CITY OF KODIAK

Downtown Water, Sewer, and Storm Drain Master Plan

February 2015

DOWL

CITY OF KODIAK
DOWNTOWN WATER, SEWER, AND STORM DRAIN
MASTER PLAN

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LIST OF ACRONYMS

ACP ..... asbestos cement pipe
ACS ..... Alaska Communication System
cfs ..... cubic feet per second
City ..... City of Kodiak
CMP ..... corrugated metal pipe
CPEP ..... corrugated polyethylene pipe
DEC ..... Department of Environmental Conservation
DIP ..... ductile iron pipe
DOT&PF ..... Department of Transportation and Public Facilities
fps ..... feet per second
GCI ..... General Communications Inc.
gpm ..... gallons per minute
HDPE ..... high-density polyethylene
I/I ..... Inflow and Infiltration
KEA ..... Kodiak Electric Association
MCMT ..... Mill Creek Management Technology
MGD ..... million gallons per day
PVC ..... polyvinyl chloride
ROW ..... right-of-way
VEI ..... VEI Consultants

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EXECUTIVE SUMMARY

Key Aspects of the Plan:

- A comprehensive analysis of the existing infrastructure, the existing demand and capacity of the water, sewer, and storm drain utility lines. The plan identifies required infrastructure needs and discusses proposed alternatives and alignment improvements throughout the Downtown Area.
- The plan proposes six phased projects to accommodate the proposed improvements. It also includes a planning level cost estimate for each phase.

Other Important Points:

DOWL HKM prepared the attached plan, with help and input from City of Kodiak staff. Several subconsultants were also included during the development of the plan as identified in this report.

The emphasis of the proposed improvements is to allow for;

- an increase in efficiency in the sanitary sewer system through improved network layout and by increasing the capacity of the sanitary sewer system,
- an increase in water system redundancy and available supply of water to Kodiak's downtown, primary industrial sector, and
- upgrades to the storm drain system, including repairs to the primary outfall lines that pass below/next to the old Food-For-Less building, and realignment of storm drain mains to reduce construction costs.

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1.0 INTRODUCTION

The Downtown Kodiak Water, Sewer, and Storm Drain Master Plan investigates water, sanitary sewer, and storm drain utility lines running in and through the downtown Kodiak area (Figure 1). The goals of the Master Plan consist of determining existing and future water demand and sewage flows, capacity of the infrastructure, and recommending improvements and potential realignment of these utilities to better serve the community.

The initial scope of work to achieve the goals of the plan began with an evaluation of the downtown area to determine the project limits and form project boundaries. The City of Kodiak assisted by identifying utility corridors that were vital to their system operations and sections of utility lines that exhibited issues in the past. These issues include observed high flows in the sanitary sewer system, a history of deteriorated storm drain mains, and the recognition of the need for system redundancy and potentially higher service capacity in the water distribution system.

Once the boundaries were defined, field investigations began that included a topographic base map survey of the project area and geotechnical investigations. These field investigations were coupled with a review of record drawings and system operational data from water metering, water storage, and wastewater treatment facilities received from the City of Kodiak Public Works Department to allow basic system modeling and capacity evaluations. Also included in the original scope was the development of a Landscaping Master Plan to be implemented as part of the proposed reconstruction. Public outreach was included as an additional service and complimented the Landscape Master Plan effort.

A conceptual utility layout was formed, followed by the development of additional scopes of work added to fill in unknown information. These scopes included;

- a detailed review of water and sanitary sewer services (approx. 130 services, including fire service connections),
- a Phase 1 Environmental Site Investigation, and
- a storm drain structural assessment.

These topics are discussed in more detail in later sections of this report.

Figure 1: City of Kodiak Vicinity Map

2.0 EXISTING CONDITIONS

The project area, as shown in Figure 2, is approximately 25 acres and contains a dense development of approximately 50 businesses. Seven industrial seafood processors are located along Shelikof Street and Marine Way. The seasonal fluctuations associated with the fishing industry create a high and varying demand for potable water. Large amounts of inflow and infiltration upstream of the project area place stress on the sanitary sewer utilities during portions of the year. The downtown area collects and transfers sanitary sewage and stormwater through gravity mains that originate from outside the project area, primarily in the higher elevations to the north. The project area is an essential link for these major utilities.

2.1 Recent Improvements

In 2008, the Alaska Department of Transportation and Public Facitlites (DOT&PF) completed the reconstruction of the Kodiak Wye Intersection. The project corridor included approximately 800 feet of Rezanof Drive and 400 feet of Lower Mill Bay Road, extending from Marine Way north past the wye intersection of Lower Mill Bay Road to Thorsheim Street. Prior to the road improvements, in May of 2007 the City of Kodiak performed utility upgrades through this high traffic area. These utility upgrades are the initial phase of the Downtown Master Plan Improvements. The primary utility improvements included upsizing sanitary sewers, and water mains and redirecting the storm drain into the right-of-way (ROW).

2.2 Locating Existing Utilities

DOWL HKM efforts began with a survey of the existing utilities in the project area (Figure 2). Water and sewer service locations were revised based on review of record drawings and the Public Works Department's extensive experience in the project area. The information was then combined into a final utility base map (Appendix A). Using available data, the base map reflects the location of utility mains and services, to the extent practical, throughout the downtown area. A thorough understanding of the existing utilities was critical when evaluating proposed alignments.

Figure 2: Project Area

2.3 Water Distribution System

Existing Water Infrastructure and Operation

The potable water supply for the downtown Kodiak area originates from the Monashka and Pillar Creek Reservoirs, and is pumped into the Upper Bettinger dam. The raw water is piped and treated at the chlorination treatment plant and then stored in storage tanks on Pillar Mountain Road. Water is then supplied by gravity flow to the city. The water system in the Downtown project area operates at a static pressure of approximately 110 psi and a residual pressure of approximately 85 psi.

The majority of the water main infrastructure in the downtown area was constructed in the early 1960s, ranging in diameter from 6-inch through 12-inch and composed of asbestos cement pipe (ACP). This pipe is nearing the end of its design life as indicated by an increase in emergency repairs.

Typical deficiencies include broken services due to freezing conditions and inadequate valves for isolation. The water services for Key Bank at 422 Marine Way and Subway at 326 Center Street burst during the winter of 2011/2012. There was a break in the main line located in Center Street near the Baranov Museum the same winter. The break occurred at a valve that controlled an uncapped stub out and caused extensive damage to the roadway section.

The Safeway Liquor Store, Henry's Restaurant, and the Treasury are served by the same water main located at the rear of the buildings. The existing valves do not allow for isolation of the Safeway Liquor Store at 512 Marine Way. The water can only be turned off by closing the main line valves which interrupts service to the other businesses as well. Existing utilities and businesses are shown in further detail in the base map located in Appendix A.

2.3.1 Existing Water Alignments

Water flows to the downtown area through transmission mains extending from the City of Kodiak's (City) water treatment plant on Pillar Mountain Road. Over the last seven years, the City has implemented several water main improvement projects within the Aleutian Homes Subdivision and along Rezanof Drive that increased the diameter of the transmission main

serving the downtown area to 20 inches. Figure 3 illustrates the existing water main distribution system.

The existing downtown water system (Figure 3) consists of 6-, 8-, and 12-inch ACP. Alignments are generally located near the edge of pavement with the exception in the Mall area. Most of the Mall businesses receive their domestic water from a main located below the Mall sidewalk approximately four to six feet from the building foundations. Several of the Mall businesses receive their fire protection from main lines located at the rear of each building.

Existing Water Demand and Capacity

Water service and supply facilities for businesses and residential consumers within the project area has met the existing demand.

Water meter information provided by the City of Kodiak spanning 5 years from January 2007 to December 2011 was used to estimate current water usage. The primary water demand within and adjacent to the project area are seafood processors. The average monthly water use by seafood processors was calculated as summarized in Table 1.

Figure 3: Existing Water Mains

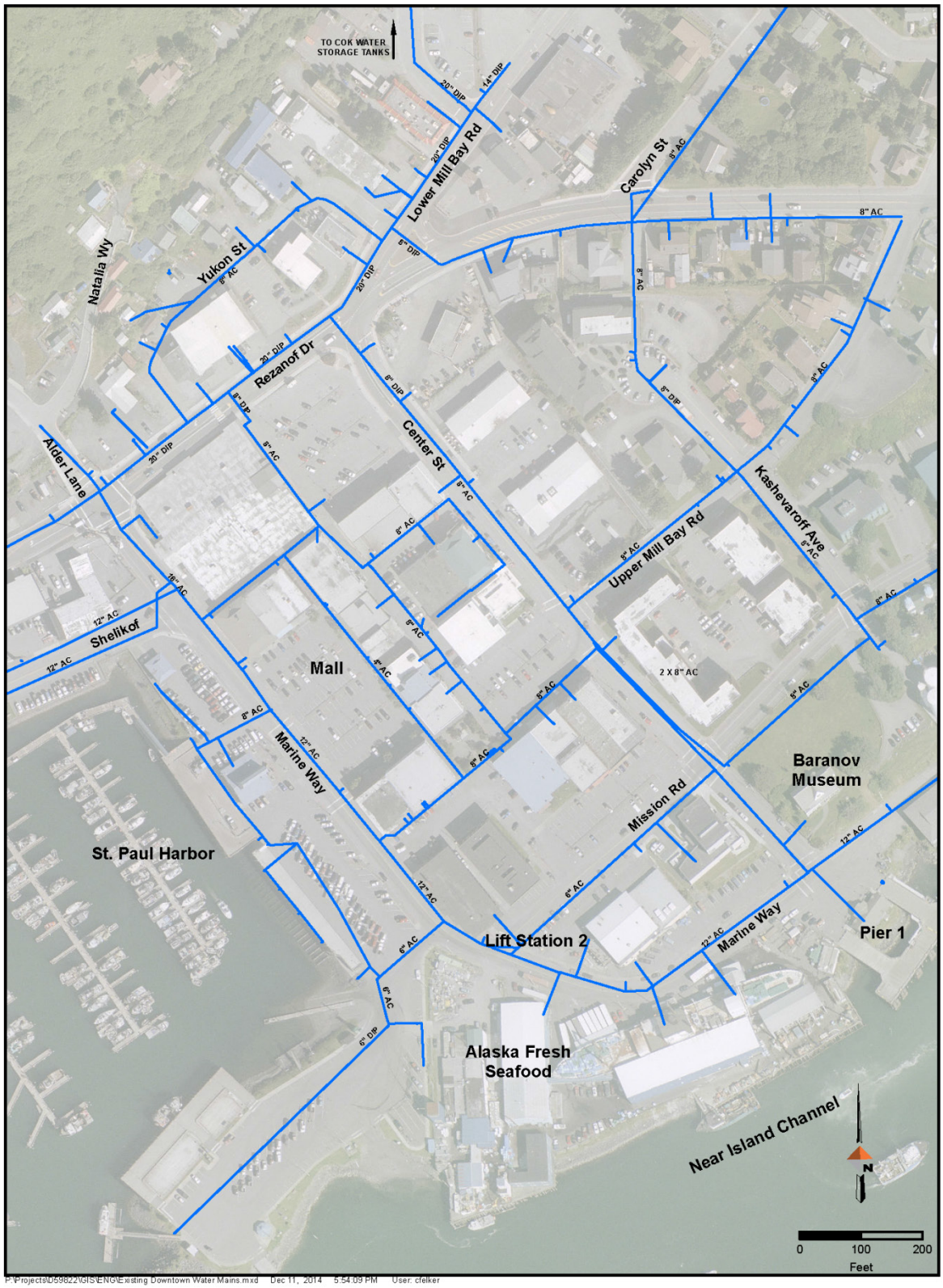


Table 1: Seafood Processor Information and 5-Year Average Monthly Water Usage (2007-2011)

Seafood Processor	Downtown Area	Shelikof Area	Marine Way (Outside Project Area)	Address	Average Monthly Water Usage (Gallons)
*Alaska Fresh Seafoods	X			105 Marine Way	1,383,987
Trident Seafoods Corporation	X			111 Marine Way	2,704,284
Trident Seafoods Corporation	X			111 Marine Way	4,099,622
Trident Seafoods Corporation	X			111 Marine Way	7,298,209
Alaska Pacific Seafoods (shrimp plant)		X		627 Shelikof	10,900,865
Alaska Pacific Seafoods (crab plant)		X		627 Shelikof	743,615
Kodiak King Crab Inc.		X		621 Shelikof	5,379,400
Kodiak King Crab Inc. (Ocean Beauty Seafoods)		X		621 Shelikof	442,879
Kodiak King Crab (Ocean Beauty Seafoods)		X			6,509,702
Kodiak King Crab		X		New Freezer Bldg	96,954
Kodiak Fishmeal		X		911 Gibson Cove	1,050,825
Pacific Pearl c/o International Seafoods		X		517 Shelikof Street	10,105,815
Western Alaska Fisheries		X		521 Shelikof	464,280
Western Alaska Fisheries		X		521 Shelikof	7,499,282
Western Alaska Fisheries		X		Shelikof Street, 1111 3rd Ave Bldg	937,040
Western Alaska Fisheries		X		521 Shelikof Street	4,588,634
Island Seafoods		X		317 Shelikof St	732,939
Island Seafoods		X		317 Shelikof St	541,627
International Seafoods (Bunkhouse Eagle)			X	714 Marine Way	75,550
International Seafoods of Alaska			X	612 Marine Way	162,520
Global Seafoods			X	800 Marine Way East	4,343,527
Global Seafoods			X	800 Marine Way East	2,496,842
				Total	**72,558,398**

*Facility was removed in 2014. A new Trident processing plant is scheduled for construction in the winter of 2014.

Table 2 summarizes the seafood processor water usage by project area.

Table 2: Seafood Processor Water Usage by Area

Seafood Processors By Area	Seafood Processing Water Use Distribution 2007-2011 (gallons per month)	% of Total Seafood Processor Use
Downtown	15,486,102	21%
Shelikof Area	49,993,857	69%
Marine Way East (Outside Project Area)	7,078,439	10%
Total	**72,558,398**	**100%**

To demonstrate the importance of providing redundancy in the system and maintaining service at all times to the seafood processors, the seafood processor water usage was compared against that used by the entire City of Kodiak as shown in Table 3. During the highest demand months, the seafood processors account for nearly 80 percent of the water used in Kodiak.

Table 3: City of Kodiak Versus Seafood Processor Water Usage (2007-2011)

	Time Period	City of Kodiak	Seafood Processors	% of Total City of Kodiak Use
Lowest Water Demand - Gallons per Month	December 2010	73,256,000	6,301,720	9%
Highest Water Demand - Gallons per Month	March 2011	216,401,000	171,333,380	79%
Gallons per Day		7,213,367	5,711,113	-
Gallons per Hour		300,557	237,963	-
Gallons per Minute		5,009	3,966	-
Average Water Demand - Gallons per Month	2007 - 2011	146,425,483	72,558,398	50%
Gallons per Day		4,880,849	2,418,613	-
Gallons per Hour		203,369	100,776	-
Gallons per Minute		3,389	1,680	-

City of Kodiak peak hour flow was recorded on March 19, 2011, at 7,600 gpm (gallons per minute). Applying the 79 percent of total City of Kodiak use from Table 3, the estimated peak hour demand by the seafood processors is estimated at 6,000 gpm.

2.4 Sanitary Sewer Collection System

Summary of Previous Studies

In 2005, the City of Kodiak contracted CH2M Hill to conduct an Inflow and Infiltration (I/I) Study to identify and reduce sources of I/I in the sanitary sewer system and to provide recommendations that included cost effective analyses for upgrades and repairs throughout the system. A model of the sanitary sewer system, calibrated using available data, was developed for the study using the citywide sanitary sewer system as it was in 2005. The model assumed a 5-year, 24-hour rainfall event which CH2M Hill cited as a basis for developing capital improvements projects. For purposes of the I/I study, the model was very generalized and did not closely evaluate the capacity of existing sewer mains in the downtown area. For purposes of this study, additional analysis and modeling was performed to properly evaluate the downtown sewer mains.

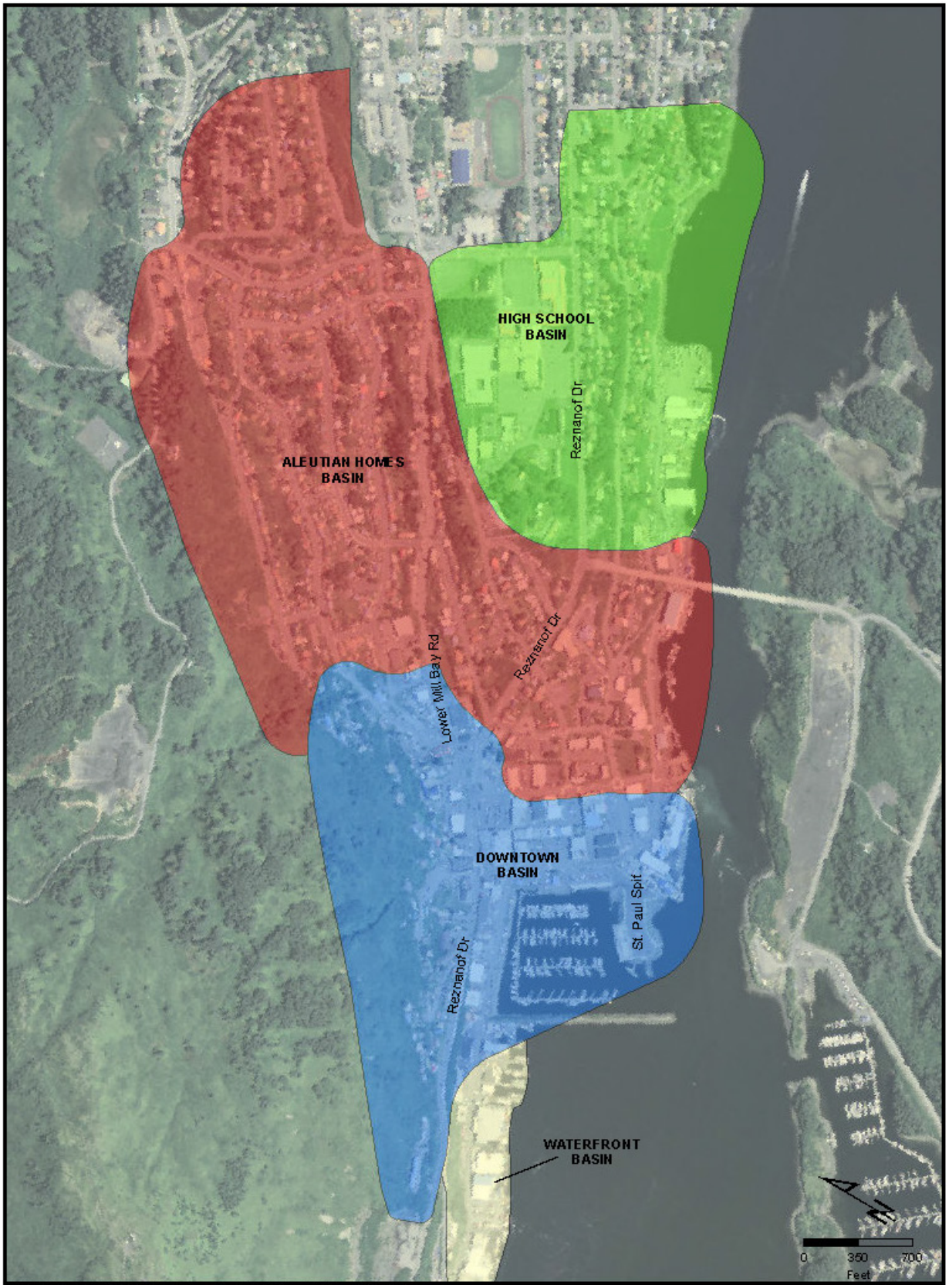
In 2012, DOWL HKM submitted an evaluation of Lift Stations 1 & 2. This evaluation looked at sewage flows into and from the lift stations and their surrounding basins. The results of the evaluation included upgrades to the lift stations with increased pumping capacity, increased storage capacity, and improvements to the electrical and control systems.

Existing Sanitary Sewer Infrastructure and Operation

Sanitary sewer service and capacity within the project area currently meets the sewage flows from area businesses and residential services.

The downtown sanitary sewer system collects wastewater from the Downtown Basin and transfers wastewater flowing from the Waterfront basin and the Aleutian Homes Basin (Figure 4).

Figure 4: Sanitary Sewer Drainage Basins



The downtown sewer system consists of 8-, 10-, and 12-inch asbestos cement mains (Figure 5). The gravity flow system collects at the southeast corner of downtown at Lift Station 2 and is located near the intersection of Mission Road and Marine Way. Lift Station 2 pumps the collected effluent through an 8-inch force main east along Marine Way to a manhole at the intersection with Center Avenue. Wastewater then gravity flows out of the downtown area northeast towards the wastewater treatment facility through a series of gravity and force mains that run along Marine Way outside the project area. The existing pump flow rate out of Lift Station 2 is approximately 700 gpm.

Waterfront Basin: Sanitary sewer flow enters the downtown area from the east through two 12-inch mains, one following West Rezanof Drive, and the other on Shelikof Street. This flow consists of sanitary sewer collected from approximately:

- 12 businesses;
- 35 residences; and
- 12 industrial facilities (primarily seafood processing plants).

Note that the industrial facilities contribute only their domestic wastewater to the system. Processing wastewater is discharged separately. Peak flow generated in the Waterfront Basin and entering the Downtown Basin is estimated at 130 gpm based on historical flows at Lift Station 1. The existing pump flow rate out of Lift Station 1 is approximately 540 gpm.

Aleutian Homes Basin: Flow enters the downtown area from the northeast via an 8-inch main and a 12-inch main, both originating on Lower Mill Bay Road. The 12-inch main exits Lower Mill Bay Road into a utility easement to the Erskine Subdivision to the southeast and the 8-inch main extends southwest along Lower Mill Bay Road to tie into a 10-inch main located on East Rezanof Drive. This flow is generated in the Aleutian Homes residential district from:.

- two businesses;
- 556 residences; and
- one industrial facility.

Figure 5: Existing Sanitary Sewer System

The City of Kodiak Public Works Department has identified capacity issues with the 12-inch sewer main extending from the Aleutian Homes Sewer Basin to East Marine Way. The 12-inch main that connects these two points originates at Lower Mill Bay Road and extends along utility easements to Center Avenue, and then follows Center Avenue to Marine Way. The capacity of this main is summarized in Table 4.

Table 4: Capacity of Existing 12-inch Sanitary Sewer from Lower Mill Bay to Center Avenue

Pipe Segment	Flow at Full Capacity	Flow at 50% Capacity
MH on Lower Mill Bay Road to MH at L109	964	288
MH at L109 to MH NW of Carolyn	964	288
MH NW of Carolyn St to MH at Carolyn St	740	221
MH at Carolyn Street to MH at E. Rezanof	964	288
MH at E. Rezanof to MH in Easement	636	190
MH in Easement to MH at Kashevarof Cir	1,244	372
MH at Kashevarof Cir to MH at 2nd Easement	5,053	1,509
MH at 2nd Easement to MH at Center St	2,123	634
MH at Center St to MH at Mill Bay	1,439	430
MH at Mill Bay to MH at Mission Rd	1,148	343
MH at Mission Rd to MH NW of Marine Way	1,723	514
MH NW of Marine Way to MH at Marine Way East	4,625	1,381

A summary of the hydraulic analysis is contained in Appendix B.

During extended rain events, this system exceeds the capacity of the 12-inch main due to excessive I/I and uses a 4-inch overflow line on Lower Mill Bay road, which has been observed to run completely full. The 4-inch overflow line allows some of the wastewater flow to divert into the 8-inch main on Lower Mill Bay Road, which then flows into the 10-inch main further southeast. The City had considered increasing the diameter of this overflow line to a 6-inch line in the future. Following further analysis of the main downstream of the bypass and along Rezonof drive, the 8- and 10-inch mains to the southeast do not have the capacity to accommodate an increase in the size of the bypass line. Table 5 shows the existing capacity of the gravity main from the overflow to the manhole on Rezanof Street at the intersection of Marine Way. The slope of the pipe is the variable used to determine the capacity.

Table 5: Capacity of Existing Sanitary Sewer from the Bypass Pipe to Rezanof Street

Pipe Segment	Flow at Full	Flow at 50%
MH at Overflow to 1st MH SW of Overflow	1,515	452
1st MH SW of Overflow to MH NE of Thorsheim	676	202
MH NE of Thorsheim to MH at Thorsheim	1,063	318
MH at Thorsheim to MH at Yukon Street	979	292
MH at Yukon Street to MH at Y Intersection	790	236
MH at Y Intersection to 1st MH Past Center	589	176
1st MH Past Center to 2nd MH Past Center	668	200
2nd MH Past Center to MH at Marine Way	668	199

A summary of the hydraulic analysis is contained in Appendix B.

Downtown Basin: The downtown basin encompasses the downtown study area and adjacent neighborhoods to the north and northwest and consists of:

- 35 businesses;
- 111 residences; and
- three industrial facilities.

Current peak flow passing through the Downtown Basin is estimated at 800 gpm based on existing flow data from Lift Station 2.

Flow capacities vary in each pipe segment due to change in pipe slope. Table 6 shows the current capacity of the sewer main along Marine Way.

Table 6: Capacity of Existing Sanitary Sewer Main on Marine Way

Pipe Segment	Flow at Full	Flow at 50%
Rezanof MH to MH SE of Rezanof	2,249	671
MH SE of Rezanof to Shelikof	2,061	616
MH at Shelikof to MH at Liquor Store	1,364	407
MH at Liquor Store to MH at Mecca Store	1,124	336
MH at Mecca Store to MH at Wells Fargo	1,123	335
MH at Wells Fargo to MH by LS2	1,376	411

A summary of the hydraulic analysis is contained in Appendix B.

2.5 Stormwater Collection System

2.5.1 Summary of Previous Studies

A drainage study of the downtown Kodiak area was completed by VEI Consultants (VEI) in 1992. The VEI drainage study was completed in support of the Alaska DOT&PF initiated Kodiak "Y" Intersection Improvement Project and was supplemental to the Mill Bay Road Drainage Study completed in 1991. (The Mill Bay Road Drainage Study was not available for review at the time of the present study.) The 1992 VEI Wye Basin Drainage Study, including a letter from VEI to the City of Kodiak Public Works Department summarizing recommendations, is included in Appendix C. The VEI study defined the area draining to the downtown area as the "Wye Basin," shown on page 5-2 of the attached study. The Wye Basin was divided into six subbasins for hydrologic and hydraulic modeling. Upon review of the VEI documentation, several shortcomings were identified that limit the effectiveness of the drainage study in evaluating the capacity of the existing storm drain systems relative to predicted peak flows. The identified limitations include:

- The drainage study does not identify the design storm used for recommending storm drain pipe sizes and capacities. A precipitation of 1.28 inches is included in the computations, but the source of this precipitation value is unknown. Readily available precipitation values used for estimating design storm events are several orders of magnitude higher than 1.28 inches. For example, 24-hour precipitation depths published in NOAA Atlas 14, Volume 7, Version 2 for the Kodiak Wastewater treatment plant are 4.01 inches, 4.76 inches, 5.37 inches, and 6.03 inches for the 10-, 25-, 50-, and 100 year storm events, respectively.
- The drainage study does not include the drainage basins encompassing Alder Lane and Natalia Way (to the northwest of the downtown area), the Aleutian Homes subdivision (to the northeast of the downtown area), or the southwest portion of the downtown area draining to Mission Road and Marine Way West. These areas all contribute stormwater runoff to the downtown area. As the storm drain systems are interconnected, having estimates for peak flows from all of these areas is necessary to accurately evaluate system capacities.

- Much of the area defined as Subbasin III in the VEI drainage study drains south along Center Street and Kasheverof Avenue to Mission Road, and not north to the Wye storm drain system as described in the drainage study. Due to the modeling program used in the VEI drainage study and the limited information provided, it is difficult to estimate the peak flows actually being contributed to each system under existing conditions.
- The area defined as Subbasin VI drains south across Rezanof Drive at existing conditions and does not contribute stormwater runoff to the downtown storm drain systems. This was noted in the VEI drainage study. This area was included in the study under the assumption that runoff from this area may someday be routed northwest along Rezanof Drive to the downtown area. The VEI study states that including Subbasin VI in their analysis does not result in significant changes affecting the required pipe sizes but this cannot be readily confirmed.

2.5.2 Existing Stormwater Design Criteria

To determine the effectiveness of the existing storm drain systems, the hydraulic capacity of the existing pipes must be compared to peak flow estimates for a design storm event. The City of Kodiak does not currently have specific design criteria specifying the design storm event to be used for sizing storm drain systems. A 10-year design storm, having an exceedance probability of 10 percent, is a commonly used design storm for residential storm drain systems and is used by the Municipality of Anchorage and Matanuska-Susitna Borough. The DOT&PF has specific criteria for sizing storm drain systems listed in the Alaska Highway Drainage Manual. The DOT&PF specifies a 25-year design storm for all storm drain system trunk lines with a 50-year design storm specified for systems in primary highways. As the City of Kodiak has experienced several 50-year storms and one 100-year storm in the past decade, we recommend that storm drain design should consider a 50-year storm at minimum. Existing storm drain systems will be evaluated for 50-year storm capacity for this study. We recommend that future storm drain improvements consider providing capacity for the 100-year storm.

2.5.3 Hydrologic Analysis

The existing storm drain system in the downtown area is an interconnected system of pipes consisting of four primary systems. The four primary systems are identified as the North System,

Northwest System, West System, and South System, as shown in Figure 6. The size of existing trunk lines is also included in Figure 6. The four systems collect stormwater runoff from the downtown area as well as significant drainage areas to the north and east on Pillar Mountain The existing storm drain alignments generally follow a sidewalk but can also be found below the roadway. Historically, the four systems drained to three separate outfalls, with flows from the Northwest System contributing to flows from the North System. However, with increased development in the downtown region over the past 50 years, the four systems have been subsequently interconnected. Stormwater runoff from all four systems combines along Marine Way West and discharges into St. Paul Harbor south of St. Paul Spit near Alaska Fresh Seafood cannery.

Four drainage basins were defined in order to determine runoff for 10-, 25-, 50-, and 100-year storm events. A map of drainage basins is presented in Figure 7. The drainage basins were defined based upon existing topographic maps and storm drain systems. The basins are primarily located within developed regions of Kodiak and the Southeast slope of Pillar Mountain, including undeveloped partially forested hillside. Figures 6 and 7 include the contributing size of each basin, in acres.

Hydrologic analyses were performed to determine peak flows for the design recurrence intervals. The 10-, 25-, 50- and 100-year peak flows were used to evaluate existing drainage infrastructure for flood conveyance capacities. The hydrologic data for this study was computed using the Soil Conservation Service (SCS) Graphical Peak Discharge Method. The SCS Method is based upon the United States Department of Agriculture National Resources Conservation Service's (NRCS) Technical Release 55 (TR-55): Urban Hydrology for Small Watersheds. The input data required for the SCS Method includes the drainage areas, runoff curve numbers (RCN), the time of concentration (TC) and the associated precipitation values. The precipitation values were acquired from NOAA Atlas 14, Volume 17. TR-55 specifies that a Type I storm should be used for all of Alaska. However, the DOT&PF Highway Drainage Manual recommends using a Type IA storm for coastal regions of Alaska. This selection seems logical in this case as the coastal climate of Kodiak is more compatible to the coastal climate of Oregon and Washington, where Type IA storms are specified for use in TR-55, than to the interior regions of Alaska where Type I storms are specified.

Figure 6: Existing Storm Drain Systems

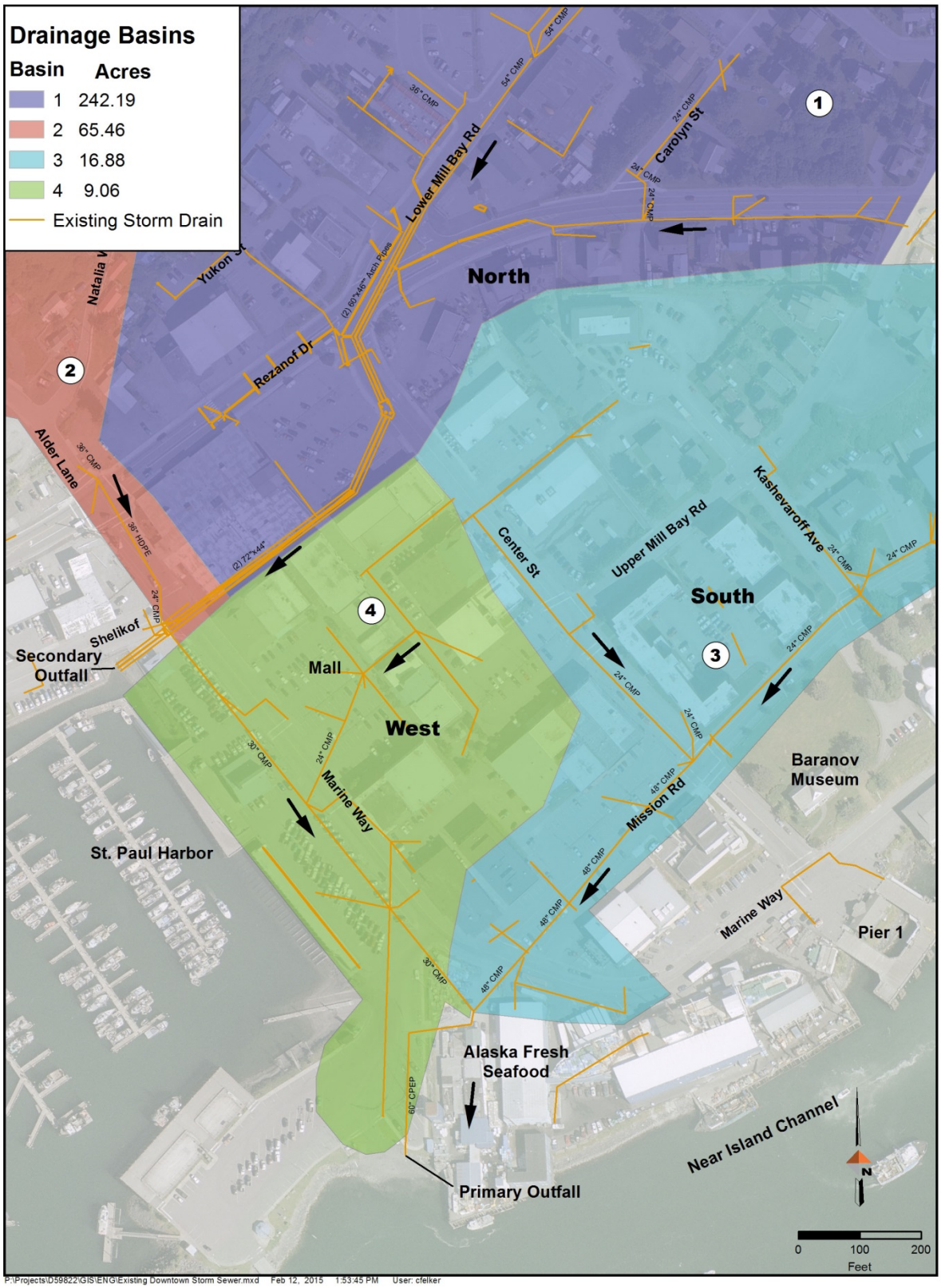
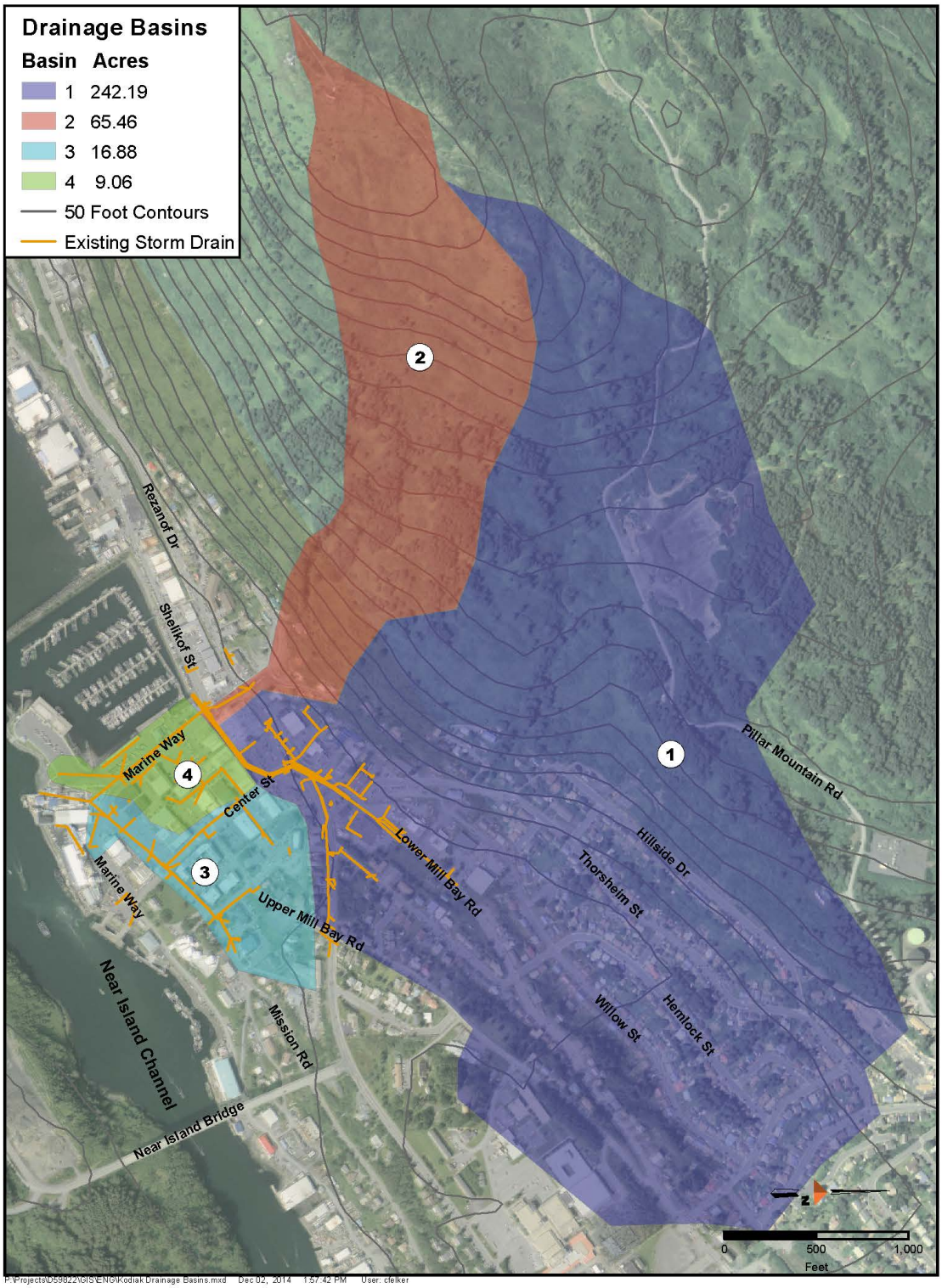


Figure 7: Drainage Basin Map



The SCS curve numbers are used to describe the surface characteristics of the drainage area and are based upon land cover and hydrologic soil type. Soils are grouped as Type A, B, C, or D based upon rates of hydrologic conductivity, where Group A soils have the most potential for infiltration and Group D soils have the least potential for infiltration. For this analysis, it was decided to classify all of the soils as Type C in order to be conservative in determining peak runoff flows and to take into account the fact that disturbed soils typically result in higher runoff quantities than undisturbed soils. After determining the hydrologic soil type, the RCN is determined based upon the land cover. For this analysis, an RCN of 72 was selected to represent partially forested areas (woods-grass combination, good condition), an RCN of 83 was selected to represent residential areas (¼ acre lots), an RCN of 94 was selected to represent commercial areas, and an RCN of 98 was selected to represent impervious areas, rooftops, and paved roads.

The T_c is the total time required for the runoff to flow from the most hydraulically remote point in the drainage basin to the point of investigation. Average basin slopes and flow lengths were determined for all four basins based upon topographical information. Slopes ranged from as low as 0.03 percent to 40 percent. The T_c was obtained using procedures described in TR-55 for each basin. The total T_c is the sum of the overland sheet flow, shallow concentrated flow and channel flow. The TR-55 computations for the SCS Method are included in Appendix C.

Results of the SCS Method for estimating runoff from the four basins are presented in Table 7.

Table 7: Summary of Peak Flow Estimates

Basin	Area (acre)	$Q_{10, 24hr}$ (cfs)	$Q_{25, 24hr}$ (cfs)	$Q_{50, 24hr}$ (cfs)	$Q_{100, 24hr}$ (cfs)
North	**237.9**	95	132	163	198
Northwest	**65.3**	19	28	36	45
West	**8.8**	8	10	11	13
South	**17.0**	14	17	20	23
Combined	**329.5**	**131**	**181**	**224**	**272**

2.5.4 Existing Stormwater System and Hydraulic Analysis

The four existing storm drain systems are evaluated below based on available survey data and information gathered from record drawings. Pipe capacities are compared to peak flows calculated in our hydrologic analysis as discussed below and summarized in Table 8: Summary

of Existing Storm Drain Systems. Storm drain systems were evaluated under the following assumptions:

- The hydraulic capacity of existing pipes was determined using Manning's equation based upon the flattest slopes of the trunk lines. Where pipe slopes could not be determined from survey data, slopes were taken from record drawings or assumed based on existing slopes of vicinity pipes and roadway surfaces.
- All hydraulic capacities were estimated assuming gravity flow. Pressurized flow was not assumed for any of the evaluated systems.
- Capacity estimates assume the existing pipes are in good condition and free of debris, sediment, and corrosion. However, considering the age of some of the existing systems, along with observed sedimentation in some systems, it is likely the hydraulic capacities of some pipes are less than the estimated values.

North System

Three general areas in and adjacent to the project area contribute runoff to the North System and are summarized as follows:

- The slope of Pillar Mountain uphill of Hillside Drive and East Hillcrest Avenue is included in the North System. Much of the runoff from this slope drains into the project area through a channel that terminates above Thorsheim Street to the south of the intersection with Lightfoot Avenue.
- The area encompassing Yukon Street and Hillcrest Street to the north of Lower Mill Bay Road, the northern portion of Center Street and area encompassing the "Y" intersection of Rezanof Drive and Lower Mill Bay Road, and much of the area to the north of Rezanof Drive (including portions of Carolyn Street and Mill Bay Road) are included in the North System.

The Aleutian Homes area of Kodiak (consisting of the residential area including Thorsheim Street, Cedar Street, Lower Mill Bay Road, and much of the encompassing area) drains to the North System. The upstream portion of the North System consists of two parallel 60-inch by 46-inch corrugated metal pipe arches, draining roughly west along Lower Mill Bay Road from the

intersection of Thorsheim Street. This portion of the system receives combined runoff from the Aleutian Homes area and Lower Mill Bay Road. The two 60-inch by 46-inch pipe arches drain to a concrete vault in Center Street. The 60-inch by 46-inch pipe arches and vault were constructed as part of the DOT&PF Kodiak "Y" Intersection Improvements project constructed in 2008. The capacity of the two 60-inch by 46-inch pipe arches are equivalent to two 54-inch corrugated metal pipe (CMP) round pipes, and was modeled this way. The pipe arches were installed at an approximate slope of 1.1 percent, resulting in a hydraulic capacity of approximately 224 cfs.

The North System continues downstream from the concrete vault on Center Street as two parallel 72-inch by 44-inch corrugated metal pipe arches, also modeled as the equivalent to two 54-inch CMP round pipes. The pipe arches drain west on the south side of the former Food4Less and parking lot from Center Street to Marine Way West. A 12-inch CMP located adjacent to the sidewalk in front of Food4Less does not have sufficient cover and frequently freezes during winter months. The two 72-inch by 44-inch pipes were installed in the late 1960's. Survey data indicates that the pipe slope range from approximately 0.2 percent to approximately 1.2 percent. The resultant hydraulic capacity of two pipe arches is approximately 95 cfs, estimated for the downstream slope of 0.2 percent. This is approximately half of the hydraulic capacity of the new 60-inch by 46-inch pipe arches located east (upstream) of Center Street. The system enters a concrete vault in Marine Way West.Historically, runoff from the concrete vault in Marine Way West drained west through dual 72-inch by 44-inch pipe arches to St. Paul Harbor (southwest of the intersection of Marine Way West and Shelikof Drive). Sedimentation has been a documented problem at this outfall with sediment building up in the downstream portions of the pipe and in St. Paul Harbor. Poor circulation within the harbor exacerbates sediment accumulation. Periodic dredging has been required to remove accumulated sediment from the harbor. As a result, the vault in Marine Way West was modified with a weir directing runoff from the North System south via a 36-inch CMP trunk line connecting to the West System. The inlet of the 36-inch CMP was installed at the vault so that it is approximately two feet below the inverts of the existing 72-inch by 44-inch pipe arches. During smaller storm events, the majority of runoff from the North System is conveyed south and combined with runoff in the West System. During large storm events, excess runoff exceeding the capacity of the 36-inch CMP can overflow the weir and drain west to the existing outfall at St. Paul Harbor.

Our hydrologic analysis predicts a 50-year peak flow of approximately 163 cfs and a 100-year peak flow of approximately 198 cfs for the storm drain reach downstream of Center Street (the dual 72-inch by 44-inch pipe arches). The 50-year peak flow of 163 cfs greatly exceeds the hydraulic capacity (95 cfs) of the existing 72-inch by 44-inch pipe arches located downstream of Center Street. The two 60-inch by 46-inch pipe arches recently installed upstream of Center Street have adequate capacity (224 cfs) to convey these peak flows.

Northwest System

The Northwest System receives runoff from the area north of Rezanof Drive encompassing Alder Lane and Natalia Way. This system includes the slope of Pillar Mountain above Alder Way. The majority of the runoff from this slope drains via a channel that terminates at the corner of Alder Way and West Hillcrest Avenue.

Stormwater from the Alder Lane and Natalia Way area is collected by a piped storm drain system and routed south across Rezanof Drive via an existing 36-inch corrugated polyethylene pipe (CPEP) system. In Marine Way West, between Rezanof Drive and Shelikof Street, the 36-inch CPEP trunk line connects with an existing 30-inch CMP system. The 36-inch CPEP system has a hydraulic capacity of approximately 86 cfs (at an approximate slope of 1.4 percent), while the downstream 30-inch CMP system has a hydraulic capacity of approximately 39 cfs (at an approximate slope of 3.0 percent). The 30-inch CMP connects with the two 72-inch by 44-inch pipe arches conveying runoff from the North System at the concrete vault in Marine Way West.

Our hydrologic analysis predicts a 50-year peak flow of 36 cfs and 100-year peak flow of 46 cfs draining to the Northwest System. The 36-inch CPEP system has adequate capacity to convey these flows, but the downstream 30-inch CMP system capacity would be exceeded during a 100-year storm. The 30-inch CMP does have adequate capacity to convey the 50-year peak flow.

West System

The trunk line of the West System consists of a 36-inch CMP installed parallel to and immediately west of Marine Way West. This system drains an area encompassing the downtown area between Marine Way West and Center Street to the south of the Food For Less building and to the north of Mission Road. Catch basins at three points along Marine Way West convey runoff to the 36-inch trunk line. Several existing catch basins in the City of Kodiak public parking lots

located around the Kodiak Mall are connected to a 12- to 24-inch storm drain system that ultimately conveys runoff to the 36-inch trunk line at Marine Way West. The West System also receives runoff from the North System. The northern end of the existing 36-inch CMP in Marine Way West was connected to an existing storm drain vault near the intersection of Shelikof Street to reroute stormwater south and reduce sedimentation and associated dredging requirements in St. Paul Harbor.

The slope of the 36-inch CMP system ranges from approximately 0.2 percent to approximately 0.5 percent. The resultant hydraulic capacity of the system is approximately 16 cfs, estimated for the downstream slope of 0.2 percent. Even when discounting the runoff contributed by the West basin, this system is significantly undersized for the peak 50-year flow of 198 cfs and 100-year peak flow of 244 cfs contributed by the North and Northwest Systems, though high flows can overflow from the vault to St. Paul Harbor when the 36-inch CMP is at capacity. The West basin contributes additional runoff to the existing 36-inch CMP, with peak flows of 11 and 13 cfs predicted for the 50- and 100-year storms.

Runoff from the West System joins with runoff from the South System near the intersection of Marine Way West and Mission Road. Currently, the combined stormwater runoff from the West System (36-inch CMP) and South System (48-inch CMP) drains via a 60-inch CMP to the existing outfall location south of St. Paul Spit, crossing Trident Seafood property. The hydraulic capacity of the existing 60-inch CMP is unknown. As part of planned expansion at the Trident Seafood plant, the existing 60-inch CMP storm drain outfall is being relocated west to City property on the St. Paul Spit and replaced with a 60-inch CPEP pipe. Assuming a slope of 0.5 percent, which is typical of other pipes in the area, the capacity of the proposed 60-inch CPEP would be approximately 200 cfs. The proposed outfall is undersized for the 50-year peak flow of 224 cfs and 100-year peak flow of 274 cfs, but provides ample capacity for the 10-year peak flow of 131 cfs.

South System

The trunk line of the South System consists of 48-inch CMP installed in Mission Road between Marine Way West and Center Street. The system drains west to a manhole north of the Alaska Fresh Seafood processing facility, where stormwater runoff is combined with runoff from the West System before being discharged south of the St. Paul Spit via a 60-inch CMP. Existing catch basins located along Mission Road collect runoff and discharge through a 12-inch CMP to the 48-inch CMP trunk line. The system has a slope ranging from approximately 1.6 percent to approximately 3.4 percent, resulting in a hydraulic capacity of approximately 96 cfs (estimated for the downstream slope of 1.6 percent).

Upstream (east) of Center Street, the storm drain system branches, with two trunk lines draining to the 48-inch CMP system. A piped system consisting of 24-inch CMP trunk lines extends to the east along Mission Road, collecting stormwater runoff from the encompassing area. Our hydrologic analysis predicts a 50-year peak flow of 20 cfs and a 100-year peak flow of 23 cfs. The 24-inch CMP system has a capacity of 28 cfs, based on an approximate existing slope of 5.2 percent, which is adequate to convey these peak flows. The other branch of storm drain system is located in Center Street and consists of an 18-inch CMP trunk line draining south from approximately Kodiak Motors to Mill Bay Road. At Mill Bay Road, the pipe size increases to 24-inch CMP and continues to drain south to the 48-inch CMP at Mission Road. The 18-inch CMP has a hydraulic capacity of approximately 4.8 cfs (at an approximate slope of 0.7 percent) and the 24-inch CMP has a hydraulic capacity of approximately 9.5 cfs (at an approximate slope of 0.6 percent).

As future improvements are designed in the area, new storm drain systems should be designed to provide adequate hydraulic capacity based on the predicted peak flows.

Table 8: Summary of Existing Storm Drain Systems summarizes the existing storm drain systems in the downtown Kodiak area including the trunk lines of the four primary systems described above. Where available, the estimated peak flows contributing to the existing storm drain systems are listed.

Table 8: Summary of Existing Storm Drain Systems

System	Pipe Description	Discharge Point	Minimum Slope	Q_{full} (cfs)	Q_{10} (cfs)	Q_{25} (cfs)	Q_{50} (cfs)	Q_{100} (cfs)
North	Dual 60"x46" pipe arches	Dual 72"x44" pipe arches in North System	1.1%	224	95	132	163	198
North	Dual 72"x44" pipe arches	36" CMP in West System/Outfall in St. Paul Harbor	0.2%	95	95	132	163	198
Northwest	36" CPEP in Alder Way	30" CMP in Marine Way West	1.4%	86	19	28	36	46
Northwest	30" CMP in Marine Way West	36" CMP in West System/Outfall in St. Paul Harbor	3.0%	39	19	28	36	46
North & Northwest Combined	36" CMP	60" CMP and outfall south of St. Paul Spit	0.2%	16	113	159	198	242
West	36" CMP	60" CMP and outfall south of St. Paul Spit	0.2%	16	8	10	11	13
South*	18" CMP in Center Street	24" CMP in Center Street	0.7%	4.8	-	-	-	-
South*	24" CMP in Center Street	48" CMP in Mission Road	0.6%	9.5	-	-	-	-
South*	24" CMP in Mission Road	48" CMP in Mission Road	5.2%	28	-	-	-	-
South	48" CMP	60" CMP and outfall south of St. Paul Spit	1.6%	96	14	17	20	23
All Systems Combined	60" CPEP	Outfall south of St. Paul Spit	0.5%**	200	131	181	224	272

*Peak flows not estimated for 18- and 24-inch pipes in upper reaches of South System.

**New outfall pipe is in design. Slope assumed based on slopes of other pipes in vicinity and to be conservative.

2.5.5 Adjacent Systems

An existing storm drain system is located to the north of the City of Kodiak Pier 1 at the intersection of Marine Way East and Center Street. The localized system consists of 12-inch CMP trunk lines and collects runoff from the intersection and discharges to Near Island Channel near Pier 1. The system has a hydraulic capacity of approximately 3.1 cfs (at an approximate slope of 2.7 percent). The peak flows draining to this system are unknown. If future drainage improvements are proposed for this area, consideration should be given to upgrading this system to increase capacity and alleviate demand on the St. Paul Spit outfall. The use of 30-inch CPEP, with a full-flow capacity of 31 cfs at a slope of 0.5 percent, is recommended as a minimum to provide adequate capacity to convey 100-year flows from the area and redirect runoff from the South System.

An existing storm drain system in Shelikof Street consists of 18- and 24-inch CMP trunk lines. This system collects stormwater runoff along Shelikof Street and portions of Rezanof Drive and drains west to an outfall along the north side of the St. Paul Harbor. The pipe capacities and peak flows draining to this system are unknown. Redirecting stormwater from Alder Lane (the Northwest System) to the outfall on Shelikof Street would alleviate demand on the existing 30-inch CMP in Marine Way West and reduce peak flows at the St. Paul Spit outfall. Rerouting runoff from the Northwest System would require installing new pipe draining west down Shelikof Street from Alder Lane. The use of 36-inch CPEP, with a full-flow capacity of 51 cfs at a slope of 0.5 percent, is recommended to provide capacity for the 100-year flow from the Northwest basin. Upgrading the existing storm drain system in Shelikof Street would likely be completed as part of a future street improvement project in this area.

2.5.6 Pipe Arch Condition Assessment

Being a critical segment of the City's storm drain system, the pair of 72-inch by 44-inch pipe arches passing through downtown Kodiak were evaluated for relocation. These culvert pipes, constructed in the 1960s, run parallel to each other for approximately 640 feet between a recently constructed vault on Center Street to the secondary outfall at the waterfront near Shelikof Street. They pass beneath several buildings located in the downtown area. This location is not ideal for operation and maintenance purposes, as well as posing a potential risk to safety and property if the pipe arches reach the end of their service life. The initial realignment evaluation determined

that relocating the storm drain pipes to Center Street would require deep and expensive excavation through a narrow road corridor bordered by multistory buildings. A decision was made to evaluate the possibility of maintaining the storm drain pipes in place.

Inspection Process

In November of 2013, the City of Kodiak contracted DOWL HKM to complete an inspection of approximately 600 feet of dual 72-inch by 44-inch storm drain pipe arch culvert. DOWL HKM subconsulted Extreme Access, Inc. to travel to Kodiak and inspect the storm pipes from the inside. Extreme Access, Inc. is an Oregon-based inspection and testing company specializing in projects that are complicated by difficult access and where traditional access and evaluation methods are unavailable. They have been providing inspection and testing services for over 23 years.

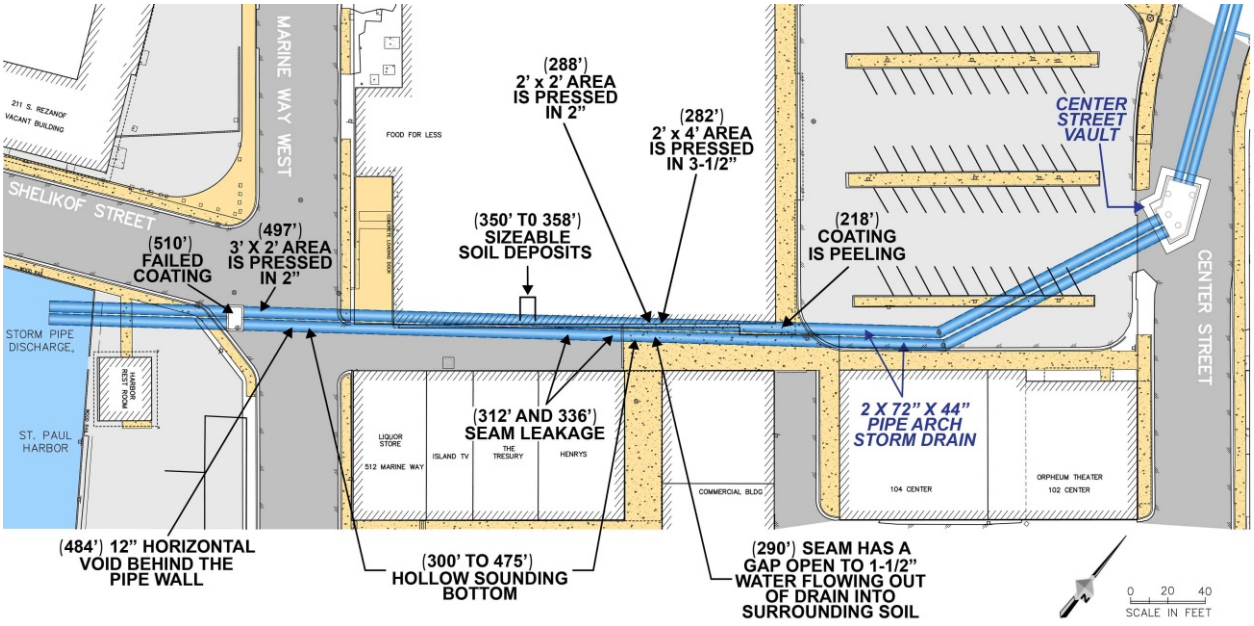
The scope of the inspection included ultrasonic wall thickness sampling, wall condition examination, coating examination, hammer sounding for missing fill, and seam condition examination.

Inspection Results

The inspection took place on February 12th and 13th of 2014. The condition of the pipe arches were determined to be in fair condition. A thick mastic coating that was applied during installation is still intact and in most locations has protected the steel from corrosion. At locations where lateral lines or manholes were torch cut into the pipe arches, the coating was damaged and corrosion was evident. Up to 11 inches of sediment was found inside the storm drain pipes.

There were noticeable defects including depressions on the top section of the pipe, minor lateral joint spreading, minor seam gaps, and potential voids behind the pipe walls, as shown in Figure 8. A full summary of the findings can be found in Appendix D - *Kodiak Storm Drain Inspection Report*.

Figure 8: Storm Drain Pipe Arch Assessment



Note: Distances shown are from Center Street vault.

3.0 DESIGN CRITERIA

Based on the goals and objectives of the Master Plan, the following design criteria are used for recommended upgrades to the utility systems. Most of these criteria can also be found inside the City of Kodiak's Standard Construction Specifications & Standard Details 2012.

Water Improvements

- Service lines shall have accessible separate isolation valves to allow for shut down for maintenance and operations.
- Main lines shall have isolation valve configurations to allow for isolation of separate sections of water mains for maintenance and operations.
- Water main separation distance from sanitary sewer or storm drain lines shall be a minimum of 10-horizontal feet, where practical.
- Water mains and service lines shall be buried at a depth allowing a minimum depth of cover of 5 feet, or installed with insulation board, for frost protection.

- Average day domestic/industrial demand = 4.88 Million Gallons per Day (MGD)
- Peak day domestic/industrial demand – 8.7 MGD.
- Peak hour domestic/industrial demand = 7,600 gpm.
- Fire flow requirements are 1,500 gpm.

Sewer Improvements

- Sanitary sewer mains and service lines will be reconfigured and reconstructed to match or exceed the existing pipe capacity.

Stormwater Improvements

A design storm event needs to be established to guide future storm drain improvements and allow for consistent evaluation of existing storm drain system capacities. Storm drain design criteria are typically based on design storm events. Conveyance design storms in other communities range from 10-year events (10 percent exceedance probability) to 50-year events (2 percent exceedance probability). Due to the high levels of precipitation common in Kodiak and numerous large storm events experienced in recent years, we suggest establishing the 50-year storm as the design event for future storm drain upgrades of City owned systems. Where cost effective and when design constraints allow, providing capacity for 100-year storm events should be considered. Storm drain improvements tying into DOT&PF storm drain systems should be designed to convey the 25-year peak discharge, at a minimum, to be consistent with DOT&PF storm drain criteria.

3.1 PROJECTED GROWTH

The City of Kodiak anticipates minimal renovations/additions to the downtown area. Among these are: a potential expansion to the Kodiak Inn, increasing the hotel's capacity by 80 rooms, and a potential transformation of Food for Less into office and retail space. These future improvements are not expected to have significant impacts on future water demand in the project area.

4.0 RECOMMENDED CAPACITY UPGRADES

4.1 Recommendations for Water System Capacity Upgrades

Assuming the Downtown seafood processors are served from Rezanof, the water main along Center Street or Marine Way will need to remain in service at all times. Currently only the water main along Marine Way is sized adequately to serve the seafood processors during peak flows. Reasonably sized pipes can be estimated from Equation 1:

$$\text{Equation 1: } D = \sqrt{\frac{C_f Q}{V}}$$

D = Estimate of required diameter
C_f = Unit conversion factor = 0.41 for Q in gpm, D in inches, V in ft/s
Q = Peak flow (gpm)
V = Maximum allowable velocity (ft/s).

Maximum allowable velocities are subjective and can vary from two feet per second (ft/s) to 10 ft/s depending on the system and the length of pipe in question. For the purposes of this evaluation, the maximum allowable velocity was assumed to be seven ft/s.

Design peak flows for the water main were estimated along Marine Way and Center Street for the following scenarios.

Scenario 1: Peak hour: Applying the peak hour seafood processor demand of 6,000 gpm as discussed in Section 2.2 and applying the 21 percent demand as summarized in Table 2, resulting in a peak flow 1,260 gpm for the water main serving the Downtown seafood processors.

Scenario 2: Peak day plus fire flow: Applying the peak day seafood processor demand of 3,966 listed in Table 3 and applying the 21 percent demand as summarized in Table 2 which equals 833 gpm. Adding a typical fire flow of 1,500 gpm results in a total peak day design flow of 2,333 gpm.

Scenario 2 results in the highest design flow and was used for the hydraulic analysis summarized in Table 9.

Table 9: Estimated Water Velocities at Peak Day Flow Plus Fire Flow

Estimated Flow by Area based on Peak Day Flow	With Contingency for Fire Flow (1,500 GPM)	Flow Velocity in 8-inch Main (FPS)	Flow Velocity in 12-inch Main (FPS)	Flow Velocity in 16-inch Main (FPS)
846	2,333	14.9	6.6	3.7

Using Equation 1, the preferred pipe diameter was estimated at 11.7 inches or a 12-inch nominal pipe diameter.

The remaining network of water mains serving the project area should be replaced with looped 8-inch mains meeting industry standards.

4.2 Recommendations for Sanitary Sewer Capacity Upgrades

Gravity Main

Based on the results of the capacity analysis of the gravity main systems entering the project area, increasing the pipe size of the Aleutian Homes Basin bypass from 4- to 6-inches is not recommended. The main line running along Rezanof Street does not have the capacity to accommodate the projected 500 gpm of additional flow that would come from the larger bypass pipe. This section of main would have to be replaced with a larger diameter main, which is not desirable due to the recent reconstruction of the roadway.

A long term solution for this problem is to upgrade the 12-inch sewer main from the Aleutian Homes Basin between Lower Mill Bay Road and East Marine Way. A preliminary sizing analysis shows that by increasing this mainline size to 16 inches, the capacity of this line would increase by at least 900 gpm. This could help reduce the flows that are bypassing this gravity system and reduce the flow of wastewater into Lift Station 2, and thereby reducing the operational and maintenance costs of pumping the wastewater. A summary of the hydraulic analysis is contained in Appendix B.

The remaining network of gravity sanitary sewer mains should be 8-inch diameter and at a slope to promote self-cleaning flow velocities of three feet per second (fps) where pipe slopes can be accommodated.

Force Main

It is generally desirable to have minimum velocities of 3 fps in force mains. It has been found that velocities of 3 fps will typically resuspend any solids that deposit in the force main when the pumps are not operating.

Velocities were calculated for a flow of 800 gpm with the following results summarized in Table 10.

Table 10: Proposed Force Main Diameters for Design Flow of 800 gpm

Diameter (inches)	Pipe Type Class / SDR	Flow Velocity (FPS)
8 (Existing)	DIP CL52	4.64
8	HDPE SDR21	5.44
8	HDPE SDR17	5.73
8	HDPE SDR11	6.74
10	HDPE SDR21	3.50
10	HDPE SDR17	3.69
10	HDPE SDR11	4.34

A summary of the hydraulic analysis is contained in Appendix B.

From the results above, and with no anticipated change in flows, we recommend a 10-inch high-density polyethylene (HDPE) force main. By increasing the pipe diameter, the friction head will be reduced and allow for future growth capacity. HDPE pipe is an ideal choice for force mains due to the longevity of the material.

4.3 Recommendations for Storm Drain Capacity Upgrades

The existing dual 72-inch by 44-inch pipes arches between Center Street and Marine Way West provide approximately half of the hydraulic capacity of the new dual 60-inch by 46-inch pipe arches installed upstream as part of the Rezanof Drive improvements. However, no known hydraulic capacity issues have been observed with the existing 72-inch by 44-inch pipe arches, likely due to available overflow capabilities to St. Paul Harbor, and the pipes are functioning well. Although the dual 72-inch by 44-inch pipe arches are roughly 50 years old, the assessment conducted by Extreme Access, Inc. in 2014 indicates the pipes are in fair condition, with pipe walls and corrosion-resistance coating in good condition. Repairing the deficiencies noted in the

assessment report, included in Appendix D, will likely significantly increase the design life of the pipes and prevent a costly full-system replacement.

If opportunity or need arises to replace the existing 72-inch by 44-inch pipe arches, the replacement system should ideally provide hydraulic capacity for the predicted 100-year peak flow of 198 cfs. Providing capacity for the 100-year storm would also provide similar capacity to the upstream pipes (approximately 224 cfs). Adequate capacity could be obtained by installing similar sized smooth-walled Type S CPEP pipes, as plastic pipe has a lower friction coefficient than metal pipe, providing twice the hydraulic capacity at equivalent diameters. The use of dual 48-inch CPEP pipes at a 0.4 percent slope would provide a hydraulic capacity of 197 cfs. Installing new CPEP of larger diameter or at greater slopes would also provide increased capacity. For example, a single 60-inch CPEP pipe installed at a 0.5 percent slope would provide a hydraulic capacity of approximately 200 cfs.

The existing 36-inch CMP culvert along Marine Way West is significantly undersized for the runoff routed through the West System. The existing 36-inch CMP has a capacity of approximately 16 cfs. The predicted 100-year peak flow from the West basin is only 13 cfs. However, the combined peak 100-year flow from the North and Northwest Systems predicted to drain to the West System is 242 cfs. At a minimum, a 48-inch CPEP trunk line is recommended for future upgrades to provide equivalent capacity to the existing 72-inch by 44-inch pipe arches draining to Marine Way West. A 48-inch CPEP at 0.5 percent has a capacity of 110 cfs, exceeding the 95 cfs capacity of the 72-inch by 44-inch pipe arches and roughly adequate for the combined 10-year peak flow of 113 cfs contributed by the North and Northwest Systems.

We understand that the combined outfall near the St. Paul Spit is being relocated off of Trident Seafood property and onto City property at the spit. The St. Paul Spit outfall receives combined flow from all four investigated storm drain systems and is the primary outfall for stormwater runoff from the downtown area. We recommend the existing 60-inch CMP be replaced with 60-inch CPEP, if cover constraints allow. A 60-inch CPEP trunk line at a slope of 0.5 percent would have a capacity of 200 cfs, adequate to convey the combined 25-year peak flow of 181 cfs and providing greatly improved capacity over the existing pipe. Upgrading an additional outfall at another location in the downtown area, such as on Shelikof Street, and routing runoff to the

second outfall would further alleviate capacity concerns at the St. Paul Spit outfall. All proposed outfalls should be evaluated with regard to tidal fluctuations and water surface elevations at discharge points to minimize backwatering of storm drain systems and resultant sedimentation within pipes. The use of CPEP is recommended for all future storm drain upgrades in the downtown area due to the corrosive effects of the marine environment on steel pipe.

Water treatment should also be considered as part of proposed storm drain improvements to improve the water quality of stormwater discharged from the City storm drain systems in the project area. The installation of structural treatment devices such as oil-grit separators (including proprietary swirl separators) is one option for removing sediment and pollutants from stormwater prior to discharging collected runoff. The Alaska Department of Environmental Conservation (DEC) regulates water quality of discharged stormwater and has criteria governing the use of oil-grit separators. The DEC requirements state that oil-grit separators should remove 50 percent of the 20-micron particles present in stormwater.

5.0 RECOMMENDED ALIGNMENTS

5.1 Proposed Water Main Alignments

The proposed upgrades to the water system will replace existing ACP with 8- and 12-inch ductile iron pipe (DIP) or polyvinyl chloride (PVC) pipe. It is recommended that an alternative to metal pipe is considered due to the potential for corrosion given this is a marine environment. The main line in Center Street will be increased from 8- to 12-inch, while most of the other proposed pipe diameters will remain unchanged.

The proposed alignments differ from existing at the Mall. The plan abandons the water main located below the sidewalk of the Mall. The proposed main line located at the rear of the buildings will provide domestic water and fire protection to each business. Proposed utility alignments are shown in the 35% drawing included in Appendix E.

5.2 Proposed Sewer Main Alignments

The proposed sewer system will consist of 8- and 12-inch PVC. The 8- and 12-inch pipes will replace the remaining gravity fed system with like diameters. The proposed alignments will

closely follow the existing alignments at or near the roadway centerline. Proposed utility alignments are shown Appendix E.

5.3 Proposed Stormwater Main Alignments

The proposed storm drain system alignment will follow the same general alignment between Henry's and Food4Less. Runoff will continue down Marine Way through a proposed 48-inch CPEP and will tie into the existing outfall near Alaska Fresh Seafood. Proposed utility alignments are shown in Appendix E.

Following a review of potential alternative alignments for replacing the 72-inch by 44-inch pipe arches with a new system in Center Street, it was determined that excessive excavation would likely be required in close proximity to structures along Center Street. Further evaluation was executed to look into the alternative of maintaining the current pipe arch storm drain lines in service.

DOWL HKM consulted with Mill Creek Management Technology (MCMT), a consultant specializing in trenchless design, to review the inspection report and provide recommendations for trenchless remedial actions for the storm drain pipe arches. The MCMT Report and Assessment of Condition and Recommended Repair Options is included in Appendix F.

Based on the inspection from Extreme Access and the report from MCMT, the following follow-up inspection and repairs are recommended.

5.3.1 Additional Inspection

Additional inspection is recommended along the pipe where sediment covered the bottom during the initial inspection. Additional inspection will further evaluate if there are additional voids beneath the pipe at these locations. This inspection is anticipated to be performed as part of future design services.

The hollow sounding bottom of both drains should be investigated by drilling three to five small 1/8-inch pilot holes in each 175-foot pipe section and probing with a light welding wire. This will also serve to inspect the fill around the pipe for voids. The holes should be sealed with epoxy, silicone, or with self-sealing sheet metal screws.

5.3.2 Repair

High Priority Repairs: finding and then pressure grouting (cementitious and acrylamide or urethane) under the invert where cavities were detected at several locations during the inspection and in several joints that are infiltrating groundwater. An example is the seam at 290 feet that should be sealed within Drain B.

Low Priority Repairs: basic redressing of coatings, including an inexpensive cleaning and caulking with a mastic or similar type coating at locations where there is exposed steel at separated and offset joints and along the pipe inverts. An example is the coating at 218 feet and 510 feet that should be repaired within Drain A.

6.0 WATER AND SEWER SERVICE IMPACTS

Given the proposed water and sewer main realignments, it was essential to understand how businesses were currently served and potential impacts resulting from utility realignment. This effort was documented by cataloging all businesses and residences throughout the downtown area (Appendix G). The water and sewer service table found in Appendix G lists the address, the type of service, the service size, the assumed location for the connection inside the building, the assumed location for the connection to the main, and how the information was obtained for each user. Overall there were approximately 85 water services, 85 sewer services, 20 dedicated fire suppression services, and five combined water and fire services. The location of each known service was verified through discussions with the City of Kodiak Public Works. After the initial evaluation, there were several services with locations that were still unknown.

A field investigation by DOWL HKM and Public Works personnel was conducted to perform locates for those remaining unknown services. The investigation included identifying where each water service entered the building by locating the water valve at the property line and recording where that service tied into the main line. Each sanitary sewer service was located by introducing dye into the pipe through an entry point inside the building and observing the dye in the downstream manhole. The few sections of storm drain that were unknown were also dye tested to verify their location.

The service base map and table allowed for a detailed evaluation that new alignments would have on existing services. The evaluation focused on what effect abandoning the existing water main within the Mall would have on services for adjacent businesses. The proposed improvements would provide water services through the rear of the buildings where the existing mainline currently only provides fire protection service to most of the businesses. Table 11 presents a summary of the impacts to individual services within the Mall.

Table 11: Impact to Individual Services

	Service	Current Location	Proposed Location
Henry's Restaurant	Water	Breezeway	Tie into Fire - Alley by Food 4 Less
	Fire	Alley by Food 4 Less	No Change
Tony's Bar	Water	Breezeway	Tie into Fire - Alley by Food 4 Less
	Fire	Alley by Food 4 Less	No Change
Port Gifts	Water	The Mall	Alley Behind Bldg (Might Need New Service)
	Fire	No Service	Alley Behind Bldg (Might Need New Service)
Key Bank	Water	Alley Behind Bldg	No Change
	Fire	Alley Behind Bldg	No Change
Norman's Gifts	Water	The Mall	Alley Behind Bldg (Might Need New Service)
	Fire	No Service	Alley Behind Bldg (Might Need New Service)
Ardinger's Furniture	Water	The Mall	Tie into Fire - Alley Behind Bldg
	Fire	Alley Behind Bldg	Alley Behind Bldg
The Village Bar	Water	Alley Behind Bldg	No Change
	Fire	Alley Behind Bldg	No Change
The Mecca Jewelry/AT&T		Alley Behind Bldg	No Change

The most significant change to the sanitary sewer alignment consists of eliminating the sanitary sewer line in the breezeway between Henry's Restaurant and Tony's Bar. This will have no impact on individual services.

7.0 UTILITY CONFLICTS

There are three primary "dry" utilities located in the downtown area. The type and operator are as follows:

- Electric - Kodiak Electric Association (KEA)
- Communications - Alaska Communications System (ACS)
- Cable - General Communications Inc. (GCI)

KEA owns several underground and overhead high voltage systems throughout the downtown area. There are also many low voltage lines connected to the street lighting system. The underground systems are primarily within the ROW and are connected to pedestal type junction boxes. The overhead systems are pole mounted and are located in the ROW and in utility easements.

ACS does not have a facility map for the downtown area. Based on their service area it is likely that facilities will be impacted during the utility replacement.

GCI owns buried cables primarily connected to the businesses located in the local Mall and the downtown area. The systems are primarily outside of the downtown ROW and have the potential for impacts during the utility replacement at crossings.

8.0 TEST BORING INVESTIGATION

Nine 15 foot deep test borings were drilled in Center Street, Marine Way, Mission Road and Kashevarof Avenue on December 2, 4 and 5, 2011. The purpose of these borings was to determine the approximate depth to bedrock in support of the Downtown Water, Sewer, and Strom Drain Master Plan project. Bedrock was found between seven to 15 feet below grade. The Test Boring Investigation Memorandum is included as Appendix H.

8.1 Findings

The depth to bedrock was difficult to determine in the test borings. The bedrock is overlain with fill composed of gravel that looks the same as the samples taken in the weathered rock. Much of the rock could be drilled with the hollow stem auger and the weathered rock broke up during

sampling to a sand and gravel. The test boring logs show interpretation of the soil and rock. The depth to bedrock was estimated based on drill action, sample blow counts, observation of the recovered samples and correlation with bedrock outcrops and previous excavations by Public Works. The results of particle size distribution tests performed on selected samples follow the boring logs.

The bedrock in the study area is nearly vertically bedded and rock quality can change from soft, easily excavated rock to hard, unrippable rock in short horizontal distances. The surface of the bedrock is very irregular, so the depth to bedrock can also vary dramatically in short distances. This area of Kodiak has been extensively reworked over the years and some borings may have hit old utility excavations made into the rock and the rock surface could be much shallower a short distance away.

Boring 3 encountered a void between eight and 10 feet below existing grade. It is assumed that this was an abandoned storm drain because the sampler suddenly encountered resistance at a depth of eight feet and after 35 blows broke through the obstruction and dropped two feet. The auger was retracted from the 7.5 foot depth and the rig moved about 3 feet away and the boring continued as Boring 4. The bedrock surface was interpreted to be at a depth of 14 feet in Boring 4. This is deeper than expected and may not be accurate.

Boring 5 encountered bedrock at a depth of about 15 feet. This is deeper than anticipated. The adjacent Kodiak National Wildlife Visitor Center building on the southeast corner of Center Street and Mission Road is founded on shallow bedrock and bedrock outcrops can be observed in the cut on the Marine Way side of the Wildlife Visitor Center and the Baranof Museum lot. Boring 6 in Marine Way encountered bedrock at a depth of about 13 feet. Although this boring location is near the bedrock outcrops, this boring is believed to accurately depict a steeply dipping bedrock surface.

No environmental testing or monitoring was conducted as a part of this investigation. However, a hydrocarbon odor and sheen was noticed in Boring 4 below a depth of about 10 feet.

8.2 Engineering Analysis and Recommendations

The bedrock penetrated with the hollow stem auger can be excavated with considerably more effort than required to excavate dense gravel. There are likely to be near vertical layers within the bedrock formation that cannot be excavated without the use of a large hydraulic hammer to fracture the rock. Blasting is not desirable considering the close proximity of utilities and structures. Should blasting be required, it should be performed in conformance with the City of Kodiak Standard Construction Specifications.

The construction contractor should expect a large backhoe equipped with a rock bucket and a large hydraulic hammer will be required for any rock excavation.

9.0 PHASE I ENVIRONMENTAL ASSESSMENT

DOWL HKM performed the Phase I Environmental Site Assessment in conformance with the scope and limitations of the American Society for Testing and Materials Practice E1527 of the Subject Property. The report, Appendix I, represents the results of the Phase I Environmental Site Assessment. The terrain of the project area is mostly flat land that has been graded and developed. There are several recognized contaminated sites within a mile of the proposed project site, including several within a quarter mile of the project site. A few of these sites are still active, and located at equal or higher elevations in relation to the Subject Property. Additionally, recognized environmental conditions exist within the Subject Property. Although the project will include ground disturbing activities, the potential for encountering recognized environmental conditions is low to moderate, due to the close proximity, elevation, status, and high number of contaminated sites present. Unknown contamination has been encountered in the project area before, during site investigations and other ground disturbing activities, thus the potential exists for undocumented or unknown contamination to be present in the area.

10.0 PHASING RECOMMENDATIONS

The proposed improvements consist of six phases that were created by evaluating each for the following criteria:

- Length of proposed pipe replaced.
- Minimize rework required to perform next phases.

- Minimize interruption to service.
- Feasible to build in one construction season.

The phasing plan is shown in Figure 9. Table 12 summarizes the proposed construction schedule and planning level estimate for each phase. The estimate is based on past utility replacement projects in Kodiak with similar scope based on a per-linear foot of roadway and utility length.

Table 12: Planning Level Estimate and Schedule

Proposed Phases of Utility Upgrades	Year of Construction	Storm Drain (lf)	Sanitary Sewer (lf)	Water Main (lf)	Total Length (lf)	Total Cost Estimate
Phase 3 - Center Street, (Rezanof Drive - Pier I)	2017	140	1,020	1,340	3,560	$ 3,900,000
Phase 4 - Marine Way East, (Mecca Lounge - Pier I)	2019	1,020	1,375	860	3,255	$ 3,700,000
Phase 5 - Marine Way West and Mall, (Rezanof Drive - Mecca Lunge)	2021	1,345	1,115	605	3,065	$ 3,600,000
Phase 6 - Alley to North of Mall, American Legion, Sunaq Tribe	2023	550	1,090	1,540	3,180	$ 4,700,000
Phase 7 - Mission Road, (Marine Way - Kashevarof Avenue)	2025	910	420	615	1,945	$ 2,900,000
Phase 8 - Kashevarof, (Rezanof Drive - Mission Road)	2027	930	1,150	1,250	3,330	$ 5,000,000

Figure 9: Proposed Project Phasing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