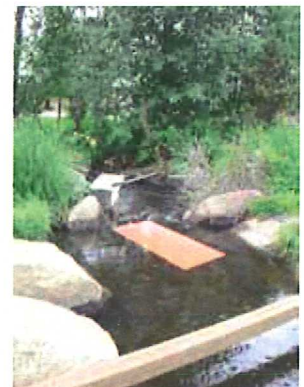


CHESTER CREEK RESTORATION MULDOON GREENHOUSE PROPERTY PLANNING REPORT



OCTOBER 24, 2007

CLIENT: ANCHORAGE PARK FOUNDATION

KPB ARCHITECTS PROJECT NUMBER: A1027.01-119/121



kpb architects
an literature planning interior design design build

CHESTER CREEK RESTORATION, MULDOON GREENHOUSE PROPERTY PLANNING REPORT

INTRODUCTION

The Municipal Parks and Recreation Department, the Heritage Land Bank and the Office of Economic and Community Development has initiated a process with the goal of establishing a best use planning vision for the property commonly referred to as the "greenhouse property" in Muldoon.

The Municipality took control of the parcel over a year ago to ensure that its ultimate development fits various community goals. In coordination with the Great Land Trust the easternmost 11.5 acres was conveyed to municipal park land and future park uses. The municipality is currently in the process of determining the best and highest value community use for the remaining ~16.5 acres.

The greenhouse property includes an approximately 3,000 feet long section of the South Fork of Chester Creek. Any future use of the parcel will be linked to and dependent upon the well documented need for the restoration of Chester Creek at the western half of the property and its crossing under Muldoon Road.

In coordination with the U.S. Fish and Wildlife Service the Anchorage Park Foundation contracted KPB ARCHITECTS to investigate background information, conduct preliminary hydraulic modeling for the creek, study the planning context and prepare a planning report. The purpose of the report is to present a recommendation for the highest and best use of the parcel based on the accumulated information.

The criteria to determine the highest and best use includes – sometimes competing – objectives as follows:

- a) Identify an ecologically sound restoration concept for both branches of Chester Creek that is sustainable for the long term with expected development pressure
- b) Establish trail connectivity between the new park land on the east and new development west of Muldoon Road that includes the new Begich Middle School
- c) Recommend a preliminary platting concept that addresses land uses, legal and physical access, dedications to Rights of Way and easements while creates the highest market value contiguous tracts or lots
- d) Provide the highest community value with the least infrastructure cost borne by the community
- e) Reduce impacts on and increase value of the surrounding parcels
- f) Maintain or enhance the functionality of the existing transportation infrastructure
- g) Consider options best suited for the least complex, least costly and most viable implementation strategy for construction

The information used for this report is obtained from a multitude of sources. Already existing surveys, planning documents, restoration plans and reports, hydraulic modeling and survey verification of existing infrastructure had all been part of the analysis that resulted in the recommendation of this plan. This data is referenced throughout the report and presented in attachments. In coordination with the USFWS, KPB ARCHITECTS also prepared and included a detailed technical memorandum in this planning document to aid planning for funding and construction of the creek restoration that is crucial for any future development of the greenhouse property.



SUMMARY OF RECOMMENDATIONS

CREEK RESTORATION

The culvert crossing under Muldoon Road for the South Branch of the South Fork of Chester Creek has long been identified by various resource agencies as a major obstacle to its ecological functionality. The stakeholders' proposed solution has long been removal of this obstacle and full replacement of the crossing.

The creek runs through the commercially zoned portion of the greenhouse property upstream from the crossing weaving in and out of the DeBarr Road right-of-way. This section has been impacted by the former greenhouse operation, continued streambank degradation due to trampling and debris in the streambed.

Immediately downstream from the crossing the North Branch tributary daylights from a culvert and joins the South Branch in a ditched section along Muldoon Road.

The current conditions don't only impact creek habitat, but make proper land planning and infrastructure development impossible at the high volume and high visibility junction of Muldoon and DeBarr Roads.

In coordination with USFWS we recommend full realignment and restoration for the creek in this area. We devised a plan which offers a new alignment that restores habitat values and hydrologic functionality in a properly designed new channel of about ~1,550 feet length. The restoration starts at the end of the already restored section downstream and extends to the Northeast side of the hill on the greenhouse property. It includes removal and abandonment of the existing crossing, installation of a box culvert crossing on Muldoon Road north of the East 14th Avenue alignment, and construction of a new channel along East 14th Avenue and the base of the hill to join the existing creek channel.

We discovered that the critical limiting factor for any realignment and restoration plan is the North Branch of the South Fork of Chester Creek. This branch was diverted in a culvert from its natural alignment by AKDOT in the 1970s and connected to the South Branch at the intersection of Muldoon and DeBarr Roads.

We consider independent restoration of the North Fork unfeasible in the current development context. The culvert under Muldoon Road does not only serve as the diversion channel for the North Branch, but also as the stormwater conveyance system for developed properties along Muldoon Road south of East 11th Avenue. We recommend extension of the existing 48" culvert to the proposed South Branch alignment and creation of a shallow vegetated channel of about 200' length at the new confluence. The existing channel along Muldoon Road will be filled and reclaimed for other uses. Sheet L1.1 in the attachment shows the restoration plan in further detail.

We designed the realignment to take into account existing grades, infrastructure and adjacent land uses in addition to principles of stream geomorphology. We created a hydraulic model for the design studying various creek flows to ensure that the new alignment can properly function without impacting existing and new development. The model was prepared by Mel Langdon P.E. and can be reviewed in the attachment.

The long term sustainability of any land and infrastructure development on the greenhouse property and its vicinity is inherently tied to the successful and timely execution of the creek realignment and restoration plan. It is a critical component that can also be the impetus for new development activity in the Northeast area of the Bowl.

TRAIL CONNECTIVITY

The newly acquired park parcel on the east 11.5 acres and the new development of housing, mixed uses, retail and a middle school west of Muldoon Road require strong trail connectivity in addition to the necessary future upgrades of the road infrastructure. The Planning and Zoning Commission approved Creekside Town Center Master Plan Framework developed by KPB ARCHITECTS for the developers of the former Alaska Village Trailer Park property established a trail connection concept for the area. It envisions a trail system in a greenbelt corridor along Chester Creek. Although the Chester Creek Greenbelt is discontinuous or non-existent in the Muldoon area it is essential that any new development plans its segment of the greenbelt and associated trail connection. Creek restoration along ~1600lf of creek and establishment of development setbacks along the whole length of the creek corridor has taken place as part of planning and development of the former Alaska Village property. This effort laid the groundwork for future design and construction of the trail west of Muldoon Road.

We recommend establishment of the greenbelt corridor east of Muldoon Road as well to allow development of a well connected trail system. The trail can be located in this corridor for the whole length of the creek, but the crossing of Muldoon Road poses a special challenge. We recommend the trail alignment that provides a separated trail for its full length, but with at grade crossing at Muldoon Road and at least two driveways for parcels to be developed in the future. The main trail will be connected to adjacent development with connecting spur trails and creek crossings as necessary. The alignment of the recommended trail is shown on Sheets L1.1 and L1.2 in the attachment.

We consider the proposed at grade trail crossing of Muldoon Road the most viable alternative at this time.

We explored options in which the creek crossing under Muldoon was paired with an underground trail crossing, but this scenario proved out to be unworkable due to engineering constraints in clearances and creek elevations. We also concluded that a combined trail and creek crossing under Muldoon road can only be feasible with the modification of road grades for Muldoon Road. This scenario would greatly impact access to Muldoon Road from adjacent parcels as it raises the road grade about 3'-4' upwards thus requiring the full reconstruction of several hundred feet length of Muldoon Road.

We further explored options for an elevated trail crossing and found that it would significantly impact properties on both sides of Muldoon Road. It would require funding to acquire land for bringing the trail down to grade and investment in a bridge structure with a span in excess of 100'. Although this solution is technically feasible we recommend against this solution at this time mainly for the lack of funding.

Lastly we considered an independent underground trail tunnel crossing under Muldoon Road near the new creek crossing. This solution is technically feasible as well and requires less impact on adjacent parcels. However this option poses significant engineering challenges in resolving storm and deep utility conflicts, particularly with sanitary sewer. The section of the trail that will fall below creek elevation would require drywells for drainage, a non-standard solution that appears feasible due to well-drained soils, but poses engineering challenges. We recommend this option for a future upgrade of the trail system when higher user demand due to full build-out of redeveloped parcel can justify the higher funding levels.

LAND PLANNING

We conducted the analysis for the creek realignment and trail connectivity planning in the context of current zoning, land use and anticipated future land and infrastructure development. The greenhouse property is commercially zoned (B-3 SL) along Muldoon Road and residentially zoned (R2-M) for the rest of the land area.

We recommend to maintain the current zoning of the property without boundary adjustments. This approach is the most viable to plan for the predictable and timely development of the parcel.

In order to protect the community's anticipated investment in creek restoration we recommend to establish a continuous tract along the creek. We recommend this tract to be dedicated as municipal park land to preserve the greenbelt and the creek habitat for perpetuity. The greenbelt tract is set to 100' width to allow proper planning for creek restoration and trail access. This width is also consistent with the current thinking of the municipal Planning Department and the Watershed Management Division for development setbacks along creeks and streams in the Anchorage Bowl.

We devised a creek restoration and trail planning strategy that allows the greenbelt dedication to be less than 100' along the East 14th Avenue alignment and the southwest side of the hill in order to maximize land value for proposed Tract A, which is commercially zoned. In this area a 70' corridor paired with a 30' ROW dedication makes up the preferred corridor width.

We recommend half dedication on East 14th Avenue to allow the full ROW to be available for access improvements to the proposed Tract B residential parcel and the existing privately owned parcels to the south. Tract B encompasses the entire hill and offers a very desirable residential property for its views, adjacencies and good soil. We recommend the remaining residential parcel (Tract C) to be a contiguous tract that offers good access to DeBarr Road and is bordered by the new greenbelt and the new municipal park parcel (Tract D/Lot 3) to the east. Future development plans will establish the most suitable development pattern that considers the poorer soils that are generally expected in this area.

✓-THIS
CASE FOR
REQUIREMENTS

A 35' half dedication for the future DeBarr Road extension has already been recorded with plat # 2007-18 along the north property line of the greenhouse parcel. This dedication is consistent with the requirements of a 1B neighborhood collector that can be constructed in the future to serve the new park parcel.

We recommend dedication of a 15' wide trail easement along DeBarr Road to ensure that a fully separated trail will properly fit next to the future neighborhood collector without interference in winter maintenance operations.

Additional 15' trail dedications are also needed along various sections of the greenbelt to ensure that a separated trail system can be constructed and maintained in the future.

We recommend to widen the trail easement to 30' at the southwest corner of proposed Tract C. This is necessary to overcome the elevation differences along the bluff in this area.

MAYBE
MAYBE-NOT

Extension of the North Branch culvert along Muldoon Road creates better interface between the commercial properties and Muldoon Road. It is also the most appropriate solution to establish a new trail easement along Muldoon Road. It is crucial that the trail be separated from the high traffic volume in this areas.

Sheet L1.2 in the attachment presents the recommended preliminary plat for the greenhouse property.



INFRASTRUCTURE DEVELOPMENT

Future development of the greenhouse parcel requires significant investment in infrastructure - especially for transportation infrastructure - in addition to the investment required for the creek realignment itself.

The extension of DeBarr Road east of Muldoon is one of the required major infrastructure improvements that are needed at full build-out of the parcel. This extension is envisioned by the municipality as a neighborhood collector to appropriately serve the new park parcel on the east end of the greenhouse property. It will also provide needed access to the new Tract A commercial parcel. That parcel will only be accessible for westbound traffic from Muldoon Road after the extension is complete. No work can be completed for the DeBarr road extension near Muldoon Road without modification to the Chester Creek alignment in the ROW and without reconstructing the creek crossing itself. The DeBarr Road extension will be a major traffic engineering undertaking to achieve the appropriate level of service for this major intersection.

The new creek crossing itself is a significant project. We recommend to scope this project in such a way that both initial costs and long term maintenance costs can be reduced and recommend a 19' wide box culvert at the new location. The hydraulic modeling proves that this 19' wide box culvert is sufficient for the South Branch of South Fork Chester Creek crossing under Muldoon Road. The attached technical memorandum provides more detailed background for this project.

The creek crossing under Muldoon Road is proposed in a way that the impact on existing infrastructure is lessened. Still, a natural gas line and the existing storm sewer system will be affected. The gas line will remain in place with adequate protection at the crossing. We do recommend proactive modifications to the storm sewer system for the area. The existing storm system serves drainage needs along Muldoon Road extending to the south. The storm system has a terminal outfall into the existing creek north of the proposed new creek crossing. Due to creek elevations the storm system is necessarily impacted by the new creek crossing. We recommend the existing storm system along Muldoon Road to be disconnected at the East 16th Avenue alignment and connected into the Creekside Center Drive Phase 3 storm system employing proper sediment control and water quality protection measures. The remaining section along Muldoon Road may remain in place with proper sediment control at the creek or evaluated for abandonment.

TEAR UP
THE NEW
ROAD?!

East 14th Avenue is currently an unimproved half dedication. The former vehicle service shop immediately south of this alignment has been demolished this summer and new construction activity is expected on this lot with Muldoon Road frontage. We recommended a 30' dedication for this ROW above to access the proposed Tract B residential parcel. This dedication will provide legal access. Improving physical access along this alignment is a necessary infrastructural investment that will increase land values to Tract B and the currently poorly served private parcel to the east as well. We recommend street improvements to urban secondary street standards with minor residential classification and a modified cross section. An asymmetrical cross section that shifts the street southward allows construction of a separated walkway along the new creek alignment while providing additional width to the creek corridor. The separated walk way will connect the existing Muldoon Road sidewalk with new development on Tract B. We recommend one sidewalk along north side of the road in this alignment as sufficient to serve the area.

IMPLEMENTATION STRATEGY

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The key to implementation of the overall land development concept is the funding, coordination and construction of the creek realignment. All other projects are dependent on the successful implementation of the creek realignment and restoration plan. There are numerous tasks that need to happen immediately and - in many instances - concurrently while others can follow in later phases. Many of the tasks are overlapping between planning and implementation, between various municipal departments and between private and public stakeholders.

We strongly recommend the creation of a singular management entity that can address the various funding, planning, design and implementation related tasks in one coordinated effort. The complexity of the project necessitates that it be supported from a single point in terms of management. Regardless of this being a public or a contracted entity, the task requires familiarity with the project and the processes to make sure that project elements don't fall behind or fall through the cracks.

Following is a list of tasks we identified in our analysis.

TO EARLY
- NEED RE-REVIEW
ONDED. APPROACH

Task A. Initiate the platting process for the greenhouse parcel based on the recommendations in this document.

- a) Identify management entity, project team and funding for the platting task
- b) Prepare preliminary plat (It will be a long plat this time.)
- c) Complete the public hearing process and resolution of plat conditions
- d) Record the plat and dedicate the tracts that remain in public ownership

CURRENT
TASKS

Task B. Secure funding for the creek restoration project described in this document.

- a.) Identify management entity, project team and funding for the funding task
- b.) Coordinate with stakeholders using the attached technical memorandum as the basis of design and establish funding level sought
- c.) Enter into agreements for funding support

Task C. Devise and implement a construction plan for creek restoration.

- a.) Identify management entity, project team and funding for the construction task
- b.) Establish delivery method and identify contracting entity
- c.) Complete engineering, project coordination in area, permitting and pricing
- d.) Complete/manage construction of restoration project

Task D. Establish a land management/real estate strategy

- a.) Identify management entity, project team and funding for land issues
- b.) Analyze the market value of new parcels and make decisions on their sale
- c.) Market excess land inventory
- d.) Craft land sale agreement that is coordinated with creek restoration effort

Task E. Plan for future infrastructure improvements

- a.) Identify management entity, project team and funding for land issues
- b.) Scope the various infrastructure projects for the surrounding area
- c.) Establish priority list and identify funding sources for each
- d.) Place the projects in the appropriate mechanism for planned delivery
- e.) Provide periodic follow-up and tracking

SCHEDULING AND COORDINATION

Scheduling and executing the above tasks in a planned timeline is crucial for the various projects to happen. There are ongoing projects in the area, land development plans being crafted and decisions being made, land sales are in progress, funding opportunities emerge and disappear. A critical path for various tasks exists in the very near term that can make execution of the project less costly, lengthy and complicated.

The most critical component for any action on the greenhouse property in terms of coordinated land development decisions for the long term is the construction of the creek realignment. There are several immediate tasks to coordinate in relation to this project.

1. Engage the Creekside Center Drive Phase 3 project manager in order to properly plan for the impacts of the new creek crossing on the existing storm sewer system under Muldoon Road. We coordinated with the engineering team for that project (DOWL Engineers) to assess the feasibility of tying the Muldoon Road storm sewer system into the new Creekside Center Drive Phase 3 system that is currently at 95% level design completion. We learned that tying the existing Muldoon Road system into the Creekside Center Drive system is feasible in terms of grades. The Creekside Drive project does not currently have the capacity to handle the flows from the Muldoon Road storm sewer system. An upsized and extended system with appropriate capacity water quality protection measures is needed in the Creekside Drive Phase 3 design in anticipation of the future creek crossing work on Muldoon. Construction of the Creekside Drive Phase 3 project is planned for the summer of 2008.

2. Coordinate and execute an agreement with the landowners in the creek restoration impact area west of Muldoon Road in order for the project to take place. Resolution on funding mechanisms and sources, a clear path of project delivery and an appropriate contracting entity representing the municipal side is needed for this step to be meaningful.

3. Prepare the design documentation for the Muldoon Road crossing. The structural and civil engineering work for the box culvert design can be in place relatively fast, if the recommended solution is embraced, depending on the project delivery method. The creek crossing will require a standard review process by the Federal Emergency Management Agency, which process may take several months.

There are several options for initiating the design work following the decision about the creek crossing and land development scenarios. If the delivery method for the project is design-build, design work can start immediately after the D/B team is engaged.

The standard PM&E delivery methods are also available by either engaging the Creekside Center Drive consultant team or by selection of a new consultant team using the standard selection process through Municipal Purchasing and PM&E. The Creekside Center Drive team has already proposed services for the crossing work as part of its original scope and can ramp up for the engineering scope by a new task order. A new consultant team will have to be selected, contracted and engaged in a compressed timeframe if that is the chosen route for obtaining the necessary design.

4. Develop a plan for executing the improvements in the west 14th Avenue corridor in order to provide access to Tract B.

LIST OF ATTACHMENTS

Sheet L1.1 - Creek Corridor – Land Development Plan, (1 page 11x17)

Sheet L1.2 - Creek Corridor – Realignment Plan, (1 page 11x17)

Technical Memorandum: Chester Creek Crossing at Muldoon Road; Bill Rice, PE, US Fish and Wildlife Service (8 pages, 8.5x11)

Sheet PL-1 – Proposed Creek Plan and Grading (1 page 11x17)

Sheet PL-2 – Proposed Creek Plan and Grading (1 page 11x17)

Sheet SK-1 – Typical Riffle Cross Section (1 page 8.5x11)

Sheet SK-2 – Typical Pool Construction (1 page 8.5x11)

Sheet SK-3 – Typical Culvert Cross Section (1 page 8.5x11)

Sheet SK-4 – Typical North Branch Channel (1 page 8.5x11)

Sheet SK-5 – Typical Pool Construction (1 page 8.5x11)

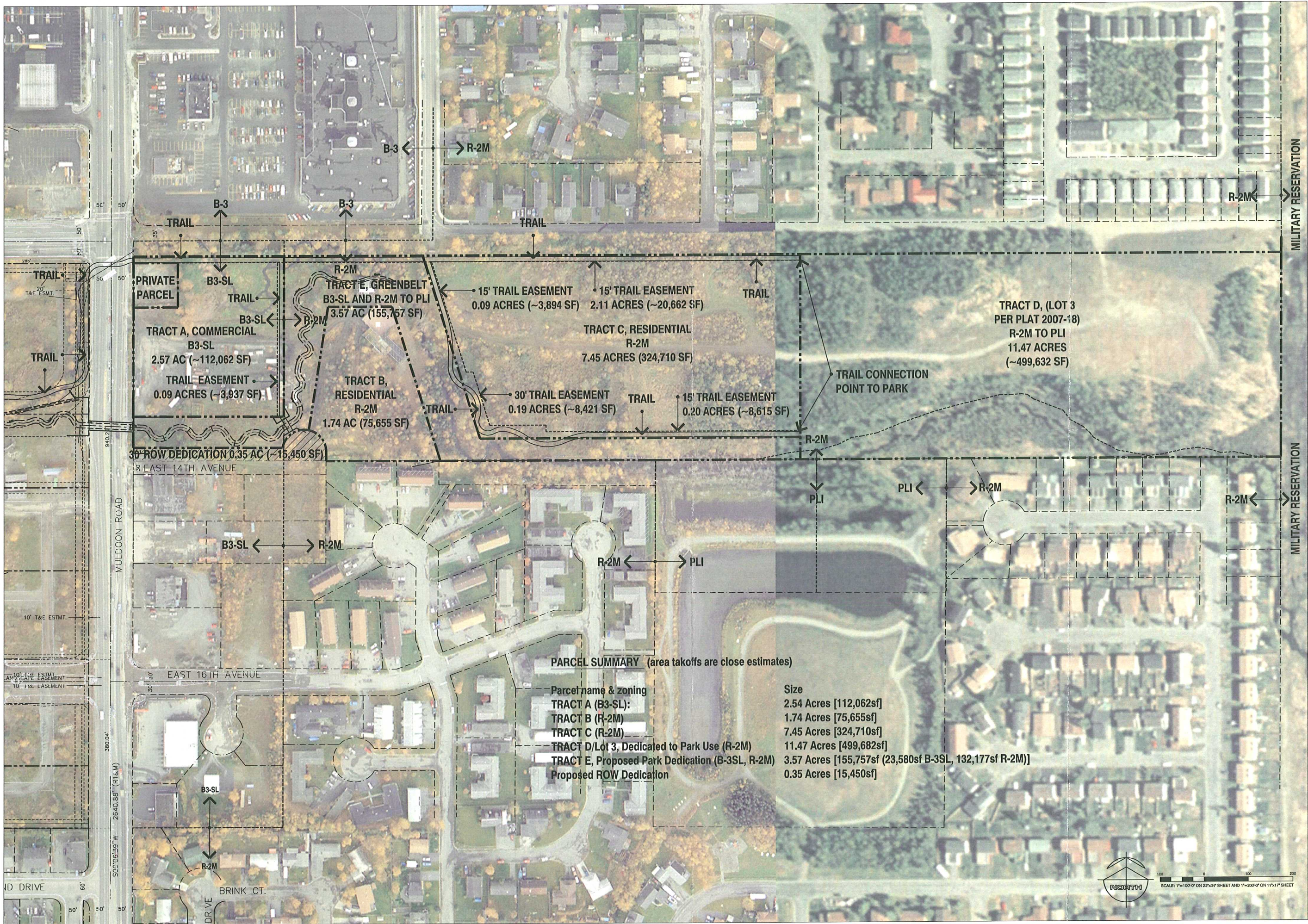
Sheet SK-6 – Typical Pool Construction (1 page 8.5x11)

Hydraulic Modeling of South Fork of Chester Creek near Muldoon Road; Mel Langdon, PE, Fluid Solutions (11 pages 8.5x11)

Survey Field Notes of storm sewer system as-built field verification, Larsen Engineering (4 pages 8.5x11)

As-built sheets 1, 7, 34, 35, 36, 37 Muldoon Road Grading, Drainage, Surfacing, Illumination and Signalization Project AKDOT M-0544(1) 1976 (6 pages 11x17)

Muldoon Estates Subdivision ("Greenhouse property") Plat #2007-18 (2 pages 11x17)



PARCEL SUMMARY (area takoffs are close estimates)

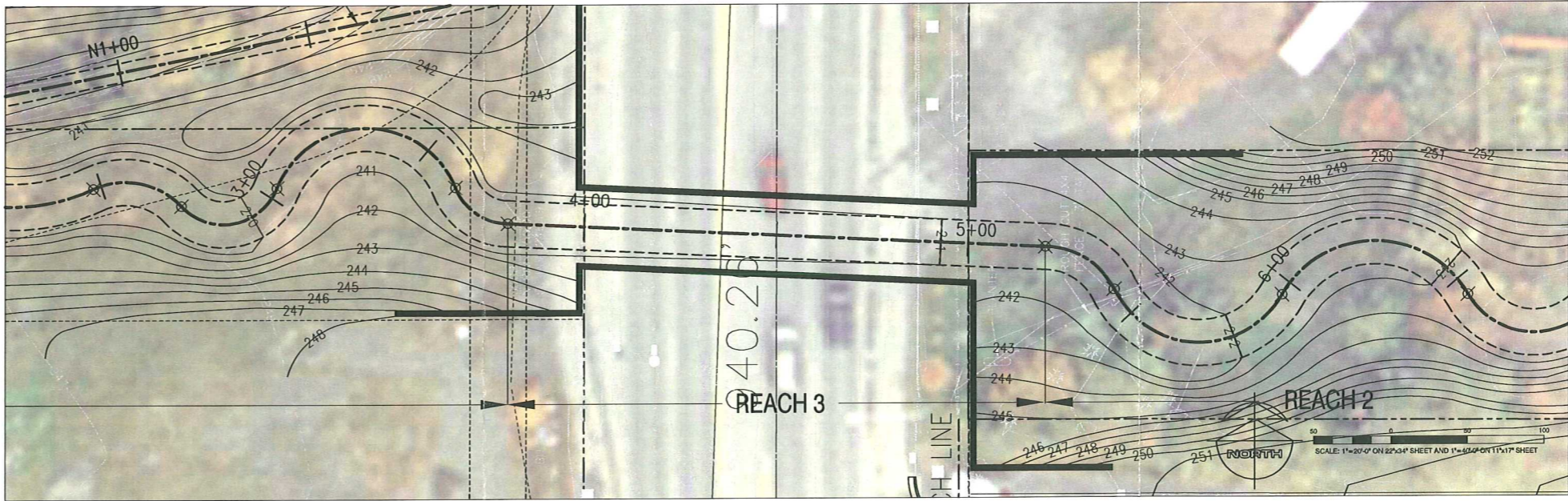
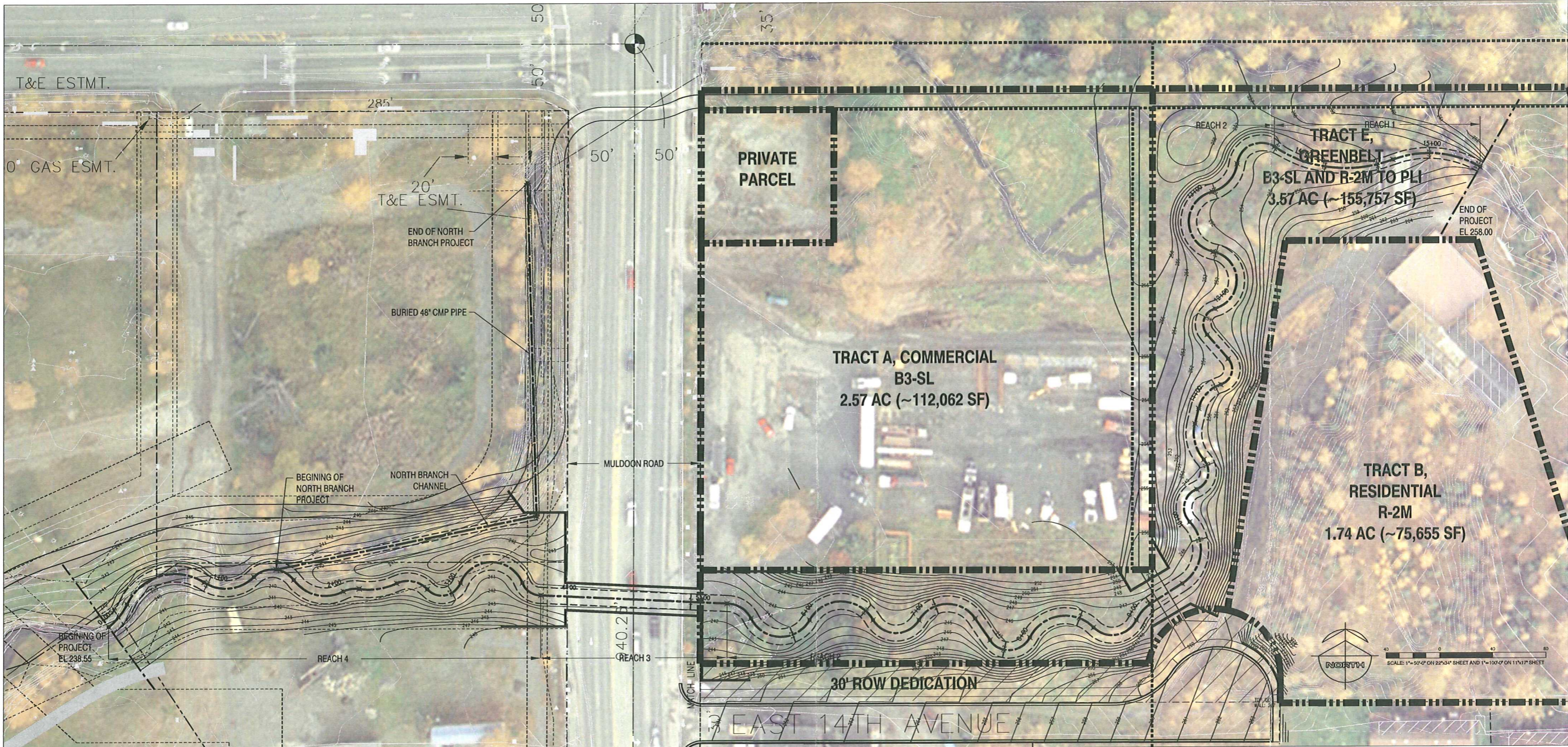
Parcel name & zoning	Size
TRACT A (B3-SL):	2.54 Acres [112,062sf]
TRACT B (R-2M)	1.74 Acres [75,655sf]
TRACT C (R-2M)	7.45 Acres [324,710sf]
TRACT D/Lot 3, Dedicated to Park Use (R-2M)	11.47 Acres [499,682sf]
TRACT E, Proposed Park Dedication (B-3SL, R-2M)	3.57 Acres [155,757sf (23,580sf B-3SL, 132,177sf R-2M)]
Proposed ROW Dedication	0.35 Acres [15,450sf]

Green House Property Chester Creek Re-Alignment Anchorage, AK

REVISIONS

JOB NO.	A1027.01-119
DATE	10-01-2007
DRAWN	TDE/EL
REVIEWED	TD

**CREEK CORRIDOR
LAND DEVELOPMENT
PLAN**



Green House Property Chester Creek Re-Alignment Anchorage, AK

REVISIONS	

JOB NO.	A1027.01-119
DATE	10-01-2007
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CREEK CORRIDOR
REALIGNMENT
PLAN

SHEET NO.
L1.2



United States Department of the Interior

FISH AND WILDLIFE SERVICE

Anchorage Fish & Wildlife Field Office
605 West 4th Avenue, Room G-61
Anchorage, Alaska 99501-2249

Technical Memorandum: Chester Creek Crossing at Muldoon Road

Date: September 16, 2007
Updated: October 12, 2007
From: Bill Rice, P.E.
To: Parks Foundation

This technical memorandum proposes a concept design for creek relocation in coordination with land development strategies for Municipal land southeast of Muldoon Road and Debarr, commonly referred to as the Greenhouse property.

Overview

With current re-development of the area surrounding Chester Creek and Muldoon Road, the Municipality and other groups desire to develop the area in conjunction with human and wildlife amenities that will enhance the quality of life in the community and increase safety from flood events. The creek has been identified as providing a focal point for the community and a natural feature that surrounding development can take advantage of.

Although straightened in the past as the creek passes a gravel till hill on the north side of the property, Chester Creek, in general, retains its historic location until it passes Muldoon Road at the Debarr intersection. The creek is littered with debris from previous buildings when the area was covered by greenhouses. The street infrastructure has resulted in higher pollutant runoff to the creek as it crosses under Muldoon Road, as intersections are typically sanded and salted throughout the winter with no treatment available prior to entering the creek. Maintenance of the crossing culvert at the intersection is also problematic due to the proximity of the intersection. AF&G, FWS and the firm HDR have determined the culvert is a partial barrier to adult salmonids, and likely a complete barrier to juvenile salmonids.

During construction of Muldoon Road, a north branch of Chester Creek was diverted and enclosed within a pipe a quarter-mile to a discharge point at the southwest corner of Debarr and Muldoon into the main branch of Chester Creek. As it came from another drainage of the watershed, its elevation was low compared to the main Chester Creek, resulting in a 5 foot drop of the road culvert to catch the north branch's new discharge point. This situation has significantly contributed to backwatering of flood events that have inundated the intersection from time to time.

The creek was modified into a ditch west of Muldoon road in the 1960's for a trailer park development. The ditched creek takes two 90 degree bends in a 10 foot deep trench, with no slope to the creek profile until a bridge about 150 feet west of Muldoon. In 2004,



restoration of the creek in much of the trailer park area was completed, and this remaining area of the creek was not restored to give maximum flexibility in realigning the creek on the east side of Muldoon Road

There has been some history of evaluation of creek realignment for the greenhouse property area. Prior to 2004, the firm KPB showed creek realignment as an option and amenity for the area town center plan. In 2004, the firm HDR produced a report for EPA giving some options for creek realignment east of Muldoon Road. Also in 2004, the developers Venture Development and Cook Inlet Housing Authority restored a quarter-mile of creek on the west side of Muldoon Road. In 2006, the US Fish and Wildlife Service contracted a survey of the Greenhouse Property and were given permission from the landowners at that time to evaluate options using the survey information. Also in 2006, a report on restoration prioritization opportunities by the firm HDR for the Municipality of Anchorage listed the restoration of the creek west and east of Muldoon Road as the #3 priority project for the Chester Creek watershed.

Assessment

Upstream of Muldoon Road, the South Fork of Chester Creek watershed composes about 10.6 square miles and includes 17 miles of creek. This area also includes the greenhouse property now owned by the Municipality (0.55 miles) and headwater areas (16.4 miles). Just downstream of Muldoon Road, the watershed area comprises 14 square miles of creek from Muldoon Road, which includes the north tributary contributory watershed area.

The natural channel has a simple cross-section. Average high flow depths are 2 to 3 feet, with width averaging 8 to 12 feet at bankfull level. There is little woody debris or large rocks.

Chester Creek has a year-round base flow of 1 to 3 cfs. Storm may generate estimated flows up to 20 cfs in this reach (NRCS, 2002), and 100-year flows determined for flood hazard mapping are 230 cfs west of Muldoon Road and 190 cfs east of Muldoon Road. Two-year bankfull flows were determined to be 28 and 22.5 cfs, respectfully (Langdon, 2007). Downstream restoration in 2004 found that groundwater depths are about 15 feet below the ground surface and this is expected within this restoration project also (NRCS, 2004).

In general, the banks of Chester Creek are composed of silts, sands, and gravels. Bed material is subangular and subrounded gravels and cobbles that average 1 to 3 inches. The current grade of the stream varies from 2.6% in the upper realignment area as the creek goes around the till hill to 0.1% west of Muldoon Road.

Water quality is thought to be fair to good until the stream meets Muldoon Road. Runoff from urbanized areas directly to the stream and delivered through storm drains along the north tributary under Muldoon Road are thought to be the primary sources of pollutants. These pollutants may be nutrients from lawn fertilizers, sediment and hydrocarbons from roads and parking lots, bacteria, chemicals from lawn and gardens.

The proposed creek realignment affects approximately 1200 feet of existing stream, from the end of the previous restoration site in 2004 upstream through Muldoon Road to the north side of the existing till hill. The creek will not be realigned or otherwise affected upstream from this point. The proposed realignment and restoration creates 1538 feet of new stream. The existing stream can be broken into three sections: upstream of the Greenhouse Reach, the Greenhouse Reach, and the Muldoon Drop, which includes the culvert and adjacent downstream section of the creek. Table 1 includes currently available physical and habitat surveys from MOA and personal field observations.

Table 1. Creek Surveys

	Upstream of Greenhouse Reach Around Till Hill	Greenhouse Reach Through Commercially- Zoned Section	Muldoon Drop
Channel Class	Riffle/Step-Pool	Run	Flat
Stability	Stable	Stable	Stable
Modification	Moderate	Moderate	High
Bankfull Depth (ft.)	1.5	1.3	1.3
Bankfull Width (ft.)	8.3	10.4	14.5
Width/Depth Ratio	5.5	8	11.1
Sinuosity	<1.1	1.6	1.0
Slope	2.6%	1.25%	0.1%
Bed Material	Cobble/Boulder	Gravel/Cobble	Sand/Gravel
Bank Material	Cobble/Peat-Root	Peat-Root	Sand/Gravel
Canopy	>75%	>75%	20-50%
Bank Undercut	10-30%	<10%	<10%
Radius of Curvatures	85,92	18.8,28.3,22.6,40.4	None

As a comparison to similar restoration, an assessment of 100 feet of the previously restored reach was performed approximately 150' downstream of the existing single-lane bridge on the Alaska Village property west of Muldoon Road. This area as constructed had a radius of curvature of 18-20, a profile slope of 0.8%, sinuosity of 1.3. The channel was designed for a 12 foot bankfull width and 1.1 foot depth, with 15 foot or more width at pool sections.

Proposed Treatments

The following treatments are proposed for creek restoration, based on assessment data and experiences with the 2004 channel restoration downstream:

- Create a platted, formal corridor for the creek
- Realign the creek for higher amenity value to both humans, fish and wildlife, improve the road crossing and minimize future conflicts with development.
- Install instream structures to provide habitat diversity for aquatic organisms.

- Replace road crossing with new, fish and small mammal friendly crossing under Muldoon Road.
- Plant native climax community vegetation as 1) grasses and willows in the annual floodplain and 2) groves of birch and spruce with understory shrubs above the annual floodplain.

Design

The new stream can be broken into:

Reach 1 -- Upstream of the Greenhouse reach as the stream wraps around the till hill

Reach 2 -- The flat-featured greenhouse reach

Reach 3 -- The channel in the culvert under Muldoon Road

Reach 4 -- The culvert downstream to about 100 feet past the existing single lane bridge and end of the 2004 restoration. Reconstruction of an appropriately designed pedestrian bridge will take place in the same approximate area by the developers of the property at the time of creek restoration or in the future, but details of its design are not part of this technical memorandum

Table 2 are the design parameters based on assessment data and previous design for 2004 channel restoration. Parameters compensate for urban environments yet stay within the basic range of dimension, plan and profile of emulated stream type (Rosgen, 1996).

Table 2. Design Parameters

	Reach #1	Reach #2		Reach #3 Crossing		Reach #4		Reach from 2004	
	Riffle	Riffle	Pool	Riffle	Pool	Riffle	Pool	Riffle	Pool
Bankfull Depth (ft.)	1.5	1	2	1		1	2	1	2
Bankfull Width (ft.)	8	12	15	12		12	15	12	15
Width/Depth Ratio	5.3	12		12		10		12	
Bankfull Area (sf)	12.1	12	30	12		12	16.5	12	16.5
Sinuosity	<1.1	1.4-1.6		1.0		1.2		1.3	
Slope	2.48%	1.50%		0.50%		0.50%		0.8-1.0%	
Bed Material	Cobble Boulder	Gravel Cobble		Gravel Cobble		Gravel Cobble		Gravel Cobble	
Bank Material	Cobble/Peat Root	Cobble/Peat Root		Cobble Boulder		Cobble/ Peat Root		Cobble/ Peat Root	
Radius of Curvature	80-95	18-28		None		20-40		18-20	

Reach #1 is a higher gradient area. The riffle channel slope is currently 2.6% and this will decrease to about 2.5% for the new channel. This riffle complex will be designed with boulders and woody debris to provide resting areas for fish as a roughened channel with cross vane step pool features.

Reach #2 contains most of the channel as it passes through the commercial property to Muldoon Road. The channel slope will decrease to 1.5% and be composed of a riffle-pool sequence with a sinuosity of around 1.5. Riffles will be design as in Reach #1 with boulder cross-vane construction on the downstream ends. Pools will be constructed with glides prior to the next riffle and will typically be located along the outside of each meander bend with point bar formation on the inside of the bend.

Reach #3 will go through a 19-foot culvert and be straight with boulders providing riffles and with an upstream transition area to 0.5% slope. Streambanks will be created within the culvert with about 4 feet width on either side of the channel. Substrate will be designed to stay stable at the 100-year storm event.

Reach #4 will maintain a 0.5% slope to its connection to previous 2004 restoration and have some sinuosity. The north fork will be extended with pipe to the floodplain and discharge into a treatment swale that will meet the channel. Reach #4 has a catch point downstream approximately 100 feet into the 2004 restoration project. The North Branch is sloped 0.18% under Muldoon Road and this slope will be carried through to the new stream alignment.

Hydrologic analysis attached show that the channel and floodplain work well during the estimated 100-year event and that the channel bankfull is at the 2-year event. A 19-foot box culvert was shown to be acceptable at the 100-year flood event with at least two feet of freeboard (Langdon, 2007).

Note that due to groundwater levels being much lower than the existing stream, a layer of silty gravel will need to be placed under the new streambed to act as a less permeable layer and keep the stream continuing along the surface.

Substrate is as shown on the Drawings and can be finalized further prior to construction. The streambed substrate is rounded to subangular sandy, gravelly cobbles, while the barrier layer is silty sand with gravel. The streambed substrate is designed to stay stable during most flood events while the silty sand with gravel layer will decrease infiltration into the surrounding gravels and will prevent losing stream to groundwater in this area.

Site plans and sections describe the design concept in more detail in the attachments.

References:

Langdon, Mel, September 30, 2007. Revised Hydraulic Modeling of South Fork of Chester Creek near Muldoon Road

HDR, 2003. Chester Creek at Muldoon Town Center Conceptual Design Report. Produced for EPA by HDR Alaska, Inc., March. 2003. 19 pp.

NRCS, 2002. Technical memo from Rob Sampson, P.E. NRCS State Conservation Engineer to Mark Pfeffer, Koonce Pfeffer and Bettis. Subject: ENG – Muldoon Town Center and Chester Creek. August 6th. 5 pp,

Rosgen, Dave 1996. Applied River Morphology. Printed Media Companies, Minneapolis, Minnesota.

Proposed Construction Sequence

The project is proposed in three phases – A,B and C. This is due to the different aspects involved with each phase. Phase A is the channel east of Muldoon Road. This channel will be created in the dry and prepared prior to stream diversion. Phase B is the culvert crossing construction under Muldoon Road. This can also be constructed in the dry but has many infrastructure aspects to its installation other than channel design. Phase C is the downstream portion west of Muldoon Road to the beginning of the project at the upstream end of the previous restoration project. This phase can be constructed in the dry but is where the existing stream will need to be diverted for construction activities for the new channel. A temporary channel will be located in Phase C for the main stem as well as the north fork tributary. Total time of diversion is estimated at less than 14 days. Upon turnover of stream discharge into the new alignment, the liner will be pulled and the temporary channel filled back to original grade.

For Phase A and C the general construction sequence for the new channel will be as follows. [Item 4) may precede the sequence in areas of overlap for the existing and proposed channel.]:

- 1) Mark ground with PC's (points of curvature) and PT's (points of tangency) and set reference staking (offset above floodplain).
- 2) Dig test pits on proposed alignment at each deviation from existing stream, at a maximum interval of 100 feet (Assume 14 test pits). Excavate to 2 foot below streambed elevation. Determine the infiltration rate in each test pit by digging a hole, filling with water and timing the water drop rate. (Reference: A Field Method for Measurement of Infiltration. USGS WSP 1544-F). If the measured infiltration rate is more than 36 inches per hour, the segment will be marked for over-excavation, to be replaced by imported select bed material as noted in Step 8. Right now, until test pitting can be performed, the restoration is assumed to need 100% material import.
- 3) Stake PI's (points of intersection) and offset reference staking for floodplain.
- 4) (Phase C only) Construct diversion ditch, working downstream to upstream. Cut into active channel bank at top of diversion ditch only after liner is in place and stabilized with clean gravel. Collect any stranded fish after cutover with a net and bucket of stream water. Release fish in a pool downstream of the project by immersing bucket.

- 5) Place silt fence at lower end of dry, diverted channel to collect runoff during construction.
- 6) Cut existing grade down to floodplain beach subgrade level, taking care to move material away from the existing creek to avoid spilling material into the creek. Preserve woody vegetation as practicable.
- 7) Reset PC & PT and mark left and right top of bank alignment with non-toxic spray paint.
- 8) Cut new channel to design grade, beginning at downstream end of phase (for both Phase B or C) and proceeding upstream, stopping 3 feet short of upstream connection to existing stream. Where required in accordance with Step 2, above, (which we are assuming is 100% of the length) over-excavate and replace existing material with streambed material and barrier layer. Where clean organic material is encountered, remove and segregate for use as native seed bank. Use in-place material as able, either by mixing with other material or by field measurements to get the required gradations.
- 9) On outer bank of meander segments, cut channel 3 feet wider than prescribed bankfull channel width. Construct outer channel bank using two layers of biodegradable fabric wrap over 6 inch lifts of native soil. Place willow cuttings (stakes) 1 foot on center in the fold between the wraps at 15 stems per foot and exposing 1/3 of a 2-3 foot stem. Willows will be Sitka or Feltleaf willows. Willow stakes are to be planted in dormant state before July 1 for better establishment and survival. If schedule requires willow stakes may be planted during fall dormancy, just before freeze-up. Substitution of willow stakes for rooted cuttings may be considered during construction to allow for summer construction if schedule requires.
- 10) Excavate for cross-vane footer rocks and place rocks gradually moving from bankfull elevation upstream to 1/3 the channel, going near perpendicular for the middle 1/3 of channel and returning on the other side. Minimum diameter is 18 inch round to subangular rock.
- 11) Place minimum 18 inch diameter rocks randomly 2-4 feet from each other in riffle areas, burying them 1/3 into the substrate.
- 12) Install north tributary piping and swale to connect to new creek.
- 13) Install 19 foot box culvert under Muldoon Road.
- 14) After subgrade elevations are set, spread a mix of stockpiled organic layer and commercial topsoil at 4 inch thickness and fine grade to finish elevation. Hydroseed above bankfull elevation at a rate of 30 pounds/acre with a mix of 60%

Bering Hairgrass, 40% Arctared Red Fescue. Hydroseed will include fertilizer at the rate of 200lbs/acre of 20-20-10 for a spring project, or 8-32-16 for a fall planting.

- 15) Set willow stakes all across the floodplain bench from bankfull elevation to six inches above toe of sideslope above the floodplain bench. Time of season effects availability of dormant willow stakes and feasibility of their use. At a minimum all areas slated for willow stakes will be hydroseeded as identified in Step 12. Willow staking may occur under consequent project phases based on evaluation of bank cover and successional stage of restored areas.
- 16) Open channel slowly to let water in, taking one-third the flow until turbidity decreases and then adding another third and then the last third of the flow. Collect any stranded fish using a net and a bucket of stream water. Release fish in a pool segment of the new channel.
- 17) Upon successful introduction of water into the new channel, backfill existing channel to floodplain or terrace elevation as indicated on the plan.
- 18) Apply topsoil and seed to backfilled channel and any other land disturbed during construction.
- 19) Implement climax community re-vegetation plan as able to plant birch and spruce trees and a mixture of native shrubs over time.

Green House Property
Chester Creek Re-Alignment
Anchorage, AK

REVISIONS

JOB NO. A1027.01-119
DATE 10-01-2007
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PROPOSED CREEK
PLAN AND GRADING

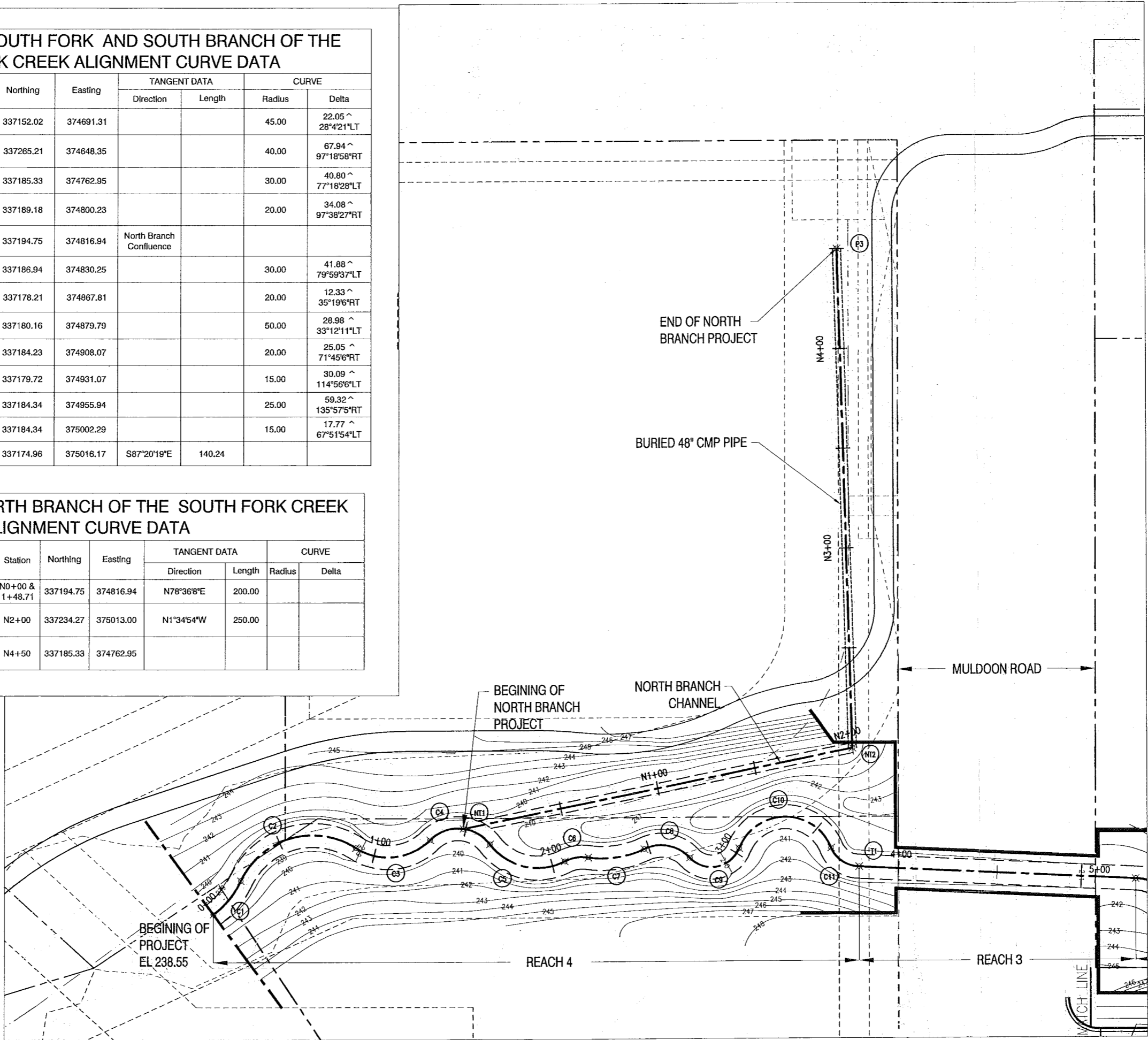
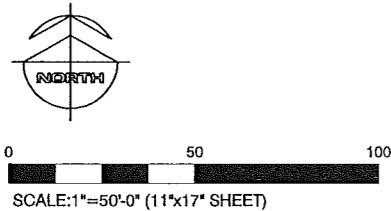
SHEET NO.

PL-1

CHESTER CREEK SOUTH FORK AND SOUTH BRANCH OF THE SOUTH FORK CREEK ALIGNMENT CURVE DATA								
Curve/ Tangent/ Point #	Reach #	Station	Northing	Easting	TANGENT DATA		CURVE	
					Direction	Length	Radius	Delta
Curve 1 PC	4	0+00	337152.02	374691.31			45.00	22.05 ^ 28°42'1"LT
Curve 2 PC	4	0+22.05	337265.21	374648.35			40.00	67.94 ^ 97°18'58"RT
Curve 3 PC	4	0+89.99	337185.33	374762.95			30.00	40.80 ^ 77°18'28"LT
Curve 4 PC	4	1+30.47	337189.18	374800.23			20.00	34.08 ^ 97°38'27"RT
NT1	4	1+48.71	337194.75	374816.94	North Branch Confluence			
Curve 5 PC	4	1+64.55	337186.94	374830.25			30.00	41.88 ^ 79°59'37"LT
Curve 6 PC	4	2+06.43	337178.21	374867.81			20.00	12.33 ^ 35°19'6"RT
Curve 7 PC	4	2+18.76	337180.16	374879.79			50.00	28.98 ^ 33°12'11"LT
Curve 8 PC	4	2+47.74	337184.23	374908.07			20.00	25.05 ^ 71°45'6"RT
Curve 9 PC	4	2+72.78	337179.72	374931.07			15.00	30.09 ^ 114°56'6"LT
Curve 10 PC	4	3+02.87	337184.34	374955.94			25.00	59.32 ^ 135°57'5"RT
Curve 11 PC	4	3+62.19	337184.34	375002.29			15.00	17.77 ^ 67°51'54"LT
Tangent 1	3	3+79.96	337174.96	375016.17	S87°20'19"E	140.24		

CHESTER CREEK NORTH BRANCH OF THE SOUTH FORK CREEK ALIGNMENT CURVE DATA								
Curve/ Tangent/ Point #	Description	Station	Northing	Easting	TANGENT DATA		CURVE	
					Direction	Length	Radius	Delta
NT1	North Branch Confluence	N0+00 & 1+48.71	337194.75	374816.94	N78°36'8"E	200.00		
NT2	North Branch Wetland Section, Outfall of proposed Culvert	N2+00	337234.27	375013.00	N1°34'54"W	250.00		
Point 3	End of North Branch Project Tie Into Existing Culvert	N4+50	337185.33	374762.95				

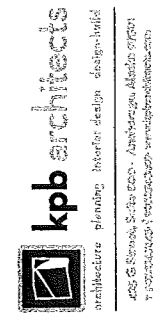
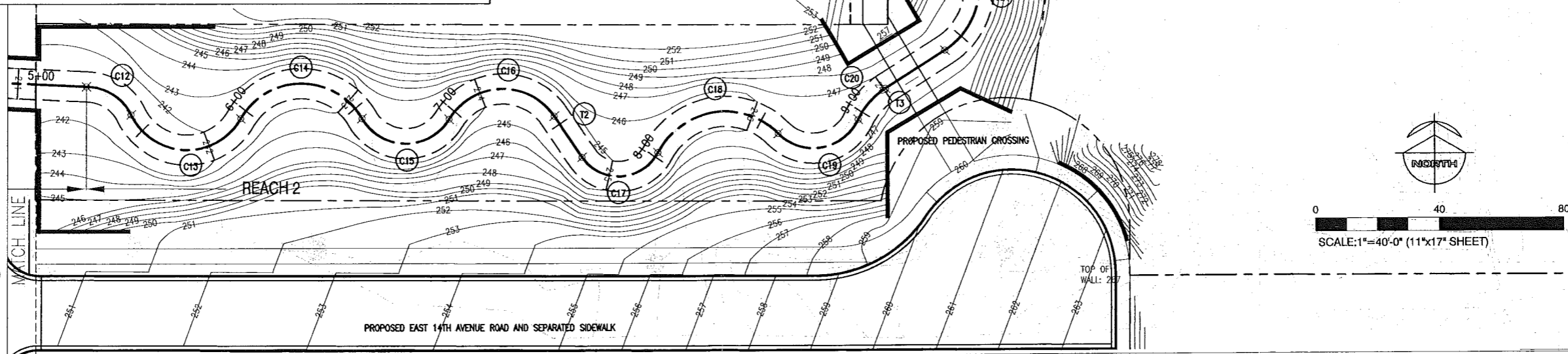
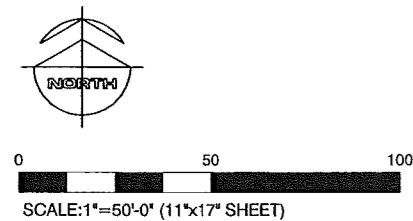
NOTE:
1. Proposed Culvert is 48" diameter pipe.
2. Datum is Anchorage Bowl 2000



CHESTER CREEK SOUTH FORK AND SOUTH BRANCH OF THE SOUTH FORK CREEK ALIGNMENT CURVE DATA

Curve/ Tangent/ Point #	Reach #	Station	Northing	Easting	TANGENT DATA		CURVE	
					Direction	Length	Radius	Delta
Curve 12 PC	2	5+20.20	337168.45	375156.26			20.00	22.14 ^ 63°25'28"RT
Curve 13 PC	2	5+42.34	337157.26	375174.06			25.00	53.97 ^ 123°40'45"LT
Curve 14 PC	2	5+96.31	337155.71	375218.11			28.00	58.51 ^ 119°42'25"RT
Curve 15 PC	2	6+54.81	337155.67	375266.55			20.00	41.43 ^ 118°41'24"LT
Curve 16 PC	2	6+96.24	337155.35	375300.95			25.00	49.98 ^ 114°32'51"RT
Tangent 2	2	7+46.22	337156.46	375343.00	S34°14'55"E	19.74		
Curve 17 PC	2	7+65.97	337140.14	375354.11			17.50	36.15 ^ 118°21'57"LT
Curve 18 PC	2	8+02.12	337141.94	375384.12			30.00	56.45 ^ 107°49'0"RT
Curve 19 PC	2	8+58.57	337149.28	375432.04			20.00	38.19 ^ 109°23'56"LT
Curve 20 PC	2	8+96.76	337154.67	375464.24			30.00	16.70 ^ 31°53'41"RT
Tangent 3	2	9+13.46	337166.97	375475.22	N57°41'53"E	27.99		
Curve 21 PC	2	9+41.45	337181.92	375498.88			30.00	53.23 ^ 101°39'40"LT
Curve 22 PC	2	9+94.68	337228.11	375504.44			15.00	29.45 ^ 112°29'8"RT
Curve 23 PC	2	10+24.13	337252.48	375509.75			14.00	26.84 ^ 109°51'29"LT
Curve 24 PC	2	10+50.97	337274.75	375515.13			30.00	28.80 ^ 55°0'17"RT
Tangent 4	2	10+79.77	337301.65	375508.51	N13°40'10"E	11.72		
Curve 25 PC	2	10+91.50	337313.05	375511.28			25.00	25.73 ^ 58°58'1"RT
Curve 26 PC	2	11+17.23	337331.00	375528.11			12.00	23.79 ^ 113°36'29"LT
Tangent 5	2	11+41.02	337350.32	375533.59	N40°58'18"W	24.05		
Curve 27 PC	2	11+65.07	337368.48	375517.82			12.00	24.27 ^ 115°53'50"RT
Curve 28 PC	2	11+89.34	337387.93	375523.76			22.00	58.91 ^ 153°25'56"LT
Curve 29 PC	2	12+48.26	337430.74	375522.42			23.00	62.14 ^ 154°48'31"RT
Curve 30 PC	2	13+10.40	337475.62	375521.56			25.00	30.06 ^ 68°53'16"LT
Curve 31 PC	2	13+40.46	337496.68	375540.43			18.00	36.36 ^ 115°45'4"RT
Curve 32 PC	1	13+76.83	337509.43	375568.12			100.00	93.64 ^ 53°39'13"LT
Curve 33 PC	1	14+70.47	337499.46	375657.83			76.13	67.84 ^ 51°3'20"RT
End of Project	1	15+38.31	337493.70	375723.19				

NOTE:
1. Datum is Anchorage Bowl 2000



Green House Property
Chester Creek Re-Alignment
Anchorage, AK

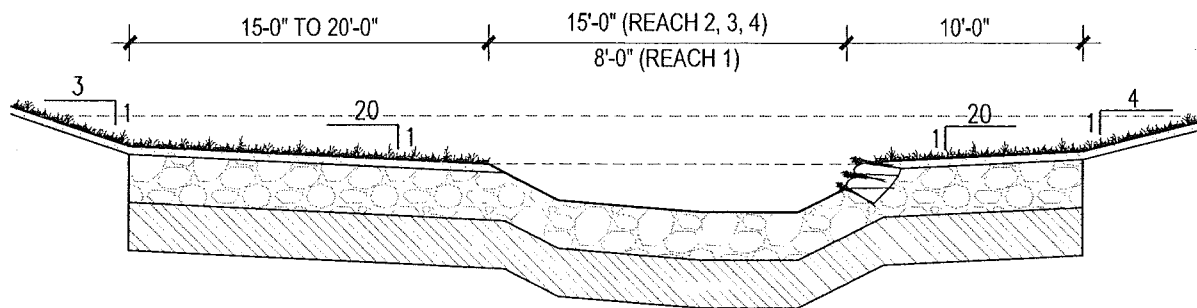
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DATE 10-01-2007
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PLAN AND GRADING

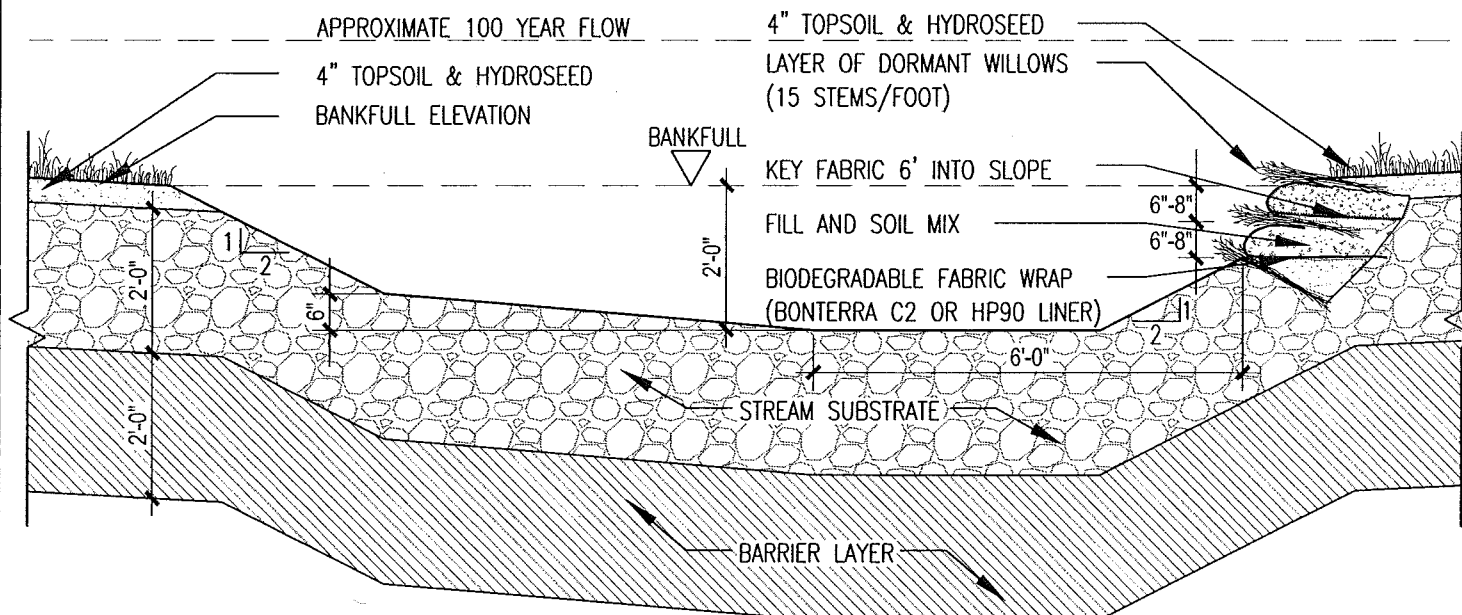
SHEET NO.

PL-2



1 TYPICAL POOL CONSTRUCTION

SCALE: 1/8"=1'-0"



2 DETAIL

SCALE: 3/8"=1'-0"

NOTES:

- BRUSH LAYERING SHALL FOLLOW AF&G STREAM BANK RESTORATION GUIDE RECOMMENDATIONS FOR INSTALLATION PRACTICES.
- SEE SUBSTRATE ON TYPICAL RIFFLE FIGURE ON SK-1.
- AT IMPLEMENTATION, POOL DEPTH SHALL BE CONSIDERED AT 2'-6" TO 3'-0".



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GREEN HOUSE PROPERTY CHESTER CREEK REALIGNMENT

ANCHORAGE, AK

TYPICAL POOL CONSTRUCTION

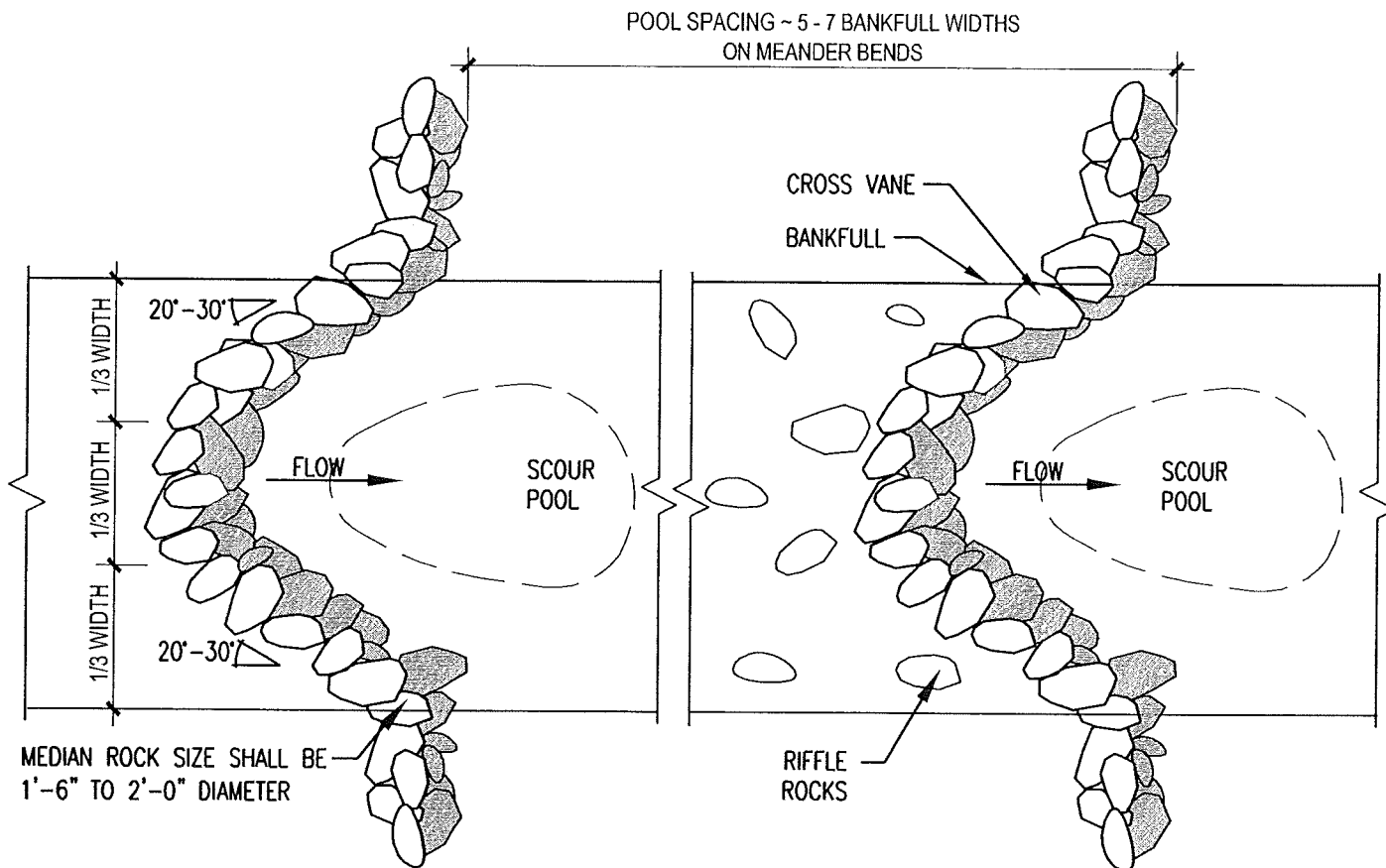
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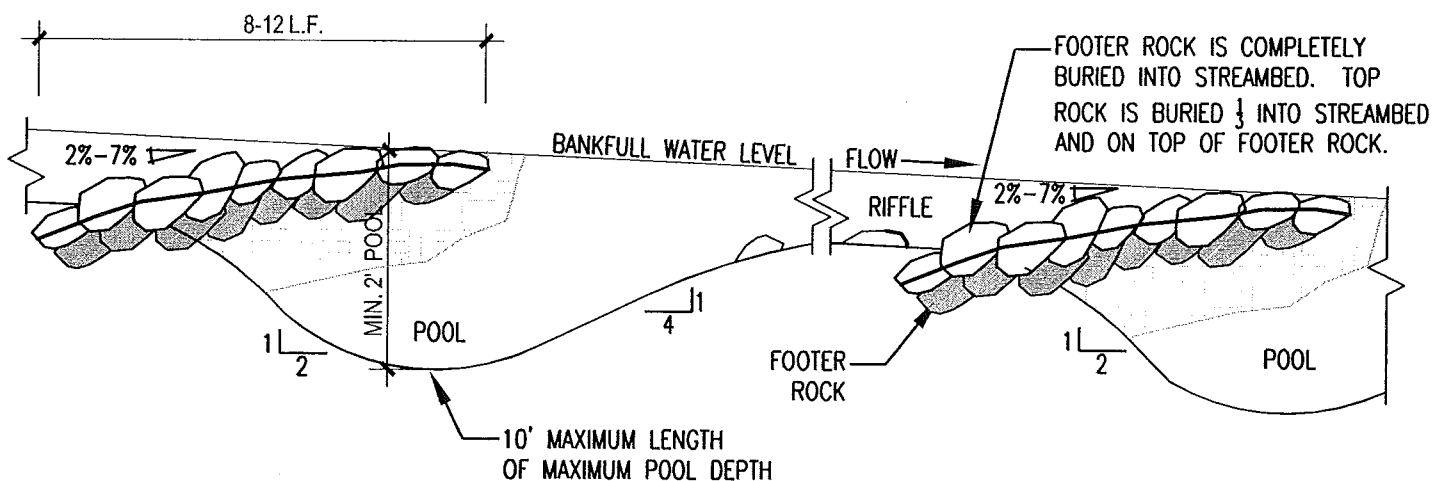
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SK NO.

SK-2



1 TYPICAL SPACING AT RIFFLE-POOL SECTION (REACH 2, 3, 4)
SCALE: 3/16"=1'-0"



2 TYPICAL POOL PROFILE ON STRAIGHT SECTIONS
SCALE: 3/16"=1'-0"



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TYPICAL POOL CONSTRUCTION

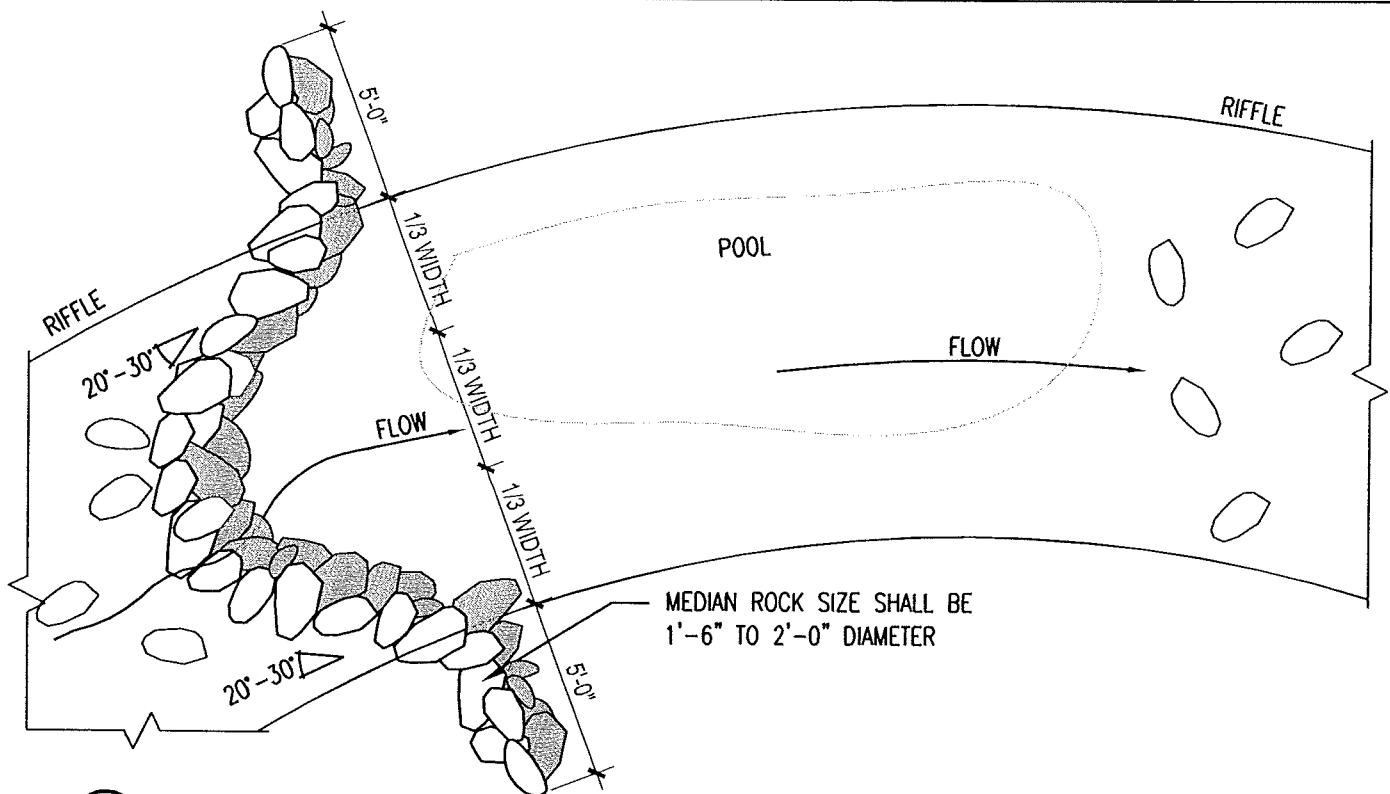
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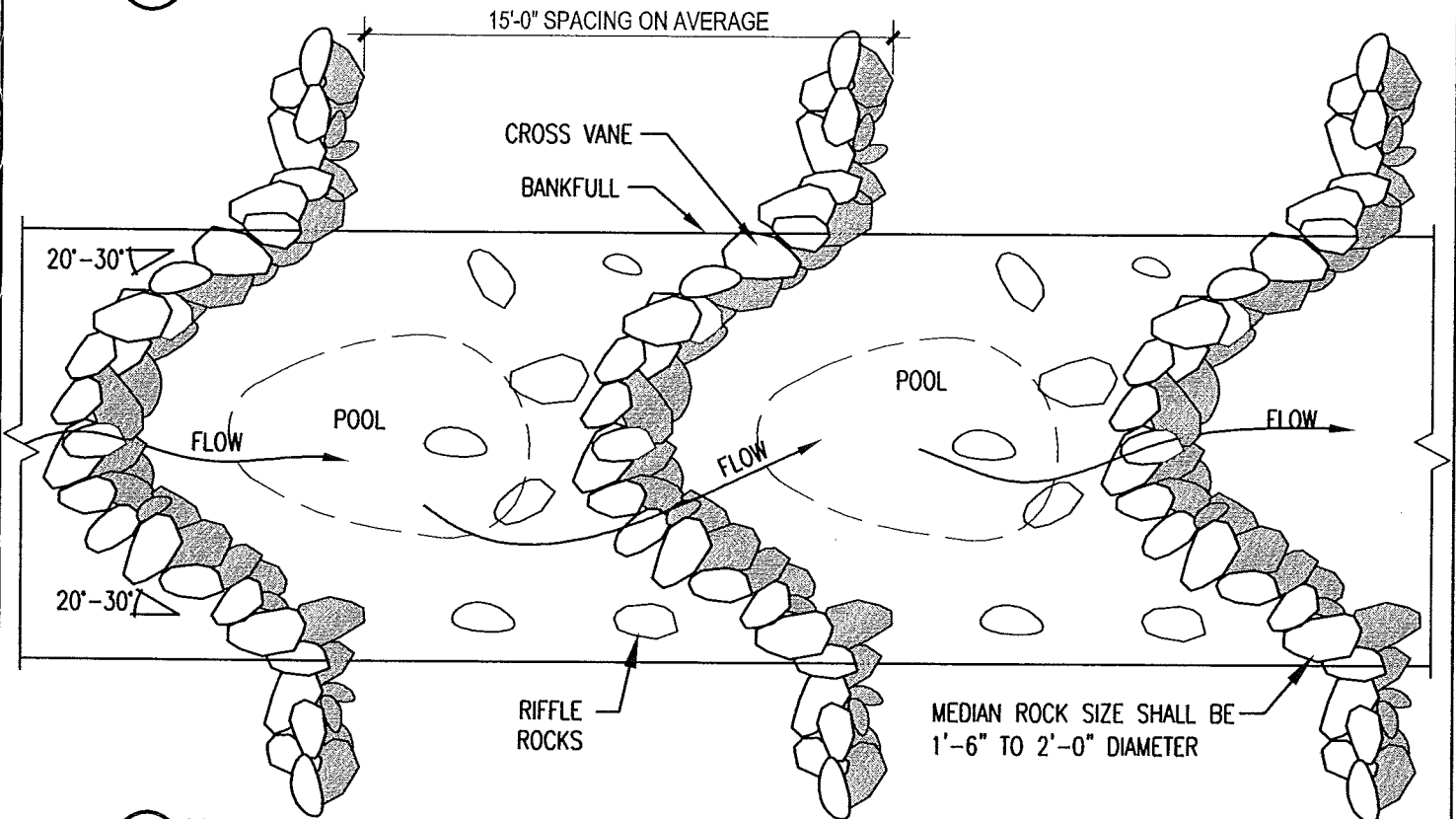
DRAWN ERL

SK NO.

SK-5



1 TYPICAL RIFFLE-POOL SECTION (REACH 2, 3, 4)
SCALE: 3/16"=1'-0"



2 TYPICAL SPACING AT RIFFLE-POOL SECTION (REACH 1)
SCALE: 3/16"=1'-0"



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JOB NO. A1027.01

DATE 10-01-2007

DRAWN ERL

SK NO.

SK-6

To: Bill Rice and Tamas Deak
From: Mel Langdon *mel*
Re: REVISED Hydraulic Modeling of South Fork Chester Creek near Muldoon Road
Date: 9-30-2007

This technical memorandum summarizes results of hydraulic modeling for a proposed creek realignment to support land development strategies for Municipal land northeast of Muldoon and Debarr Roads in Anchorage, Alaska.

Overview

A hydraulic model was developed for the South Fork of Chester Creek to evaluate the stability of a proposed realignment design. The project location is shown in Figure 1. The hydraulic model was based on typical cross sections developed by the U.S. Fish and Wildlife Service (USFWS) and detailed horizontal alignment and points at grade changes in overall slope provided by Koonce Pfeffer and Bettis (KPB).

Two previous hydraulic studies in this reach were used for reference.

- The Federal Emergency Management Administration's (FEMA) Flood Insurance Study (FIS) for this reach of the creek and a 2006 Letter of Map Revision (LOMR).
- A hydraulic study for the realignment of approximately 1,700 feet of the South Fork of Chester Creek downstream of this proposed project through the Chester Town Center (CTC).

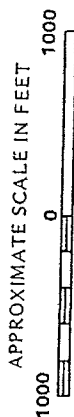
Modeling Extents

The upstream end of the proposed creek realignment is approximately 600 feet northeast of the intersection of Muldoon and Debarr Road; the downstream end is approximately 350 feet west of Muldoon Road. Overall, the channel length along the thalweg of the modeled realignment is 1,538 feet. Channel lengths and grades within the project area were based stationing received from KPB, summarized in Table 1 and depicted in plan view in Figure 2.

Table 1 Stream Realignment Elevations at Grade Breaks

Station	Elevation	Reach	Description
Feet	feet		
0+00	238.55		Downstream end of this project matches upstream end of CTC restoration project.
		4	380 lineal feet at slope = 0.005 feet per feet.
3+80	240.45		20 feet west of the western Muldoon Road right-of-way.
		3	140 lineal feet at slope = 0.005 feet per feet. This reach includes a box culvert under Muldoon Road.
5+20	241.15		20 feet east of the eastern Muldoon Road right of way.
		2	857 lineal feet at slope = 0.015 feet per feet. This reach includes a pedestrian bridge.
13+77	254.01		Hill at Debarr Road.
		1	161 lineal feet at slope = 0.0248 feet per feet.
15+38	258.0		Match existing creek.

The hydraulic model extends downstream from the downstream end of the proposed realignment through the recently reconstructed reach (CTC) to East 17th Avenue. The upstream end of the model is at the upstream end of the FIS, approximately 2,200 feet upstream of the upstream end of the proposed realignment.



NATIONAL FLOOD-INSURANCE PROGRAM

**FLOODWAY
FLOOD BOUNDARY AND
FLOODWAY MAP**

MUNICIPALITY OF
ANCHORAGE,
ALASKA
ANCHORAGE DIVISION

PANEL 235 OF 625
(SEE MAP INDEX FOR PANELS NOT PRINTED)

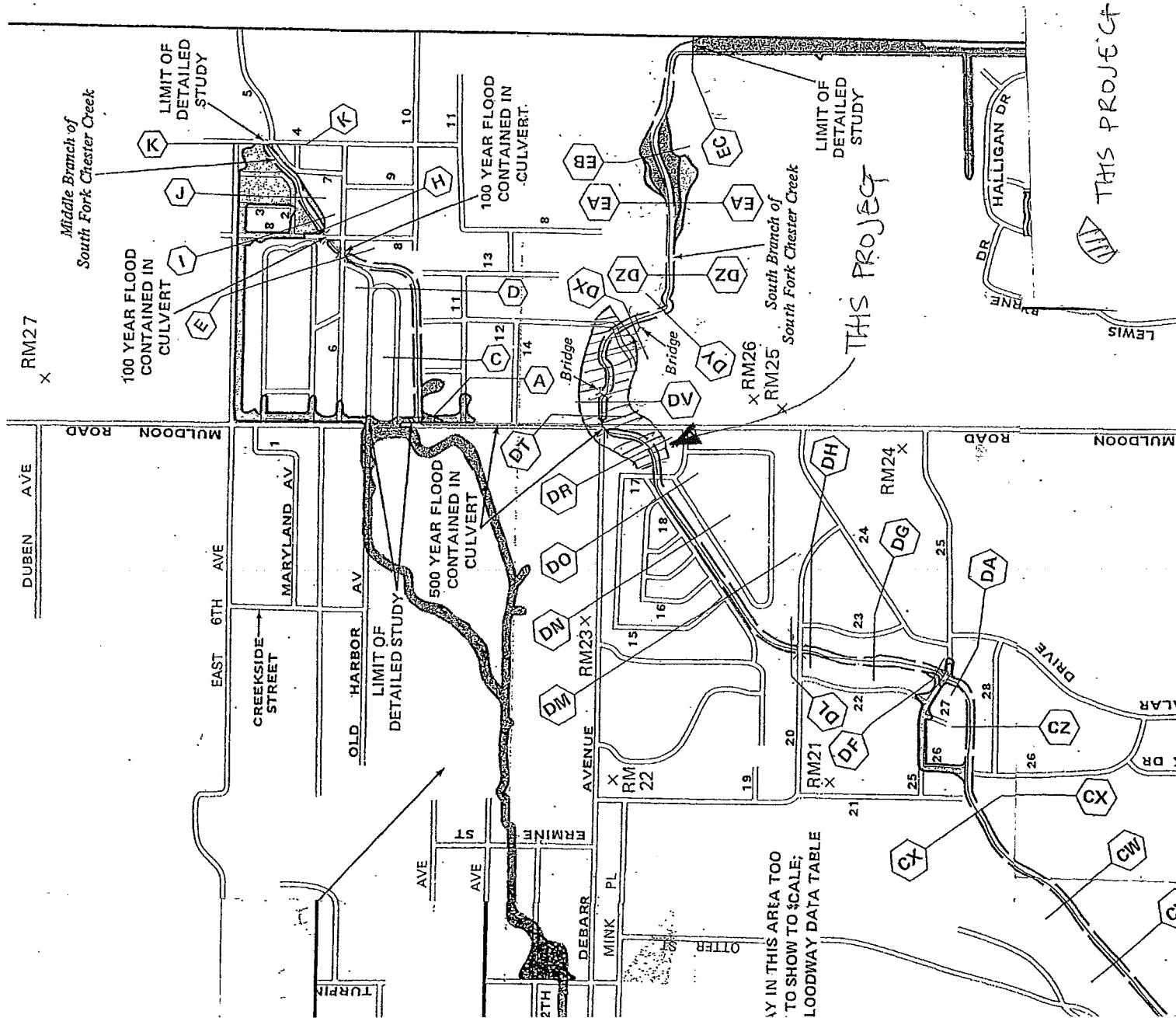
COMMUNITY-PANEL NUMBER
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**MAP REVISED:
MARCH 5, 1990**

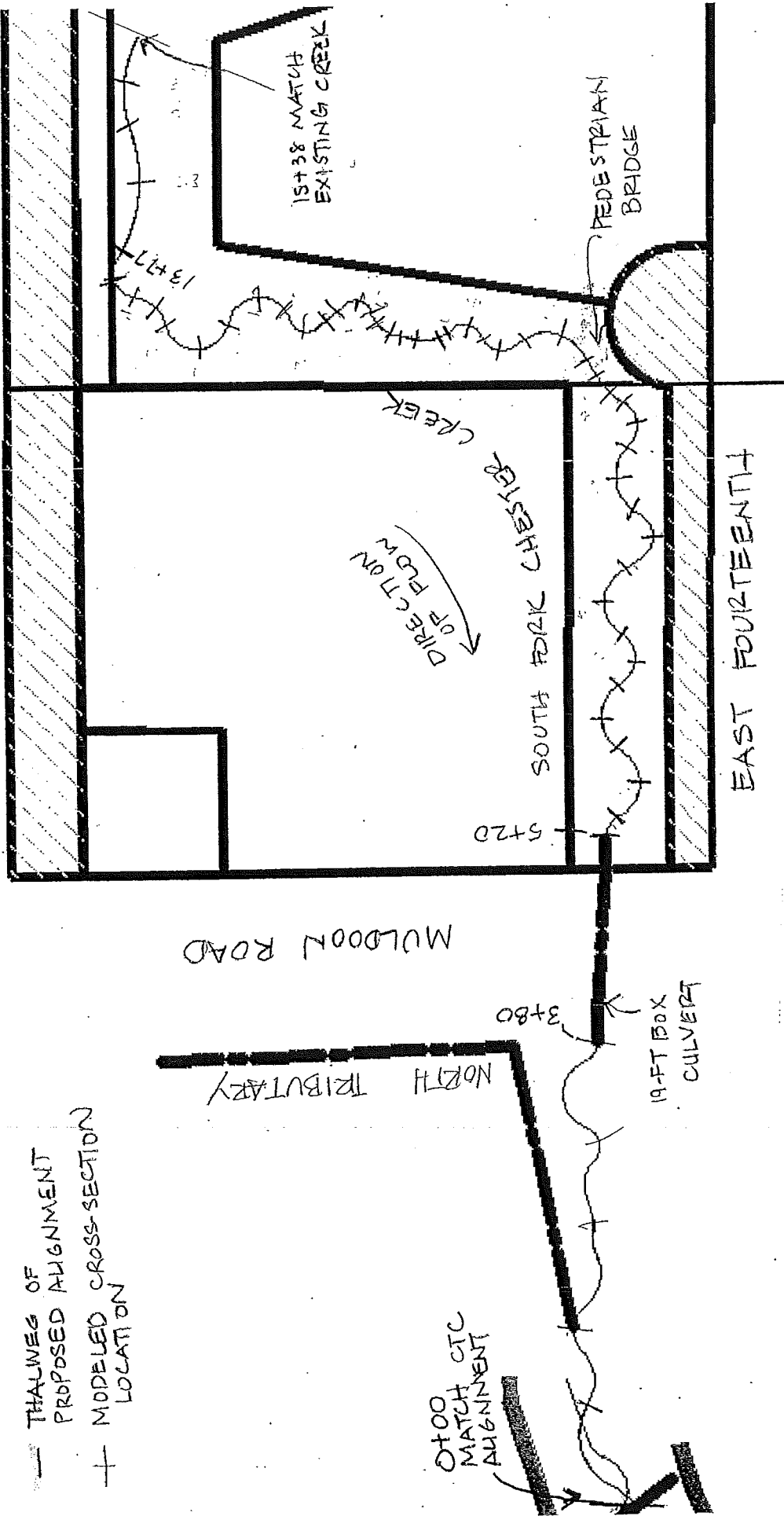


Federal Emergency Management Agency

CHESTER CK EAST OF MULDWIN
PROJECT LOCATION



— THALWEG OF
PROPOSED ALIGNMENT
+ MODELED CROSS-SECTION
LOCATION



↑
NORTH
1" = 107'

CHESTER CREEK EAST of MULDOON
PROJECT STATIONING
FIGURE 2

Flows

Two levels of flow were modeled for the analysis: the bankfull (approximately 1-year recurrent flow) and the 100-year recurrent flow. A tributary from the north discharges into the South Fork just downstream (west) of Muldoon Road within Reach 4 of the proposed project. The FIS used flows for the 10, 50, 100, and 500 year recurrent events in this reach; one flow for the reach below Muldoon (Reach 4) and a smaller flow for the reach above (Reaches 1 through 3). The previous CTC study modeled a bankfull flow for Reach 4 which was used for this analysis. The only remaining flow to determine was a bankfull flow for Reaches 1, 2, and 3.

The reach through the box culvert and upstream of Muldoon Road can be represented as a portion of the downstream flow. This portion was based on two approaches: either the ratio from the FIS model or pro-rated based on tributary land areas.

- FIS Model. The relative portion of the four levels of flow used in the FIS was averaged. The upstream flow averaged 80% of the downstream flow across all 4 flow levels.
- Land Area. The north tributary area to the creek just downstream of Muldoon road is approximately 3.5 square miles; South Fork tributary area is 8.5 square miles. Prorated, the South Fork tributary area is 77% of the total tributary area.

Use of 80% of the downstream flow is conservative and provides a slightly higher flow that may reflect the groundwater contribution in this reach of the South Fork. A summary of the modeled flows is shown in Table 2.

Table 2. Flow Levels used for Hydraulic Model

Return period	Reference study for flow Reach 4	Modeled Flow for Reach 1	Reference study for flow for Reaches 1 - 3	Modeled Flow for Reaches 1 - 3	Ratio of Reach 4 to Reach 1-3 flows
Years		Cfs		cfs	
100	FIS	230	FIS	190	0.82
Bankfull	CTC	28	Proportion of CTC	22.4	0.80

FIS – Flood Insurance Study CTC – Chester Town Center

Channel Parameters

1. Channel Lengths

Stationing along the project centerline for tangents and points of curvature were supplied by KPB. Additional stations were inserted halfway between each point of curvature provided. Stations and elevations are shown in the attached Table A. An alternative was modeled, with a slope of 0.0274 feet per feet between station 13+71 and 15+20. However, the slope of 0.0248 feet per feet was selected for the design and final hydraulic model. Between cross-sections 1+34 and 3+80, the channel is divided to accommodate inflows from the north tributary.

Channel lengths were based on the project stationing. Overbank lengths were taken based on a 7-foot offset from each side of the centerline, corresponding to the approximate bankfull width, and measured as lengths around the curve.

2. Cross Sections

Three typical cross section geometries were provided by USFWS and are shown in Figure 3. Riffle sections (items Riffle Reach 1 and Riffle Reach 2-3-4 in Figure 3) were modeled at points

of curvature and tangents along the project centerline and pool sections (item Pool Reach 2-3-4 in Figure 3) were modeled at the halfway points of the curve. Bankfull widths were 8 feet for the riffle Reach 1 section, 12 feet wide for the Riffle Reach 2-3-4 and 15 feet wide in the pool sections.

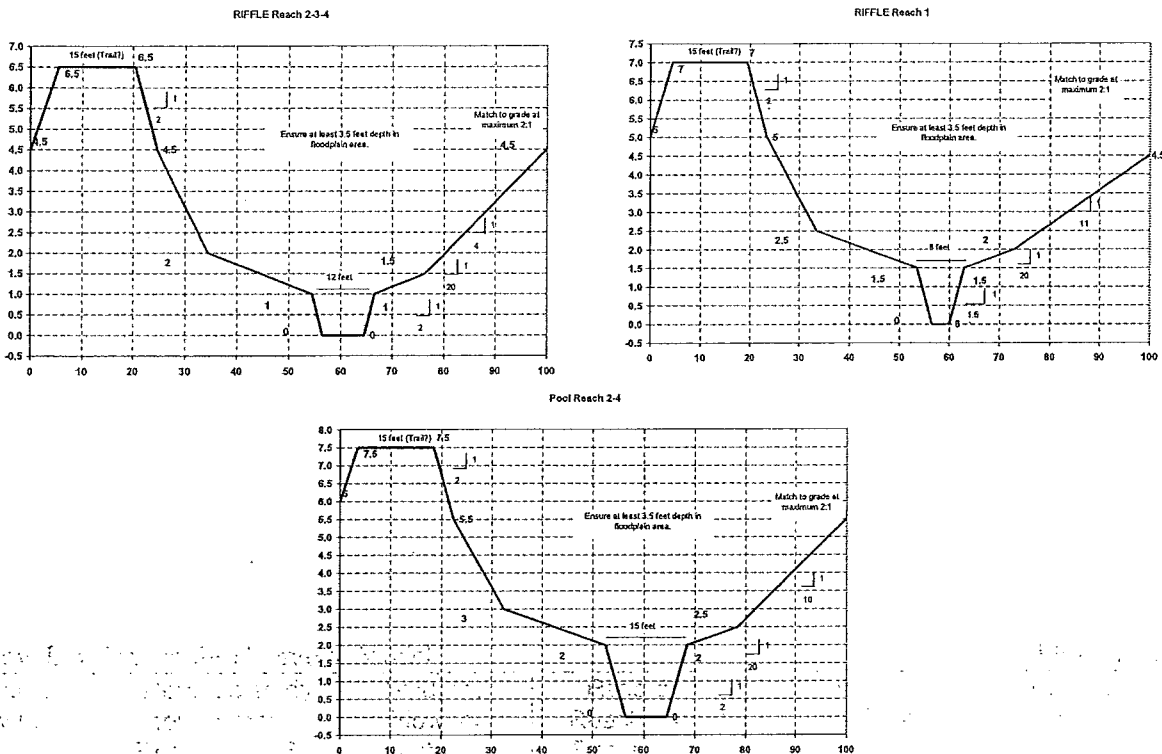


Figure 3 Typical Cross-sections

3. Elevations

Elevations received from KPB are referenced to the datum used for the FIS. Elevations used in the hydraulic model between stations 0+00 and 5+20 and between 13+20 and 15+20 were based on the slopes and points of grade change in Table 1; that is, a constant slope of 0.005 and 0.248 feet per foot, respectively. For the pool-riffle complexes between stations 5+20 and 13+20, riffles were modeled with a steeper slope than shown in Table 1, and pools with a flatter slope. The riffle and pool elevation variations are shown in Figure 4.

Figure 4 Project Channel Profile as Modeled

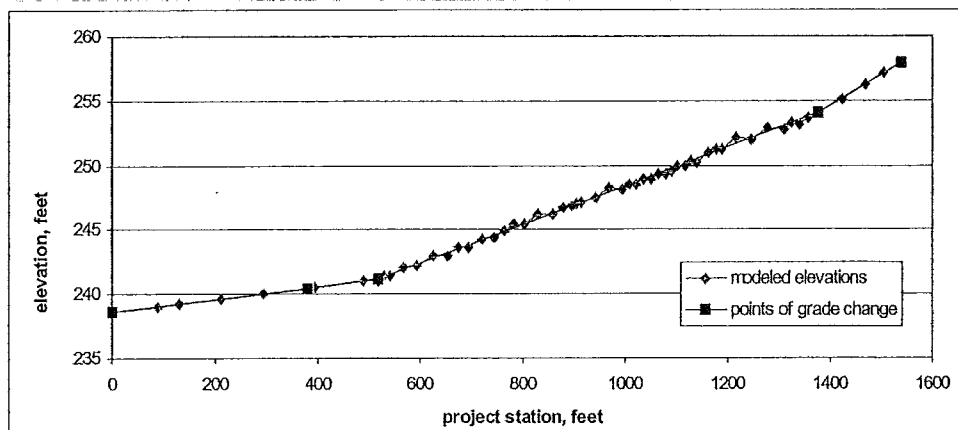


Figure 5 Water Surface Elevation Profile

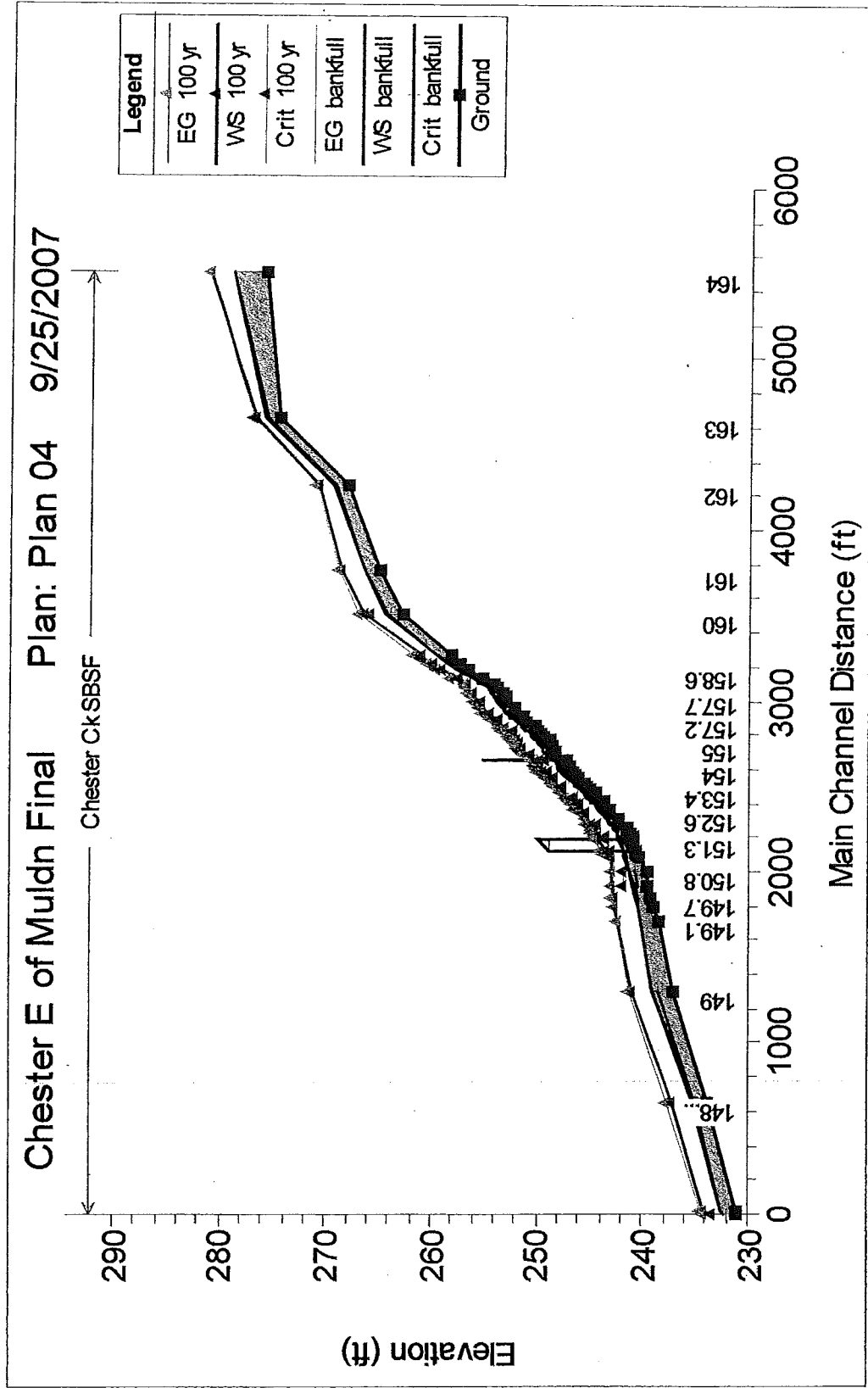


Figure 6 Representative Model Output Cross Sections

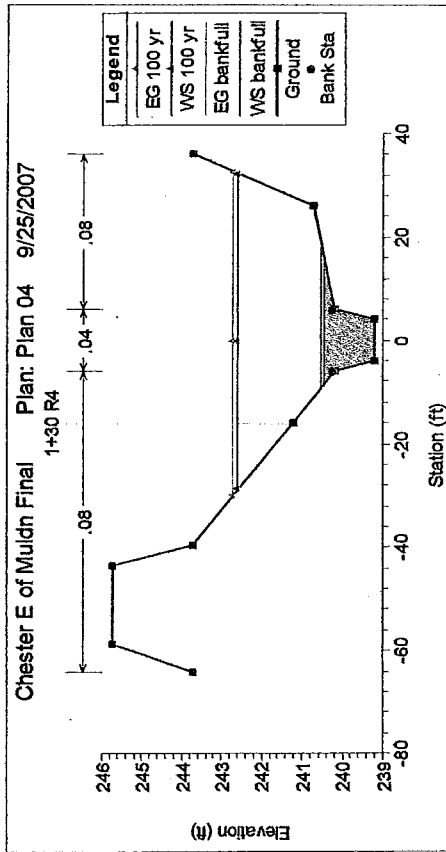


Figure 4a. Reach 4 – below confluence with north tributary

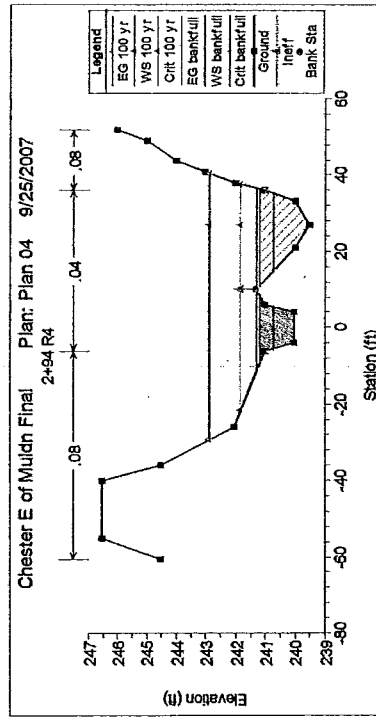


Figure 4b. Reach 4 – below box culvert, divided channel. Right channel is for the north tributary. Cross-hatching indicates that main flow is concentrated in the left-most channel.

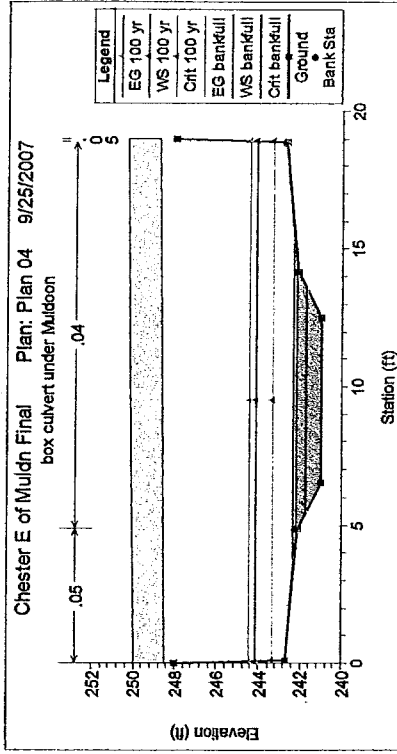


Figure 4c. Box culvert under Muldoon Road

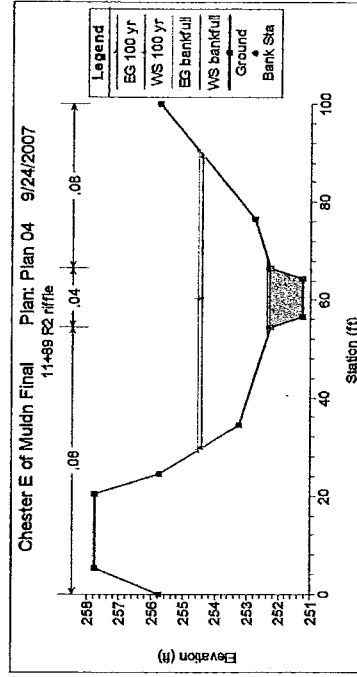


Figure 4d. Reaches 2 and 3 – Typical Riffle – slope = 0.015 feet per foot

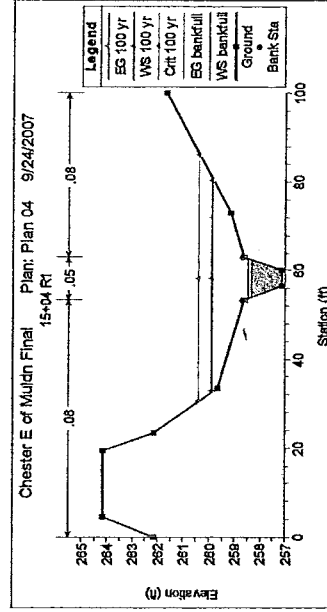


Figure 4e. Reach 1 – slope = 0.0248 feet per foot

Table A Model Station and Results
A1. Hydraulic Variables with bankfull flow

Project Station	River Station	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Shear LOB (lb/sq ft)	Shear Chan (lb/sq ft)	Shear ROB (lb/sq ft)	Shear Total (lb/sq ft)
FISEC	164	22.4	275.9	278.69		278.72	0.001082	1.22	18.36	14.23	0.19		0.08		0.08
FISEB	163	22.4	274.5	275.65	275.63	275.92	0.035165	4.2	5.34	9.3	0.98		1.22		1.22
FISEA	162	22.4	267.99	269.09		269.18	0.010432	2.37	9.46	15.93	0.54		0.38		0.38
FISDZ	161	22.4	265	266.35		266.4	0.003424	1.75	12.84	14.44	0.33		0.18		0.18
FISDY	160	22.4	262.6	263.99	263.9	264.26	0.033482	4.15	5.39	7.47	0.86		1.4		1.4
FISDX	159	22.4	258.2	259.43		259.56	0.012946	2.83	7.91	9.79	0.56		0.62		0.62
15+38	158.9	22.4	258	259.03		259.27	0.027229	3.9	5.75	7.63	0.79		1.2		1.2
15+04	158.8	22.4	257.16	258.29		258.47	0.019505	3.45	6.48	8.01	0.68		0.92		0.92
14+71	158.6	22.4	256.32	257.28	257.22	257.57	0.035872	4.3	5.21	7.34	0.9		1.5		1.5
14+24	158.5	22.4	255.16	255.75	255.75	256.02	0.030391	4.13	5.42	10.36	1.01		0.97		0.97
13+77	158.3	22.4	254.01	254.87	254.6	254.98	0.012851	2.67	8.38	11.45	0.55		0.57		0.57
13+59	158.2	22.4	253.74	254.33	254.33	254.6	0.030043	4.12	5.44	10.37	1		0.96		0.96
13+40	158.1	22.4	253.21	254.22		254.3	0.004643	2.21	10.15	12.5	0.42		0.24		0.23
13+25	157.8	22.4	253.26	254.02		254.17	0.012963	3.11	7.19	11.02	0.68		0.51		0.51
13+10	157.7	22.4	252.82	253.99		254.04	0.002601	1.85	12.63	18.82	0.33	0.01	0.16	0.01	0.11
12+79	157.6	22.4	252.93	253.52	253.52	253.79	0.030334	4.13	5.43	10.36	1.01		0.97		0.97
12+48	157.5	22.4	252.02	253.18		253.23	0.002721	1.88	12.38	18.29	0.33	0.01	0.16	0.01	0.11
12+19	157.4	22.4	252.12	252.71	252.71	252.98	0.030334	4.13	5.43	10.36	1.01		0.97		0.97
11+89	157.3	22.4	251.26	252.25		252.33	0.005025	2.26	9.9	11.97	0.44		0.25		0.25
11+77	157.2	22.4	251.3	251.9	251.89	252.16	0.029461	4.09	5.48	10.38	0.99		0.94		0.94
11+65	157.1	22.4	250.94	251.53	251.53	251.8	0.030022	4.11	5.44	10.37	1		0.96		0.96
11+41	156.9	22.4	250.24	251.21		251.29	0.005419	2.32	9.65	11.88	0.45		0.26		0.26
11+29	156.8	22.4	250.28	250.99		251.16	0.016419	3.37	6.65	10.82	0.76		0.61		0.61
11+17	156.7	22.4	249.93	250.94		251.02	0.004678	2.21	10.13	12.43	0.42		0.24		0.23
11+04	156.6	22.4	249.98	250.57	250.57	250.84	0.030334	4.13	5.43	10.36	1.01		0.97		0.97
10+91	156.5	22.4	249.6	250.32		250.49	0.015678	3.32	6.75	10.86	0.74		0.59		0.59
10+80	156.3	22.4	249.26	250.27		250.35	0.004677	2.21	10.13	12.43	0.42		0.24		0.23
10+65	156.2	22.4	249.31	249.93	249.9	250.17	0.025069	3.88	5.78	10.5	0.92		0.84		0.84
10+51	155.1	22.4	248.88	249.87		249.95	0.004984	2.26	9.93	11.98	0.44		0.25		0.25
10+37	155	22.4	248.93	249.6		249.8	0.019692	3.58	6.26	10.68	0.82		0.7		0.7
10+24	154.9	22.4	248.54	249.55		249.62	0.004761	2.22	10.08	12.25	0.43		0.24		0.24
10+09	154.8	22.4	248.59	249.32		249.48	0.014556	3.24	6.92	10.92	0.72		0.56		0.56

9+95	154.7	22.4	248.16	249.29		249.35	0.002994	1.93	11.9	17.21	0.35	0.01	0.17	0.01	0.13
9+98	154.6	22.4	248.25	248.84	248.84	249.11	0.030072	4.12	5.44	10.37	1		0.96		0.96
9+41	154.3	22.4	247.47	248.26	248.06	248.4	0.011122	2.96	7.57	11.16	0.63		0.46		0.46
footbridge	154.2	Bridge													
9+13	154.1	22.4	247.05	247.94		248.04	0.007292	2.57	8.73	11.57	0.52		0.33		0.33
9+05	154	22.4	247.03	247.83		247.96	0.010692	2.92	7.67	11.2	0.62		0.44		0.44
8+97	153.95	22.4	246.81	247.79		247.88	0.005159	2.28	9.81	11.94	0.44		0.25		0.25
8+78	153.9	22.4	246.77	247.37	247.36	247.63	0.029481	4.09	5.48	10.38	0.99		0.95		0.95
8+59	153.8	22.4	246.25	247.29		247.36	0.004137	2.13	10.54	13.69	0.4	0.01	0.22	0.01	0.19
8+30	153.7	22.4	246.2	246.79	246.79	247.06	0.030334	4.13	5.43	10.36	1.01		0.97		0.97
8+02	153.6	22.4	245.43	246.4		246.48	0.005464	2.33	9.62	11.87	0.46		0.27		0.27
7+84	153.5	22.4	245.4	246.03	245.99	246.26	0.023719	3.81	5.88	10.54	0.9		0.8		0.8
7+66	153.4	22.4	244.91	245.5	245.5	245.77	0.030022	4.11	5.44	10.37	1		0.96		0.96
7+46	153.3	22.4	244.38	245.4		245.48	0.004469	2.18	10.28	12.89	0.42		0.23		0.21
7+21	153.2	22.4	244.33	244.92	244.92	245.19	0.030334	4.13	5.43	10.36	1.01		0.97		0.97
6+96	152.9	22.4	243.65	244.65		244.73	0.004883	2.24	10	12	0.43		0.24		0.24
6+76	152.8	22.4	243.61	244.2	244.2	244.47	0.030334	4.13	5.43	10.36	1.01		0.97		0.97
6+55	152.7	22.4	243.05	244.09		244.16	0.004147	2.13	10.54	13.67	0.4	0.01	0.22	0.01	0.19
6+26	152.6	22.4	242.99	243.58	243.58	243.85	0.030334	4.13	5.43	10.36	1.01		0.97		0.97
5+96	152.5	22.4	242.21	243.24	243.24	243.31	0.004354	2.16	10.37	13.16	0.41		0.23		0.21
5+69	152.4	22.4	242.15	242.74	242.74	243.01	0.030612	4.14	5.41	10.36	1.01		0.97		0.97
5+42	152.3	22.4	241.42	242.43		242.51	0.00489	2.2	10.17	12.54	0.43		0.24		0.24
5+31	152.2	22.4	241.4	242.36		242.45	0.005572	2.34	9.56	11.85	0.46		0.27		0.27
5+20	151.9	22.4	241.15	242.34		242.39	0.00242	1.81	13.03	19.65	0.32	0.01	0.15	0.01	0.1
4+90	151.6	22.4	241	242.19	241.71	242.28	0.005172	2.42	9.29	10.84	0.44	0.01	0.28		0.26
box culvert	151.3	Bridge													
3+95	151.2	22.4	240.53	241.58		241.7	0.007563	2.81	7.96	9.15	0.53		0.38		0.38
3+80	151.1	22.4	240.45	241.55		241.6	0.002849	1.74	12.88	15.35	0.33		0.15		0.15
2+94	150.8	28	239.5	241.17	240.7	241.26	0.005103	2.32	12.27	42.6	0.44	0.02	0.26		0.22
2+12	150.4	28	239.49	240.75	240.29	240.84	0.005052	2.36	11.95	34.14	0.44	0.02	0.27		0.24
1+30	149.7	28	239.2	240.43		240.5	0.003327	2.17	14.03	23.4	0.37	0.02	0.21	0.02	0.12
0+90	149.5	28	239	240.32		240.38	0.002481	1.98	15.89	24.8	0.33	0.02	0.17	0.02	0.1
0+00	149.1	28	238.55	240.08		240.14	0.002934	1.94	14.52	16.48	0.35	0.01	0.17	0.01	0.16
FIS DN	149	28	237.22	239.03	238.33	239.08	0.002365	1.77	15.83	16.56	0.31		0.14		0.14
FIS DM	148	28	233.91	234.97	234.97	235.3	0.028736	4.61	6.08	9.42	1.01		1.12		1.12
FIS DL	147	28	231	232.33		232.36	0.001092	1.31	21.44	19.83	0.22	0.01	0.08	0.01	0.07
FIS DK	146	28	231	232.23	231.82	232.31	0.004941	2.3	12.15	14.21	0.44		0.26		0.26

Table A Model Stations and Results (continued)
A2. Hydraulic Variables with 1-percent probability flow (100 year flow)

Project Station	River Station	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Shear LOB (lb/sq ft)	Shear Chan (lb/sq ft)	Shear ROB (lb/sq ft)	Shear Total (lb/sq ft)
FIS EC	164	190	275.9	280.92		281.03	0.002026	2.83	81.68	64.57	0.3	0.06	0.33	0.06	0.16
FIS EB	163	190	274.5	276.69	276.69	276.91	0.020005	4.87	69.94	183.25	0.82	0.43	1.33	0.43	0.53
FIS EA	162	190	267.99	270.72		270.9	0.00532	3.59	70.53	92.54	0.47	0.12	0.6	0.12	0.25
FIS DZ	161	190	265	268.49		268.68	0.003732	3.52	54.79	26.42	0.4	0.05	0.54	0.06	0.46
FIS DY	160	190	262.6	266.27	265.81	266.79	0.016005	5.82	35.61	31.29	0.7	0.23	1.92	0.13	1.08
FIS DX	159	190	258.2	260.91	260.83	261.65	0.030713	6.93	27.43	16.68	0.95		2.94		2.94
15+38	158.9	190	258	260.69	260.69	261.2	0.018971	6.63	46.79	47.68	0.78	0.79	2.44	0.81	1.14
15+04	158.8	190	257.16	259.85	259.85	260.36	0.018978	6.63	46.78	47.68	0.79	0.79	2.44	0.81	1.14
14+71	158.6	190	256.32	259.01	259.01	259.52	0.018971	6.63	46.79	47.68	0.78	0.79	2.44	0.81	1.14
14+24	158.5	190	255.16	257.31	257.31	258.11	0.020621	7.18	26.91	22.11	0.98	0.1	2.01	0.1	1.5
13+77	158.3	190	254.01	256.5		256.75	0.008603	4.71	64.2	51.67	0.54	0.49	1.2	0.49	0.66
13+59	158.2	190	253.74	256.4		256.63	0.004574	4.5	73.17	53.68	0.5	0.3	0.68	0.29	0.38
13+40	158.1	190	253.21	256.4		256.52	0.001944	3.34	103.56	60.01	0.34	0.18	0.35	0.16	0.21
13+25	157.8	190	253.26	256.03		256.39	0.00653	4.98	47.49	43.2	0.58	0.16	0.87	0.18	0.44
13+10	157.7	190	252.82	256.11		256.22	0.001885	3.18	109.67	61.2	0.32	0.16	0.32	0.14	0.19
12+79	157.6	190	252.93	255.08	255.08	255.88	0.020597	7.17	26.92	22.13	0.98	0.1	2.01	0.1	1.5
12+48	157.5	190	252.02	255.3		255.4	0.001721	3.2	108.75	61.03	0.32	0.16	0.32	0.15	0.19
12+19	157.4	190	252.12	254.27	254.27	255.07	0.020601	7.17	26.92	22.12	0.98	0.1	2.01	0.1	1.5
11+89	157.3	190	251.26	254.39		254.51	0.002137	3.45	99.72	59.25	0.35	0.19	0.38	0.17	0.22
11+77	157.2	190	251.3	253.45	253.45	254.25	0.020601	7.17	26.92	22.12	0.98	0.1	2.01	0.1	1.5
11+65	157.1	190	250.94	253.35		253.68	0.007223	5.28	60.43	50.8	0.62	0.39	0.97	0.39	0.53
11+41	156.9	190	250.24	253.37		253.49	0.002127	3.44	99.89	59.28	0.35	0.19	0.38	0.17	0.22
11+29	156.8	190	250.28	252.95		253.36	0.007755	5.27	43.4	40.54	0.63	0.16	0.99	0.18	0.51
11+17	156.7	190	249.93	253.04		253.17	0.002176	3.47	98.99	59.1	0.36	0.19	0.39	0.17	0.22
11+04	156.6	190	249.98	252.22	252.13	252.94	0.017269	6.8	29	25.62	0.91	0.13	1.77	0.13	1.18
10+91	156.5	190	249.6	252.4		252.58	0.0036	4.14	80.73	55.33	0.45	0.26	0.57	0.24	0.32
10+80	156.3	190	249.26	252.4		252.52	0.002107	3.43	100.28	59.36	0.35	0.19	0.38	0.17	0.22
10+65	156.2	190	249.31	251.93		252.37	0.008482	5.43	41.4	39.18	0.66	0.16	1.06	0.18	0.55
10+51	155.1	190	248.88	252.04		252.16	0.002048	3.4	101.42	59.59	0.35	0.18	0.37	0.16	0.21
10+37	155	190	248.93	251.62		252.02	0.007442	5.2	44.34	41.17	0.62	0.16	0.96	0.18	0.49
10+24	154.9	190	248.54	251.72		251.83	0.001987	3.36	102.67	59.83	0.34	0.18	0.36	0.16	0.21
10+09	154.8	190	248.59	251.32		251.7	0.006913	5.08	46.09	42.31	0.6	0.16	0.91	0.19	0.46

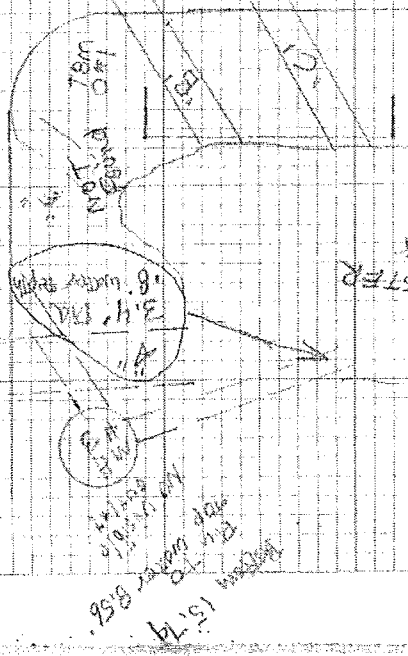
9+95	154.7	190	248.16	251.41		251.52	0.001777	3.24	107.35	60.75	0.32	0.17	0.33	0.15	0.19
9+98	154.6	190	248.25	250.4	250.4	251.2	0.020601	7.17	26.92	22.12	0.98	0.1	2.01	0.1	1.5
9+41	154.3	190	247.47	250.1	249.58	250.4	0.005626	4.95	57.94	35.34	0.56	0.38	0.83	0.44	0.55
	154.2	Bridge													
9+13	154.1	190	247.05	250.03		250.24	0.00328	4.13	70.55	35.65	0.43	0.28	0.55	0.32	0.38
9+05	154	190	247.03	249.75		250.14	0.007049	5.11	45.63	42.01	0.6	0.16	0.92	0.19	0.47
8+97	153.95	190	246.81	249.84		249.98	0.002466	3.63	94.13	58.12	0.38	0.21	0.42	0.19	0.25
8+78	153.9	190	246.77	249.24	248.92	249.78	0.011079	5.92	36	34.87	0.74	0.16	1.29	0.16	0.69
8+59	153.8	190	246.25	249.36		249.49	0.002175	3.47	99	59.11	0.36	0.19	0.39	0.17	0.22
8+30	153.7	190	246.2	248.35	248.35	249.15	0.020601	7.17	26.92	22.12	0.98	0.1	2.01	0.1	1.5
8+02	153.6	190	245.43	248.51		248.65	0.002279	3.53	97.16	58.74	0.36	0.2	0.4	0.18	0.23
7+84	153.5	190	245.4	247.55	247.55	248.35	0.020601	7.17	26.92	22.12	0.98	0.1	2.01	0.1	1.5
7+66	153.4	190	244.91	247.47		247.73	0.005444	4.78	68.07	52.55	0.54	0.33	0.78	0.32	0.43
7+46	153.3	190	244.38	247.47		247.6	0.002257	3.52	97.55	58.81	0.36	0.2	0.4	0.18	0.23
7+21	153.2	190	244.33	246.5	246.48	247.28	0.019723	7.08	27.4	22.98	0.96	0.11	1.95	0.11	1.41
6+96	152.9	190	243.65	246.69		246.83	0.002443	3.61	94.49	58.19	0.38	0.21	0.42	0.19	0.24
6+76	152.8	190	243.61	246.03	245.76	246.6	0.01224	6.11	34.2	32.74	0.78	0.16	1.38	0.16	0.78
6+55	152.7	190	243.05	246.16		246.29	0.002192	3.48	98.7	59.04	0.36	0.19	0.39	0.17	0.23
6+26	152.6	190	242.99	245.14	245.14	245.94	0.020601	7.17	26.92	22.12	0.98	0.1	2.01	0.1	1.5
5+96	152.5	190	242.21	245.26		245.4	0.002403	3.59	95.11	58.32	0.37	0.2	0.42	0.18	0.24
5+69	152.4	190	242.15	244.6	244.3	245.15	0.011524	5.99	35.27	34.02	0.76	0.16	1.33	0.16	0.73
5+42	152.3	190	241.42	244.74		244.83	0.001431	2.83	111.63	61.58	0.29	0.13	0.25	0.12	0.16
5+31	152.2	190	241.4	244.41		244.74	0.004521	4.89	58.89	49.7	0.51	0.17	0.77	0.2	0.33
5+20	151.9	190	241.15	244.5		244.59	0.001562	3.09	113.02	61.85	0.31	0.15	0.3	0.14	0.18
4+90	151.6	190	241	244.13	243.29	244.45	0.004976	4.72	44.11	18.86	0.52	0.42	0.75	0	0.61
box culvert	151.3														
3+95	151.2	190	240.53	242.9	242.9	243.7	0.016914	7.74	29.75	18.83	0.93	0.91	2.14	0.91	1.5
3+80	151.1	190	240.45	242.83		243.18	0.00754	4.97	49.66	46.18	0.63	0.19	0.9	0.24	0.5
2+94	150.8	230	239.5	242.82	241.8	242.88	0.000862	2	136.99	69.68	0.22	0.06	0.13	0.04	0.1
2+12	150.4	230	239.49	242.76	241.79	242.81	0.000756	1.86	144.77	75.42	0.21	0.05	0.12	0.04	0.09
1+30	149.7	230	239.2	242.54		242.68	0.002249	3.71	112.61	60.78	0.37	0.17	0.43	0.25	0.26
0+90	149.5	230	239	242.47		242.59	0.001947	3.54	120.55	63.27	0.34	0.2	0.39	0.18	0.23
0+00	149.1	230	238.55	242.14		242.36	0.002852	4.09	85.8	49.86	0.41	0.19	0.53	0.22	0.3
FIS DN	149	230	237.22	240.85		241.09	0.003448	4.28	82.52	57.45	0.45	0.2	0.59	0.19	0.31
FIS DM	148	230	233.91	237.01		237.54	0.009463	6	46.02	31.93	0.71	0.3	1.26	0.49	0.83
FIS DL	147	230	231	234.1		234.36	0.003011	4.1	60.45	24.6	0.43	0.13	0.54	0.16	0.43
FIS DK	146	230	231	233.39	233.39	234.18	0.021684	7.11	32.34	20.96	1.01		2.01		2.01

Sample
 Swenson
 Mitchell
 CR-2
 AUG 24.07

MULDOON



DE BAR



CHESTER

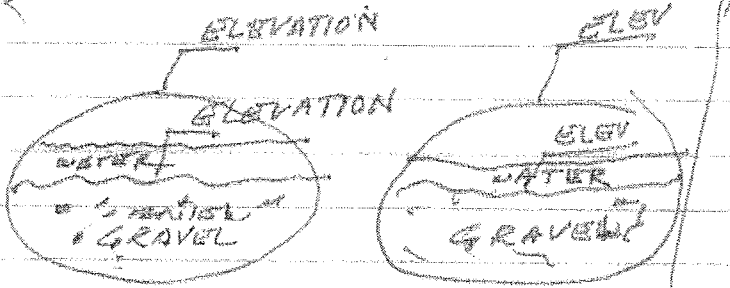
Flow

Top of water = 242.6
 2.4' = 240.1'

STA	LEVEL	HI	FS	ELEV	(Good condition)
BS	4.680			248.38	BA 00293
	6.480		4.605	248.455	GA 889 on curb
	5.560		4.470	250.465	on curb
	5.850		5.010	251.005	on curb
			4.520	251.845	TRM#1 Bass Top to in side walk
	4.500				3.4' 10.412 TR 11.611 2002.61
	5.160		5.335		
			5.710		
	4.430		6.430		
	4.170		4.260	248.870	BA 00293 GA 889
				251.845	TRM#1
	5.32		(13.31)	243.86	Top of Collect
			15.65	241.52	TRM#1
	15.58		5.235	251.86	TRM#1
			5.2	251.845	TRM#1
	5.235		14.61	242.147	Top of Collect
	14.61				up 0.1' to
			5.23	251.85	Top of Rocks

HEAD WALL

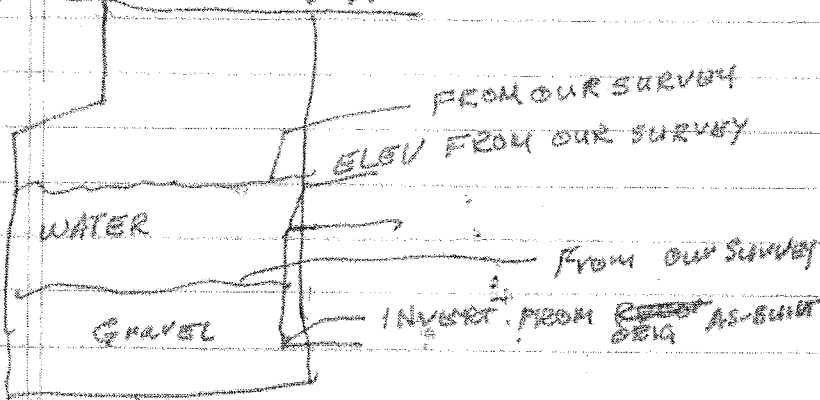
2 DEEPENINGS



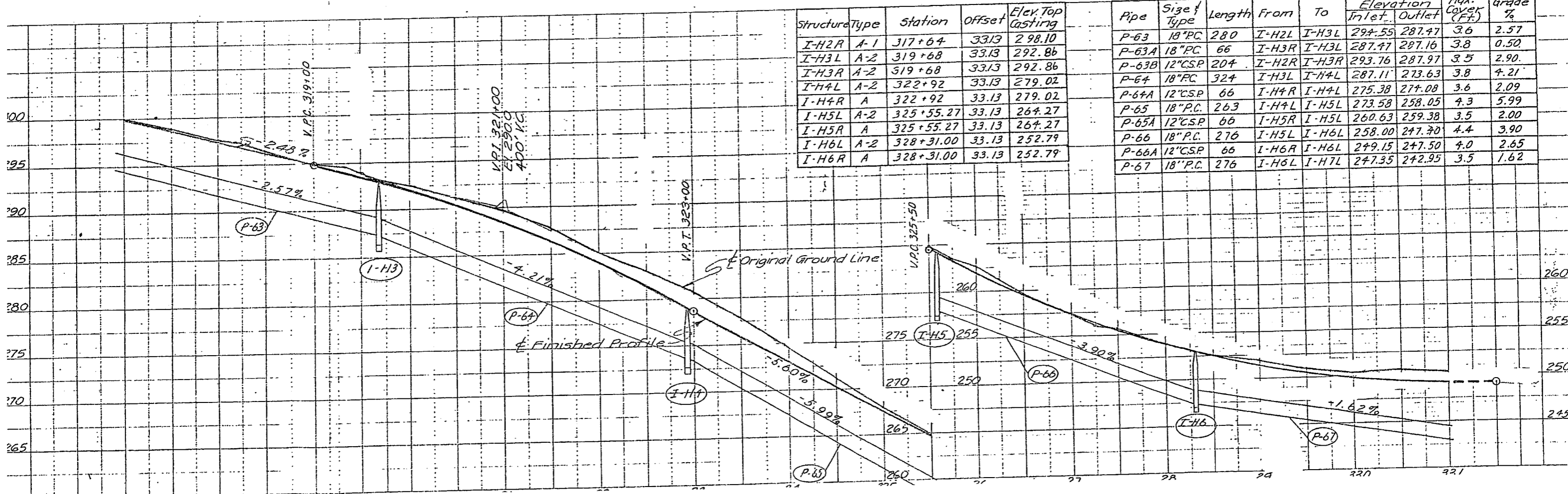
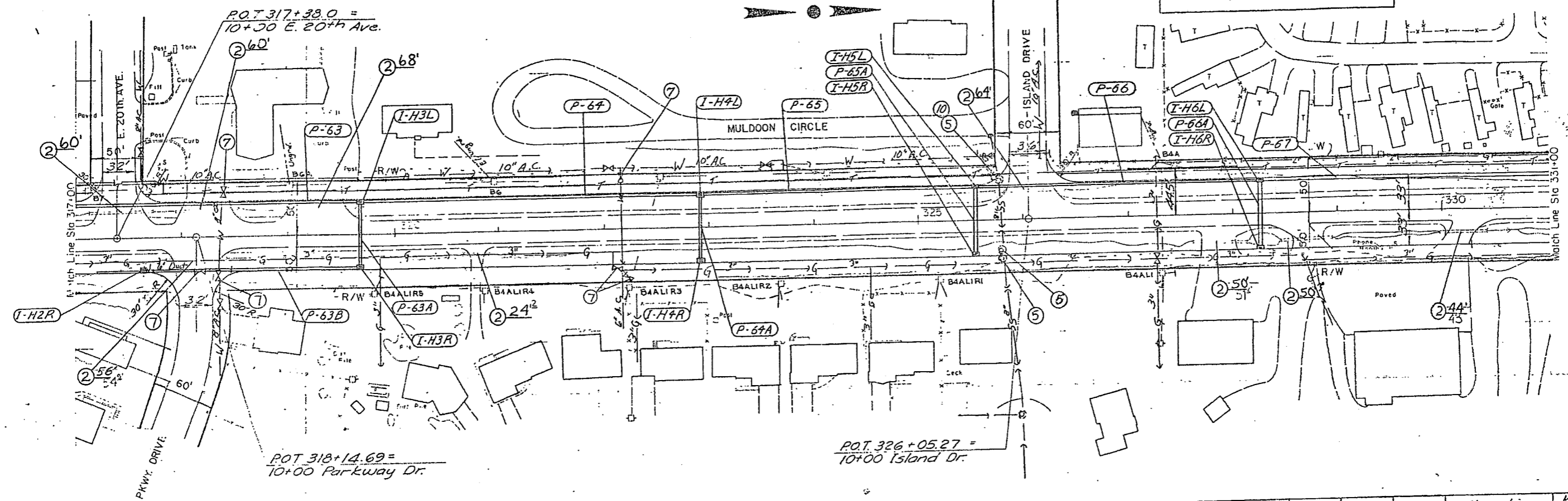
EAST WEST HEAD WALLS

TWO STRUCTURES

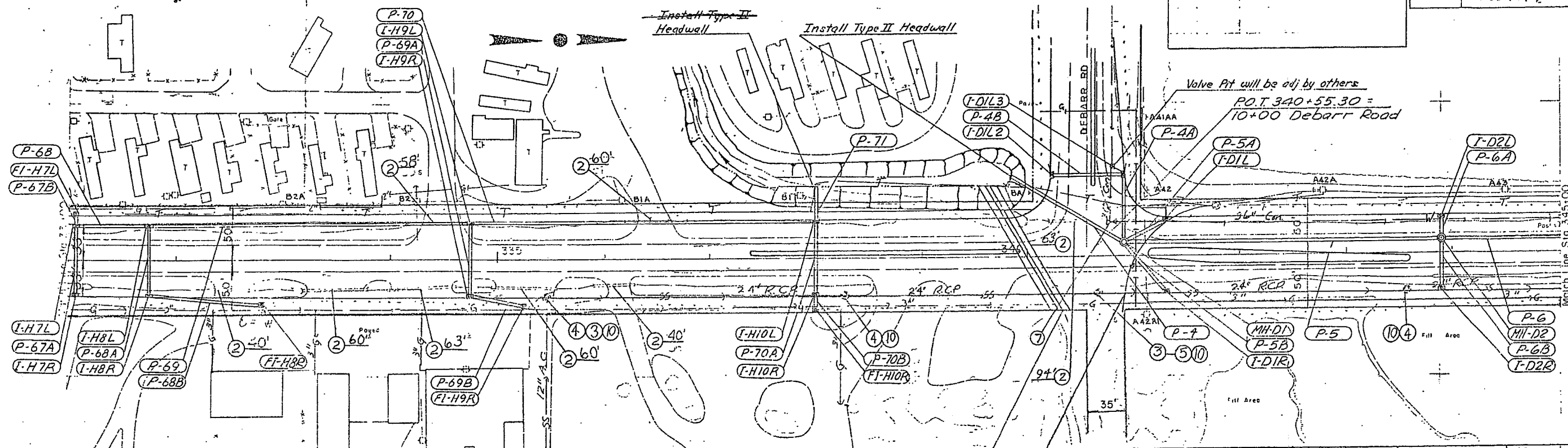
2 - 21.65



RECORD BOTTOM (From original As-Built)



STATE	PROJECT DESIGNATION	YEAR	SHEET NO	TOTAL SHEETS
ALASKA	M-0544(1)	1976	36	51



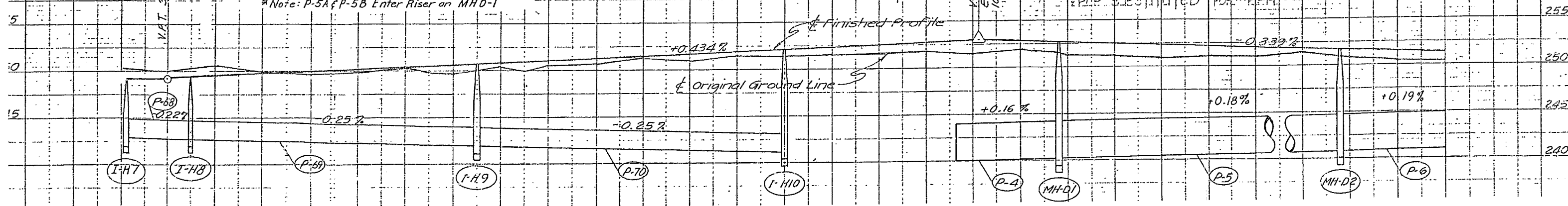
Structure	Type	Station	Offset	Elev. Top Casting
I-H 7L	A-2	331+06.84	33.13	248.97
I-H 7R	A	331+06.84	33.13	248.97
FI-H 7L	A	331+06.84	44.00	247.20
I-H 8L	A-2	331+75.35	33.13	249.17
I-H 8R	A-2	331+75.35	33.13	249.17
FI-H 8R	A	332+80.00	41.00	248.92
I-H 9L	A-2	334+75	33.13	250.47
I-H 9R	A-2	334+75	33.13	250.47
FI-H 9R	A	335+25	42.50	249.62
I-H 10L	A-2	338+00	35.13	251.84
I-H 10R	A-2	338+00	35.13	252.04
O-P-7I	~	338+00	65.00	~
O-P-4	~	339+81	75.00L	~
I-D 1L	A	341+30.30	35.13	252.81
I-D 1L 2	A	9+28 Rt	33.24	252.41
I-D 1L 3	A-1	9+28 Lt	33.24	252.41
I-D 1R	A	341+30.30	35.13	252.81
*MH-D 1	C-1	340+90.43	13.00L	252.56
I-D 2L	A	343+90	35.13	251.50
I-D 2R	A	343+90	35.13	251.50
MH-D 2	C-1	343+90	13.00L	251.39
FI-H 10R	A	338+00	45.00	249.75

*Note: P-5A & P-5B Enter Riser on MHD-1

Pipe	Size & Type	Length	From	To	Elevation		Max. Cover (Ft.)	Grade %
					Inlet	Outlet		
*P-68	24" RPM	69	I-H7L	I-H8L	242.90	242.76	4.0	0.22
P-67A	12" CSP	66	I-H7R	I-H7L	245.33	244.00	3.5	2.14
P-67B	12" CSP	11	FI-H7L	I-H7L	244.00	243.45	4.1	8.00
*P-69	24" RPM	300	I-H8L	I-H9L	242.71	241.99	6.0	0.24
P-68A	12" CSP	66	I-H8R	I-H8L	244.22	243.30	4.4	1.48
P-68B	12" CSP	105	FI-H8R	I-H8R	245.34	244.27	4.0	1.06
*P-70	24" RPM	325	I-H9L	I-H10L	241.93	241.13	8.3	0.25
P-69A	12" CSP	66	I-H9R	I-H9L	244.98	243.56	5.4	2.28
P-69B	12" CSP	51	FI-H9R	I-H9R	246.04	245.04	4.5	2.13
P-71	24" RPM	30	I-H10L	Outlet	241.07	241.00	23	0.23
P-70A	12" CSP	70	I-H10R	I-H10L	246.46	244.80	40	2.51
P-4	48" RPM	126	MH-D1	Outlet	240.20	240.00	88	0.16
P-4A	12" CSP	59	I-D1L3	MH-D1	248.45	247.24	4.5	2.20
P-4B	12" CSP	66	I-D1L2	I-D1L3	248.72	248.50	2.5	0.35
*P-5	48" RPM	300	MH-D2	MH-D1	240.78	240.24	88	0.18
P-5A	12" CSP	46	I-D1L	MH-D1	249.17	247.24	4.5	4.70
P-5B	12" CSP	63	I-D1R	MH-D1	249.17	247.24	4.5	3.33
*P-6	48" RPM	236	MH-D3	MH-D2	241.27	240.84	6.6	0.19
P-6A	12" CSP	22	I-D2L	MH-D2	247.77	243.00	7.35	27.06
P-6B	12" CSP	48	I-D2R	MH-D2	247.77	243.00	7.35	10.93
P-70B	12" CSP	10	FI-H10R	I-H10R	246.67	246.52	4.6	2.56

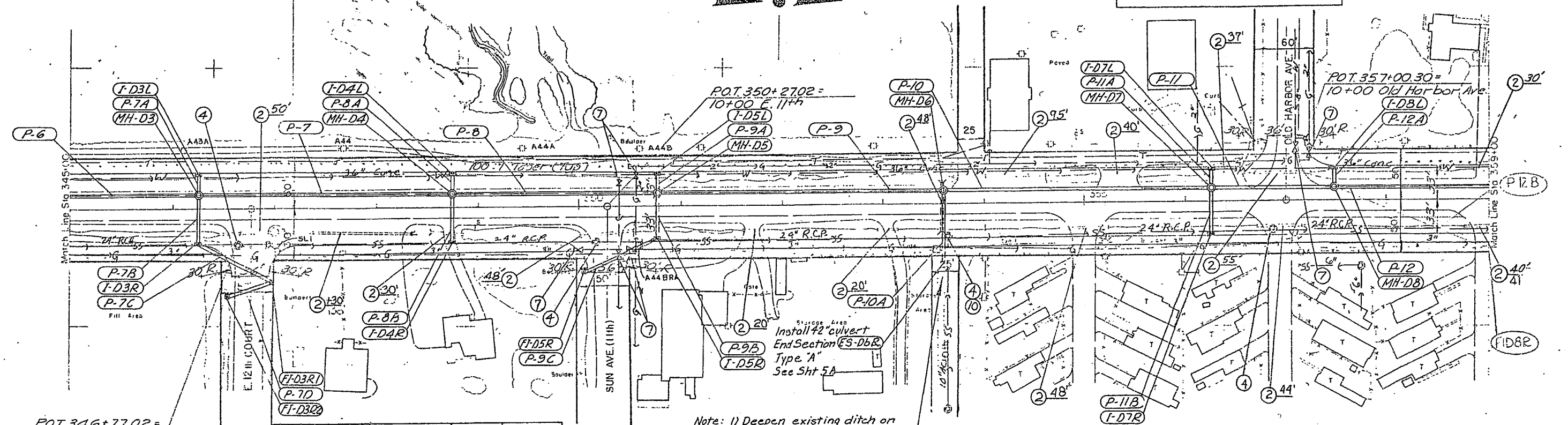
* RCP may be substituted for RPM.

PARA EL ESTIUTOLO POR REP



REVISIONS		
No.	Date	Description

STATE	PROJECT	DESIGNATION	YEAR	SHEET NO.	TOTAL SHEETS
ALASKA	M-0544(1)		1976	37	51



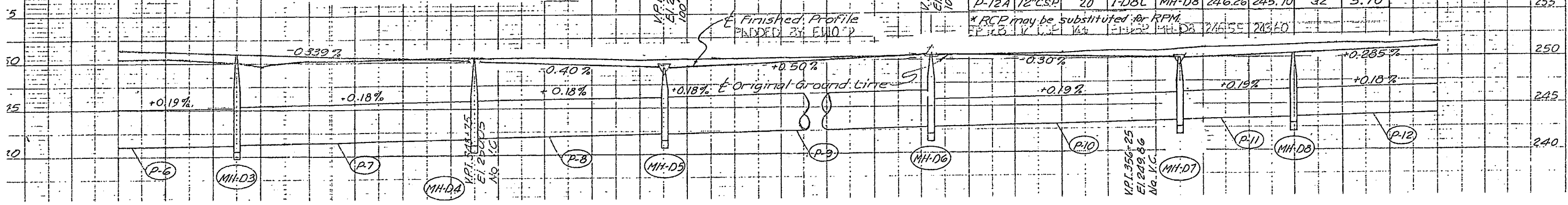
POT. 346+77.02 =
10+00 E. 12th Court

Note: 1) Deepen existing ditch on right side Sta. 353+60. From pipe inlet elev. of 245.50 at Sta. 353+60 55' Rt. slope upward on 2% grade to existing ditch bottom elev. 248.00 at Sta. 353+60 155' Rt.

Structure	Type	Station	Offset	Elev. Top Casting
MH-D3	C-1	346+25.01	13.00L	250.56
I-D3L	A	346+25.81	33.17	250.63
I-D3R	A-2	346+25.81	33.17	250.63
FI-D3R2	A	346+54.02	85.00	247.80
FI-D3R1	A-2	346+98	70.00	247.80
I-D4L	A	348+75	33.13	249.82
I-D4R	A	348+75	33.13	249.82
MH-D4	C-1	348+75	13.00L	249.71
I-D5L	A	350+76.50	33.13	249.01
I-D5R	A-2	350+76.50	33.13	249.01
FI-D5R	A	350+01.50	53.50	247.50
MH-D5	C	350+76.50	13.00L	248.90
ES-D6R		353+60	55.00	
MH-D6	C	353+60	13.00L	250.32
I-D7L	A	356+25	33.13	249.63
I-D7R	A	356+25	33.13	249.63
MH-D7	B	356+25	13.00L	249.52
I-D8L	A	357+49.51	33.13	249.99
MH-D8	B	357+49.51	13.00L	249.88
ES-D8R	A	358+79.5	47.5 RT	249.30

Pipe	Size & Type	Length	From	To	Elevation Inlet	Elevation Outlet	Max. Cover (Ft.)	Grade %
P-6		See Sheet No. 36						
*P-7	48" RPM	249	MH-D4	MH-D3	241.78	241.33	5.3	0.18
P-7A	12" CSP	20	I-D3L	MH-D3	246.99	243.83	5.8	20.17
*P-7B	18" RPM	46	I-D3R	MH-D3	241.65	241.54	7.5	0.25
P-7C	12" CSP	81	FI-D3R1	I-D3R	241.90	241.71	8.0	0.25
*P-7D	8" RPM	44	FI-D3R2	FI-D3R1	245.06	243.39	3.7	4.15
*P-8	48" RPM	202	MH-D5	MH-D4	242.20	241.84	3.9	0.18
P-8A	12" CSP	20	I-D4L	MH-D4	246.06	244.03	4.7	12.98
P-8B	12" CSP	46	I-D4R	MH-D4	246.06	244.03	4.7	4.87
*P-9	48" RPM	284	MH-D6	MH-D5	242.77	242.26	3.5	0.18
P-9A	12" CSP	20	I-D5L	MH-D5	245.28	244.97	3.1	1.98
*P-9B	18" RPM	46	I-D5R	MH-D5	243.56	243.46	4.2	0.24
*P-9C	18" RPM	78	FI-D5R	I-D5R	243.92	243.62	4.1	0.41
P-10	36" RPM	265	MH-D7	MH-D6	243.31	242.83	4.4	0.19
P-10A	42" R.C.	68	ES-D6R	MH-D6	245.50	242.83	4.0	4.07
*P-11	36" RPM	125	MH-D8	MH-D7	243.60	243.37	3.4	0.19
P-11A	12" CSP	20	I-D7L	MH-D7	245.90	245.52	3.0	2.51
P-11B	12" CSP	46	I-D7R	MH-D7	245.90	244.87	3.6	2.50
*P-12	36" RPM	210	MH-D9	MH-D8	244.15	243.66	3.5	0.18
P-12A	12" CSP	20	I-D8L	MH-D8	246.26	245.70	3.2	3.70

*RCP may be substituted for RPM.
P-10, P-11, P-12, P-12A



CERTIFICATE OF OWNERSHIP AND DEDICATION

I (we), hereby certify that I (we) hold the herein specified property interest in the property described hereon. I (we) hereby dedicate to the municipality all areas depicted for use as public utility easements, streets, alleys, thoroughfares, parks, and other public areas shown hereon. There shall be reserved adjacent to the dedicated streets shown hereon a slope reservation easement sufficient to contain cut and fill slopes of 1.5 feet horizontal for each one foot vertical (1.5 to 1) of cut or fill for the purpose of providing and maintaining the lateral support of the constructed streets. There is reserved to the grantors, their heirs, successors and assigns, the right to use such areas at any time upon providing and maintaining other adequate lateral support, as approved by the municipality.

I (we) hereby agree to this plat, and to any restriction or covenant appearing hereon and any such restriction or covenant shall be binding and enforceable against present and successive owners of this subdivided property.

Owner's

Kelly Bryant, Executress for
Joe Bryant
3705 ARCTIC BLVD #1816
ANCHORAGE AK, 99503-5774

Notary Acknowledgement

for Kelly Bryant Subscribed and
sworn to before me this 20 day of May, 2006
Shirley J. Smith My Commission Expires
June 13, 2008
Notary Public for the State of Alaska
Nada M. Mortenson Subscribed and
sworn to before me this 19 day of May, 2006
Thomas Michael Cody IV My Commission Expires
October 3, 2009
Nada Mortenson, Conservator for
Thomas Michael Cody IV
3705 ARCTIC BLVD #1816
ANCHORAGE AK, 99503-5774

Notary Acknowledgement

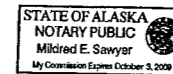
for NADA M. MORTENSON Subscribed and
sworn to before me this 19 day of MAY, 2006
Mildred E. Sawyer My Commission Expires
October 3, 2009
Notary Public for the State of Alaska

Beneficiary

Carl Benson PRESIDENT
Name Title
CARL BENSON
Printed Name
Alaska Greenhouses, Inc.
1821 Bunker Street
Anchorage, AK 99503

Notary Acknowledgement

for Carl Benson Subscribed and
sworn to before me this 20 day of May, 2006
Mildred E. Sawyer My Commission Expires
October 3, 2009
Notary Public for the State of Alaska

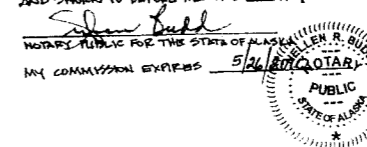


OWNER'S

DENNIS C. LEBLANC, MUNICIPAL MANAGER
MUNICIPALITY OF ANCHORAGE
P.O. BOX 196650
ANCHORAGE, ALASKA 99519-6650

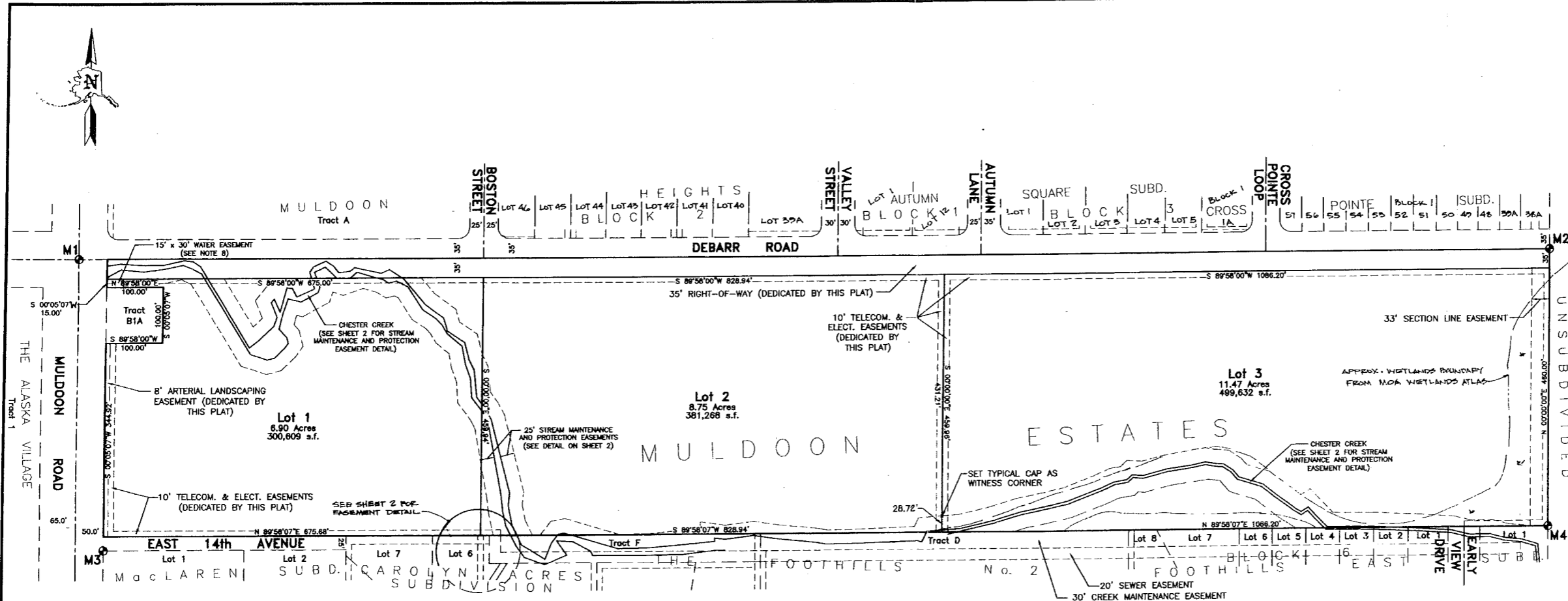
NOTARY ACKNOWLEDGEMENT

FOR DENNIS C. LEBLANC Subscribed
AND SWORN TO BEFORE ME THIS 19 DAY OF FEBRUARY 2007
Shirley J. Smith
NOTARY PUBLIC FOR THE STATE OF ALASKA
MY COMMISSION EXPIRES 5/26/2009

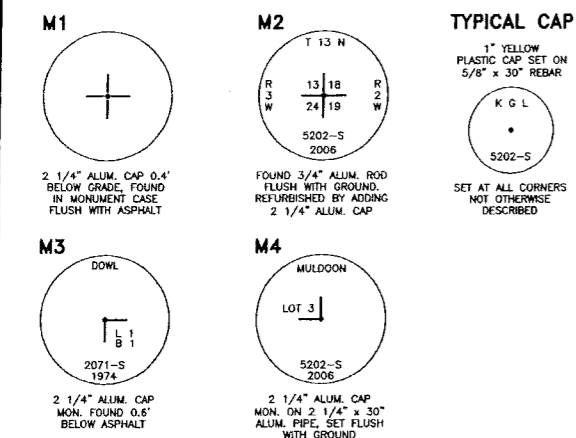


NOTES

- ARTERIAL LANDSCAPING MEETING THE REQUIREMENTS OF AMC 21.45.125.C.4 SHALL BE INSTALLED AND MAINTAINED WITHIN THE ARTERIAL LANDSCAPE EASEMENT FOR THE LIFE OF THE PROPERTY BY THE PROPERTY OWNER OR HIS/HER DESIGNEE.
- WITHIN THE STREAM MAINTENANCE AND PROTECTION EASEMENTS, ALL STRUCTURES AND USES OF LAND SHALL CONFORM TO THE REQUIREMENTS OF AMC 21.45.210. THIS EASEMENT MAY ALSO BE USED FOR TRAILS.
- APPROPRIATE PERMITS SHALL BE OBTAINED FROM THE ARMY CORPS OF ENGINEERS FOR ANY WORK PERFORMED IN THE STREAM MAINTENANCE AND PROTECTION EASEMENT OR WITHIN THE WETLANDS AREA.
- LOT 1 IS SPLIT ZONED B3-SL AND R-2M.
- PORTIONS OF THIS SUBDIVISION ARE SITUATED WITHIN THE FLOOD HAZARD DISTRICT AS IT EXISTS ON THE DATE HEREOF. THE BOUNDARIES OF THE FLOOD HAZARD DISTRICT MAY BE ALTERED FROM TIME TO TIME IN ACCORDANCE WITH THE PROVISIONS OF AMC 21.60.020. ALL CONSTRUCTION ACTIVITIES AND ANY LAND USE WITHIN THE FLOOD HAZARD DISTRICT SHALL CONFORM TO THE REQUIREMENTS OF CHAPTER 21.60 (ANCHORAGE MUNICIPAL CODE). A FLOOD HAZARD PERMIT IS REQUIRED FOR ANY CONSTRUCTION IN THE FLOODPLAIN.
- STORM WATER RUNOFF PLANS ARE REQUIRED FOR ALL LOTS AND TRACTS IN THIS SUBDIVISION, AND SHALL BE APPROVED BY WATERSHED MANAGEMENT SECTION.
- ALL DIMENSIONS SHOWN TO THE NEAREST FOOT (I.E. 30', 35') ARE ACTUALLY MEASURED TO THE HUNDREDTH OF A FOOT (I.E. 30.00', 35.00').
- THE 15' x 30' WATER EASEMENT WAS GRANTED MAY 20, 1982 IN BOOK 732 AT PAGE 799 AND IS NOT DEDICATED BY THIS PLAT.



MONUMENTATION



SURVEYOR'S CERTIFICATE

I, KENNETH G. LANG, professional land surveyor, do hereby certify that the plat of THIS PLAT is a true and correct representation of lands actually surveyed and that the distances and bearings are shown correctly and that all permanent exterior control monuments, all other monuments, and lot corners have been set and staked, or if final completion is assured by subdivision agreement, they will be set as specified in said subdivision agreement.

Lot corners to be set by N/A
Monuments to be set by N/A

PLAT APPROVAL

Plat approved by the Municipal Platting Authority
this 26 day of February, 2007

APPROVALS

Platting Officer [Signature]
Municipal Surveyor [Signature]



TAX CERTIFICATION

ALL REAL PROPERTY TAXES LEVIED BY THE MUNICIPALITY OF ANCHORAGE ON THE AREA SHOWN ON THIS PLAT HAVE BEEN PAID IN FULL, AND IF APPROVAL IS SOUGHT BETWEEN JANUARY 1 AND THE TAX DUE DATE, THERE IS ON DEPOSIT WITH THE CHIEF FINANCIAL OFFICER AN AMOUNT SUFFICIENT TO PAY ESTIMATED REAL PROPERTY TAX FOR THE CURRENT YEAR.

[Signature] AUTHORIZED OFFICIAL
[Signature]

ACCEPTANCE OF DEDICATION

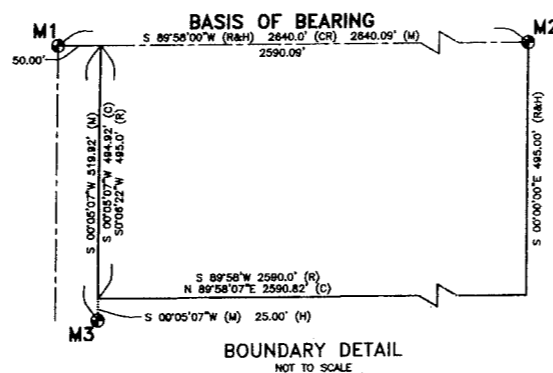
THE MUNICIPALITY OF ANCHORAGE HEREBY ACCEPTS FOR PUBLIC USES AND FOR PUBLIC PURPOSES THE REAL PROPERTY DEDICATED ON THIS PLAT INCLUDING, BUT NOT LIMITED TO THE EASEMENTS, RIGHTS-OF-WAY, ALLEYS, ROADWAYS, THOROUGHFARES AND PARKS SHOWN HEREON.

DATED AT ANCHORAGE, ALASKA THIS 22 DAY OF November, 2006

ATTEST:

[Signature] MUNICIPAL CLERK

[Signature] MAYOR OF ANCHORAGE



ON-SITE
WATER & WASTE WATER: Date: _____

