY	$3.00	3,501	700	4,201
7	Bedding	1758	CY	$25.00	43,950	8,790	52,740
8	Filter Fabric	2560	SY	$2.00	5,120	1,024	6,144
9	Concrete Bottom Slab	491	CY	$180.00	88,380	17,676	106,056
10	Concrete Walls	204	CY	$300.00	61,200	12,240	73,440
11	Utility Relocation	1	LS	$300.00	300	60	360
12	Drainage Line Modifications	1	LS	$12,000.00	12,000	2,400	14,400
13	Drainage Maintenance During Construction	1	LS	$20,000.00	20,000	4,000	24,000
14	Safety Fencing	916	LF	$6.00	5,496	1,099	6,595
15	Fertilizing and Seeding	1	AC	$350.00	350	70	420
	SUBTOTAL						$987,060
	Item Cost				$822,550		
	Contingencies					$164,510	
	Project Cost						$987,060

RAILROAD CANAL

PROPOSED IMPROVEMENTS

Add 2-72" Pipes under Spur - 148' — Section 6

ITEM NO.	ITEM DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	PRICE	20% CNTGNCY	PROJECT COST
1	Mobilization and Demobilization	1	LS	$20,000.00	20,000	$4,000	$24,000
2	Clearing and Grubbing	1	AC	$1,000.00	1,000	200	1,200
3	Cofferdam	6800	SF	$11.00	74,800	14,960	89,760
4	Excavation	582	CY	$3.00	1,746	349	2,095
5	Backfill from excavation	180	CY	$3.00	540	108	648
6	Excavation to Stockpile	402	CY	$3.00	1,206	241	1,447
7	Bedding	111	CY	$25.00	2,775	555	3,330
8	Filter Fabric	393	SY	$2.00	786	157	943
9	Jack & Bore 72" Steel Pipe	160	LF	$700.00	112,000	22,400	134,400
10	Open trench Installation of 72" Pipe	136	LF	$200.00	27,200	5,440	32,640
11	Drainage Maintenance During Construction	1	LS	$5,000.00	5,000	1,000	6,000
12	Safety Fencing	80	LF	$6.00	480	96	576
13	Fertilizing and Seeding	1	AC	$350.00	350	70	420
	SUBTOTAL						$297,460
	Item Cost				$247,883		
	Contingencies					$49,577	
	Project Cost						$297,460

RAILROAD CANAL

PROPOSED IMPROVEMENTS

14' Flume at Confluence with Keyhole Canal - 268'

ITEM NO.	ITEM DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	Section 7 PRICE	20% CNTGNCY	PROJECT COST
1	Mobilization and Demobilization	1	LS	$30,000.00	30,000	$6,000	$36,000
2	Clearing and Grubbing	1	AC	$1,000.00	1,000	200	1,200
3	Cofferdam	26800	SF	$11.00	294,800	58,960	353,760
4	Excavation	2078	CY	$3.00	6,234	1,247	7,481
5	Backfill from Excavation	927	CY	$3.00	2,781	556	3,337
6	Excavation to Stockpile	1151	CY	$3.00	3,453	691	4,144
7	Bedding	1021	CY	$25.00	25,525	5,105	30,630
8	Filter Fabric	1487	SY	$2.00	2,974	595	3,569
9	Concrete Bottom Slab	282	CY	$180.00	50,760	10,152	60,912
10	Concrete Walls	119	CY	$300.00	35,700	7,140	42,840
11	Drainage Line Modifications	1	LS	$25,000.00	25,000	5,000	30,000
12	Drainage Maintenance During Construction	1	LS	$10,000.00	10,000	2,000	12,000
13	Safety Fencing	536	LF	$6.00	3,216	643	3,859
14	Fertilizing and Seeding	1	AC	$350.00	350	70	420
	SUBTOTAL						$590,152
	Item Cost				$491,793		
	Contingencies					$98,359	
	Project Cost						$590,152