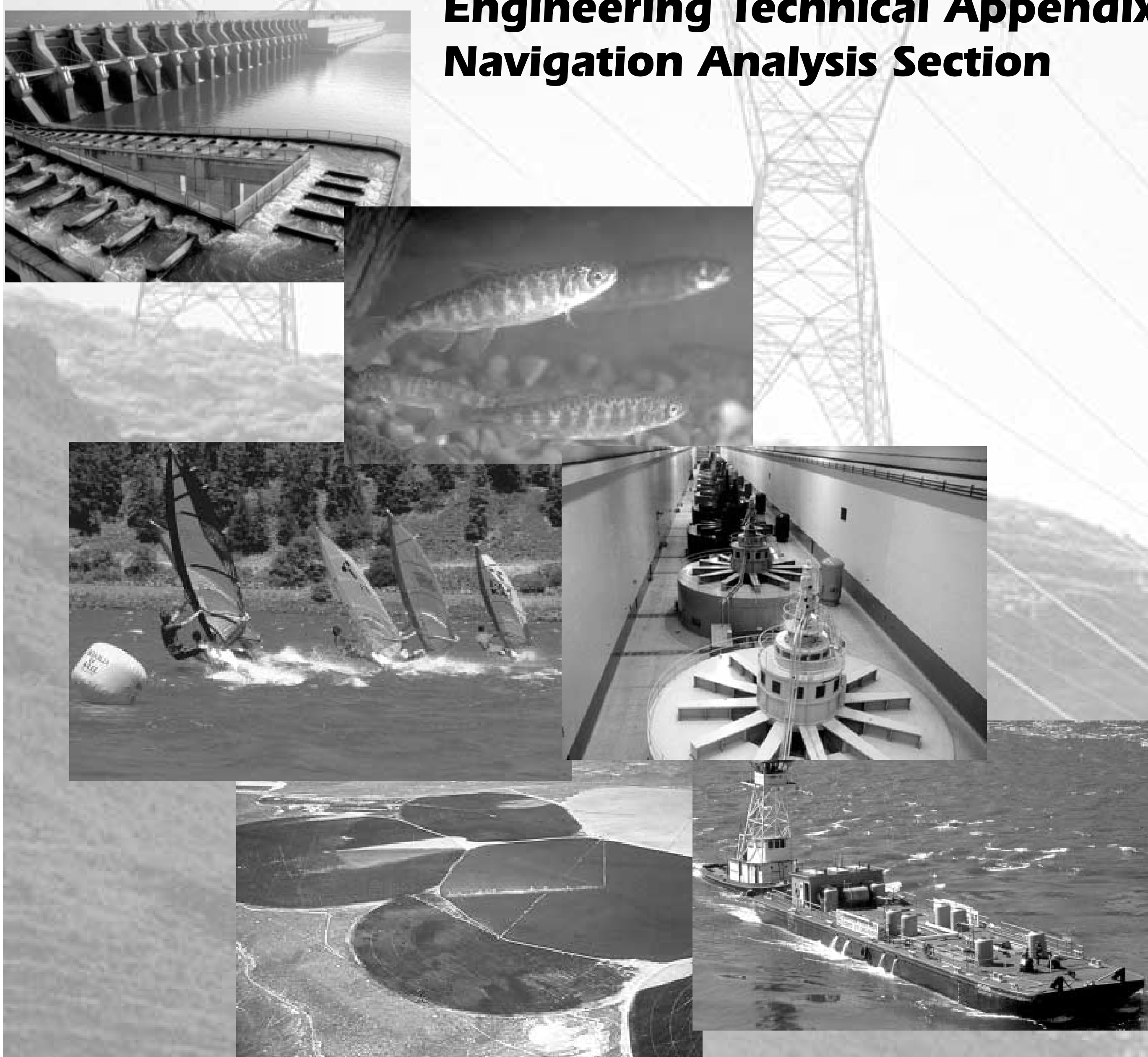
US Army Corps
of Engineers ®
Portland District

Salmon Recovery through John Day Reservoir

John Day Drawdown
Phase I Study

Engineering Technical Appendix
Navigation Analysis Section



September 2000

JOHN DAY DRAWDOWN STUDY

NAVIGATION ANALYSIS

U.S. Army Corps of Engineers
Portland District

Prepared for

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1. INTRODUCTION

1.1 General

This report presents an evaluation of the potential impacts to commercial and recreational vessel navigation by the proposed drawdown of the John Day Reservoir. This action is recommended by the National Marine Fisheries Service (NMFS) in Reasonable and Prudent Alternative Action (RPA) # 5 of its Biological Opinion on Operation of the Federal Columbia River Power System.

John Day Dam is located on the Columbia River at the head of Lake Celilo, at River Mile (RM) 215.6. John Day Dam is a multiple purpose project providing inland navigation, hydroelectric power, and flood control benefits. The U. S. Army Corps of Engineers, Portland District (CENWP) operates the dam as part of a series of dams and reservoirs located on the Columbia and Snake River system. The reservoir behind John Day Dam (Lake Umatilla), hereafter referred to as John Day Reservoir, is 76.4 miles long with an average width of 1.1 miles and a maximum width of 2.5 miles. Normal pool elevation is 265 feet above National Geodetic Vertical Datum (NGVD). Minimum power pool elevation is 262 feet NGVD. The navigation lock is 675 feet long and 86 feet wide, with a 15 feet minimum depth over the upper sill at the minimum operating pool (MOP) elevation of 257 feet NGVD.

Navigation through John Day Reservoir is currently achieved by means of a lock at the dam and a navigation channel throughout the length of the reservoir. The navigation channel is 250 feet wide by 14 feet deep and allows for two-way barge traffic along the entire length of John Day Reservoir. This arrangement facilitates the transport of the modern barge tow configurations (lengths up to 650 feet and widths up to 85 feet). About 9 million tons of commodities move through John Day Lock each year. This lock provides a maximum lift of 113 feet, and is one of the highest single-lift locks in the world.

Two basic drawdown scenarios were evaluated for this study, including the spillway drawdown and natural river drawdown scenarios. For the spillway drawdown scenario, the existing 20-bay spillway will be operated differently from current operations, but without any structural modifications. All project inflows will be directly passed through the dam spillway with the spillway gates fully opened in free overflow condition, resulting in a pool elevation that will vary from about 217 to 230 feet NGVD. Furthermore, two separate conditions were investigated for this spillway drawdown scenario, including with and without flood control operations.

The natural river drawdown scenario would consist of opening John Day Dam to an extent that permits acceptable upstream fish passage conditions. This would return the river to a free-flowing state similar to conditions that existed prior to construction of the dam. This would lower the pool by about 100 feet. Furthermore, two separate conditions were investigated for this natural river drawdown scenario, including with and without flood control operations.

1.2 Goals and Objectives

The goals of this navigation analysis are:

- Determine the impacts of the two basic drawdown scenarios on both the navigation channel and associated ports and marinas. Furthermore for both drawdown scenarios, two separate conditions will be investigated that include with and without flood control operations.
- Provide four alternative channel designs for the two basic drawdown scenarios, and estimate the amount of work necessary to construct the new designs.
- Identify possible modification measures for the ports and recreational facilities located along John Day Reservoir.

1.3 Organization of Report

In addition to this introductory section, the study report is comprised of eight additional sections:

Section 2, DATA, summarizes the sources of information relevant to the study. Previous studies identified from the literature relevant to the current work are reviewed.

Section 3, IMPACT EVALUATION, discusses the impacts of drawdown to the navigation channel, ports, marinas, and parks. Modification for ports and marinas is also discussed.

Section 4, FLOOD CONTROL CONSIDERATIONS, discusses the impacts of flood control operations to the main navigation channel, and also to the ports and marinas.

Section 5, DESIGN ALTERNATIVES FOR COLUMBIA RIVER CHANNEL, presents four alternative channel designs (pre-dam, existing, revised, and towboaters') for the Columbia River navigation channel.

Section 6, DREDGING REQUIREMENTS, estimates dredging requirements associated with the four alternative channel designs. Initial and maintenance dredging volumes and requirements for disposal sites are also estimated.

Section 7, CONCLUSIONS AND RECOMMENDATIONS, describes the overall conclusions and recommendations of navigation issues associated with the two basic drawdown alternatives for John Day Reservoir.

Section 8, SUMMARY, summarizes the methodology and findings of the navigation analysis.

Section 9, REFERENCES, identifies the sources of information utilized in preparing the study.

2. DATA

2.1 Previous Studies

Numerous navigation studies have been previously conducted by entities with an interest in navigation along the Columbia River. Information used for this navigation analysis was obtained from the following studies:

- A navigation analysis conducted for the Columbia River Towboater's Association by Ogden Beeman & Associates, titled "Navigation Impacts of a Drawdown on John Day Reservoir," dated 1997.
- A study of economic impacts prepared by the Ports of Morrow, Umatilla, and Arlington in conjunction with the Oregon Economic Development Department, titled "Economic Impact Study of Eastern Oregon," dated 1998.
- A study of environmental and economic impacts prepared by the Pacific Northwest Grain & Feed Association, titled "Draft Technical Report—Navigation."

2.2 Economic Data from Ports and Marinas

A field reconnaissance was made to all commercial ports and major recreational sites located along John Day Reservoir to obtain both facility values and input on possible modification measures. Appendix A includes a list of these facilities with associated basic data.

2.3 Hydrographic Surveys

The following hydrographic data were used for this navigation analysis:

- Digital Terrain Models (DTM's) in ArcInfo (GIS) format from 1935 and 1994 surveys were obtained from Portland District, U.S. Army Corps of Engineers (CENWP).
- Coast & Geodetic Survey (C & GS) nautical charts from 1961 were obtained from Dan Craemer of Port of Morrow and Glen Comstock of Foss Maritime.
- National Oceanic and Atmospheric Administration (NOAA) nautical charts from 1990.

2.4 Bottom Sediment Data

No record of sediment borings was found for the project area. The U.S. Geological Survey provided riverbed surface sediment data along the entire length of the John Day Reservoir. Appendix C presents this data. While this information was useful in determining the types and distribution of surface sediment present, it could not be used to calculate dredging quantities. Subsurface data is required for this analysis.

2.5 Barge Fleet Data

Appendix D provides information on barges and barge tows for both the present-day and pre-dam barge fleets.

2.6 Barge Operators' Input on Channel Design

Barge operators were sought for input on channel design, including key design parameters. The three major design features requested by the operators were:

- Sufficient width along the entire length of the channel to accommodate two-way barge traffic for the existing barge fleet
- A 14-feet channel depth and an additional two feet of advanced maintenance dredging
- Widening the channel between Arlington and Boardman to 350 feet to compensate for high winds and higher channel velocities resulting from drawdown

3. IMPACT EVALUATION

3.1 Columbia River Navigation Channel

The Columbia River authorized ship channel begins near the confluence with the Pacific Ocean at River Mile (RM) 4.0 and extends through the Tri-Cities area in Washington. Navigation project authorization provides for a 40 feet deep, 600 feet wide ship channel from the Columbia River Bar to Vancouver, Washington (RM 106.5). From Vancouver to The Dalles Dam (RM 191.4), the authorized channel is 27 feet deep and 300 feet wide. Typically, this channel is only dredged to 17 feet reflecting the maximum depth required by commercial traffic through this reach of the river. A 14 feet deep by 250 feet wide channel is maintained from The Dalles Dam to various upstream ports along John Day Reservoir and into the Tri-Cities area, and from the mouth of the Snake River upstream to Lewiston, Idaho.

The lower Columbia River projects of Bonneville, The Dalles, John Day, and McNary were sited in order to provide continuous slackwater navigation upstream to Richland, Washington. Therefore, the tailwater elevation of the upstream project is controlled in part by the forebay elevation of the downstream project.

3.1.1 Operational Characteristics for Existing Conditions Navigation Channel

John Day Dam is normally operated as a run-of-river project. The project is operated to provide optimum conditions for navigation and hydroelectric power without creating “unnecessary” detriment to fish passage, irrigation, recreation, fish and wildlife, and water quality. Most of the time, these competing needs are generally complimentary and no major problems occur.

Operation for navigation, a major project function, consists of making the necessary lockages and observing pondage and release limitations. The lock facilities are operable for a full range of flow conditions on the Columbia River, from 80,000 cubic feet per second (cfs) to 800,000 cfs. At the minimum operational pool of 257.0 feet, NGVD, the upstream sill of the navigation lock will have 15 feet of water depth. The project was originally designed for barges with nine feet of draft but currently some of the larger barges have up to 14 feet of draft. Information to date indicates that entrance and exit velocities at the lock do not cause safety problems.

The authorized federal navigation channel through the 76.5-mile length of John Day Reservoir is 14 feet deep by 250 feet wide. Emergency dredging operations in 1992 removed areas of rock (at elevation of approximately 242 feet) in and adjacent to the navigation channel in the upstream portions of the reservoir. These rock outcrops would have caused a major concern for navigation if the forebay of John Day Dam had dropped below elevation 261.0 feet, in combination with low releases from McNary Dam.

Numerous local port and dock facilities are located along John Day Reservoir. Most of these facilities require local access channels and were originally designed and dredged by local sponsors. These channels are not considered to be a part of the “federal channel” and are normally not within the Corps authority to be maintained. In 1992, however, special authorization and funds were provided by Congress to perform limited dredging in anticipation of special drawdown operation at the John Day Project. Currently, all local access channels are operable at the minimum operating pool of 257.0 feet, NGVD.

If drawdown were to occur, the navigation channel would have to be redesigned to more closely follow the deeper parts of the Columbia River. As discussed below, the navigation channel would have to be redesigned accordingly under either drawdown scenario. The next Phase 2 study will investigate the temporary impacts to both the navigation channel and associated ports during the extended construction sequence that extends from drawdown until final completion of the selected modification measures for navigation.

3.1.2 Natural River Drawdown

Under this scenario for an average flow condition of 200,000 cfs, the water surface elevation behind John Day Dam would be lowered from 265 feet to about 162 feet NGVD. As a result, the existing channel would not only lack sufficient depth for navigation in many locations, but its current alignment would cross some areas of emergent ground (see Appendix E). The natural river drawdown scenario would, therefore, convert this reach of the Columbia River navigation channel from a canalized waterway to a natural river condition, and end all navigation through the existing channel. An effective open river waterway in this natural river condition environment necessarily needs suitable channel dimensions and velocities for year-round commercial navigation by modern equipment without improvement of channel depth, width, or alignment by rectification and stabilization works and maintenance dredging.

3.1.3 Spillway Drawdown

Under this scenario for an average flow condition of 200,000 cfs, the water surface elevation behind John Day Dam would be lowered from 265 feet to about 223 feet NGVD. For this flow condition, the slackwater pool elevation of about 223 feet NGVD created by the smaller dam would extend about 47 river miles from the dam to about River Mile (RM) 263. At that point, it would transition from a slackwater pool to a natural river condition or profile. Although the channel would not cross dry land, it would still lack sufficient depth to serve as an effective open river waterway for commercial traffic at a number of locations upstream of RM 263. During periods of high flow, depth would be great enough to allow shallow-draft vessels to negotiate the low water areas. However, the channel would still lack the depth necessary to provide continuous navigation for modern barge configurations. Therefore, the spillway drawdown scenario would also effectively end navigation through the existing main navigation channel above John Day Dam.

3.2 Barge Traffic Statistics for John Day Reservoir

Barge lines operating on the Columbia River were contacted to obtain information on current barge traffic and predictions of the effects of a drawdown on barge traffic for the John Day Reservoir. Three sources were contacted for this study:

1. Glenn Comstock, Foss Maritime
2. Dixon Shaver, Shaver Transportation
3. Michael Rike, Tidewater Barge Lines

3.2.1 Barge Travel Time Between John Day and McNary Dams

Each of the barge lines contacted has different equipment and hauls different types of loads through the John Day Reservoir. For example, Tidewater Barge Lines will often tow a combination of full petroleum barges and empty grain barges up the Columbia River, and return with full grain barges and empty petroleum barges. Because of the different configurations and payloads unique to each company, the current travel times will vary up and down John Day Reservoir. Travel times from John Day Dam to McNary Dam were estimated to be between 8 and 11 hours, while travel times from McNary Dam to John Day Dam were estimated to be between 9 and 11 hours.

If the reservoir were drawn down to the levels of spillway drawdown and natural river drawdown scenarios, Mr. Rike and Mr. Comstock both agreed that travel time upstream from John Day Dam to McNary Dam would increase substantially due to the presence of swift currents. Mr. Rike also stated that travel time from McNary Dam to John Day Dam would increase, while Mr. Comstock stated that the swifter speeds would force barge tows to move even faster and trim an hour or two off of the current downstream travel time. Table 3-1 provides a summary of barge tow travel times estimated by these three sources for current conditions and for both drawdown scenarios.

Table 3-1. Summary of Barge Tow Travel Times.

Estimated Barge travel time through John Day Reservoir (hours)			
	Source 1	Source 2	Source 3
Current Configuration, upstream	10	8-9	10-11
Current Configuration, downstream	11	9-10	10-11
Spillway Drawdown			
Pre-Dam channel, upstream	12-14		
Pre-Dam channel, downstream	9-10		
Existing channel (modified), upstream	16-18		16
Existing channel (modified), downstream	8-10		16
Revised channel, upstream	16-18		16
Revised channel, downstream	8-10		16
Towboaters' recommendation, upstream	16-18		16
Towboaters' recommendation, downstream	8-10		16
Natural River Drawdown			
Pre-Dam channel, upstream	16	16	
Pre-Dam channel, downstream	6		
Existing channel (modified), upstream	18-22		24
Existing channel (modified), downstream	8-10		24
Revised channel, upstream	18-22		24
Revised channel, downstream	8-10		24
Towboaters' recommendation, upstream	18-22		24
Towboaters' recommendation, downstream	8-10		24

3.2.2 Barge Tow Configurations

Due to the varying nature of cargoes and barge sizes, several different tow configurations are currently in use. Presently, between 70 and 95 percent of barge tows consist of four barges. A large percentage of the remainder of tows consists of 4.5 to 5 barges, with a smaller percentage using one to three barges per tow. Table 3-2 provides a summary of estimated barge tow configurations for current conditions and for both drawdown scenarios.

Table 3-2. Summary of Barge Tow Configurations.

Tow configurations, percentage of total barge traffic			
Current Configuration	Source 1	Source 2	Source 3
4 barges/tow	70	80	95
4.5 - 5 barges/tow	20	10	
1-3 barges/tow	10	10	
Spillway Drawdown			
Pre-dam channel			
4 barges/tow	0		
4.5 - 5 barges/tow	0		
1-3 barges/tow	0		100
Existing channel (modified)			
4 barges/tow	80		
4.5 - 5 barges/tow	0		
1-3 barges/tow	20		100
Revised channel			
4 barges/tow	80		
4.5 - 5 barges/tow	0		
1-3 barges/tow	20		100
Towboaters' recommendation			
4 barges/tow	80		
4.5 - 5 barges/tow	0		
1-3 barges/tow	20		100
Natural River Drawdown			
Pre-dam channel			
4 barges/tow	0		
4.5 - 5 barges/tow	0		
1-3 barges/tow	0		100
Existing channel (modified)			
4 barges/tow	80		
4.5 - 5 barges/tow	0		
1-3 barges/tow	20		100
Revised channel			
4 barges/tow	80		
4.5 - 5 barges/tow	0		
1-3 barges/tow	20		100
Towboaters' recommendation			
4 barges/tow	80		
4.5 - 5 barges/tow	0		
1-3 barges/tow	20		100

Under either drawdown scenario, a larger percentage of tows would consist of one to two barges. This reduction in tows is necessary due to general safety issues and the increased difficulty of navigation in an open river environment. Furthermore, smaller tows have greater maneuverability needed for this difficult open river environment. Mr. Comstock predicted that a one to two-year familiarization period after the drawdown would be necessary, but that eventually the majority of tows would consist of four barges again. According to Mr. Comstock, the barge operators during the first one or two years would probably utilize two-barge tows while they became accustomed to the different navigation conditions. He did not think it would be feasible for barge lines to operate using the Pre-Dam Channel design and the smaller barges that would be required in such a scenario. Mr. Rike anticipated that it would not be possible to operate four-barge tows under either drawdown scenarios in any of the channel designs, but that two-barge tows would be feasible for all designs.

3.2.3 Volume of Current Barge Traffic on John Day Reservoir

The current amount of barge traffic between the John Day and McNary Dams consists of eight to ten barge tows per day, including both upstream and downstream travel. Based on the most common tow configurations of 2 to 4.5 barges per tow, there are typically between 25 and 40 barges traveling daily through the John Day Reservoir. Between 85 and 90 percent of the barge traffic passes through the John Day Reservoir to destinations either upstream or downstream of the reservoir. Table 3-3 provides a summary of current barge traffic volume on John Day Reservoir for current conditions and for both drawdown scenarios.

Mr. Comstock expects that at least eight tows would still travel the John Day Reservoir under either drawdown scenario. Although it would require more time to travel upstream, downstream trips would require less time, and therefore eight tows per day would be possible. He ruled out the possibility of operating on the Pre-Dam Channel design. Using a 14-feet deep by 250 feet-wide channel, Mr. Comstock believes that four-barge tows would eventually be utilized again. About 20 to 30 barges would therefore utilize the waterway daily, with 90 percent passing through to upstream or downstream destinations.

Mr. Rike stated that there would be less barge traffic, with three to four tows per day at spillway drawdown level and two to three tows per day at natural river level. Mr. Rike predicted that only one and two-barge tows would be utilized. Therefore, the total number of barges per day would be four to eight under the spillway drawdown scenario and two to six under the natural river conditions scenario.

Table 3-3. Summary of Barge Traffic Volume.

Barge Traffic Volume (total both ways)			
Current Configuration	Source 1	Source 2	Source 3
Barges per day	28-35		25-40
Tows per day	8		8-10
Percent passing through	90	90	85
Spillway Drawdown			
Pre-dam channel			
Barges per day	0		4-8
Tows per day	0		3-4
Percent passing through	0		
Existing channel (modified)			
Barges per day	20-30		4-8
Tows per day	8		3-4
Percent passing through	90		
Revised channel			
Barges per day	20-30		4-8
Tows per day	8		3-4
Percent passing through	90		
Towboaters' recommendation			
Barges per day	20-30		4-8
Tows per day	8		3-4
Percent passing through	90		
Natural River Drawdown			
Pre-dam channel			
Barges per day	0		2-6
Tows per day	0		2-3
Percent passing through	0		
Existing channel (modified)			
Barges per day	20-30		2-6
Tows per day	8		2-3
Percent passing through	90		
Revised channel			
Barges per day	20-30		2-6
Tows per day	8		2-3
Percent passing through	90		
Towboaters' recommendation			
Barges per day	20-30		2-6
Tows per day	8		2-3
Percent passing through	90		

3.3 Secondary Navigation Features

Under the two basic drawdown scenarios evaluated, the water level would be lowered to the extent that most of the marine facilities investigated would be rendered inoperable. The following sections describe the effects of the proposed drawdown scenarios on specific ports and marinas. The next Phase 2 study will investigate the temporary impacts to both the navigation channel and associated ports during the extended construction sequence that extends from drawdown until final completion of the selected modification measures for navigation. See Chapter 4 for a discussion of flood control operations at the following seven ports for the two drawdown scenarios.

Additionally, permanent elimination of navigation through the John Day Reservoir for reactor compartment shipments would stop the Navy's disposal of decommissioned nuclear powered ships. River transportation is the only feasible means of transporting the reactor compartment packages because of their large size and weight.

Puget Sound Naval Shipyard inactivates and disposes of naval nuclear powered ships at Puget Sound Naval Shipyard, in Bremerton, Washington. Defueled reactor compartments are shipped up the Columbia River to Richland, Washington for land burial at the Hanford Site. The Hanford Site is the only approved radioactive disposal site in the United States that is accessible by navigable water for barge shipment of large packages weighing over 1000 tons. In addition to reactor compartment removal and disposal, dismantling and recycling of the nonradioactive portions of decommissioned nuclear power ships is a major task of this Shipyard.

If full navigation is interrupted, the Shipyard would have to suspend the reactor compartment disposal and ship recycling program since prompt removal of reactor compartment packages from drydocks is necessary to make room for new shipyard work.

3.3.1 Port of Arlington, Oregon

The Port of Arlington is located at RM 241.5. For an average flow condition of 200,000 cfs, the water level would be about 192 feet NGVD under the natural river conditions scenario and 226 feet NGVD under the spillway drawdown scenario. For reference purposes, a discharge of 200,000 cfs corresponds to the median five-day exceedance daily flow value for the USGS streamgage Columbia River at The Dalles, and for this study is the limiting design condition for channel velocities. Compared to existing conditions, these water levels would respectively result in 73- and 39-feet drops in the water surface elevation. Because of these lower water levels, all current commercial and water recreation facilities at Arlington would be inoperable without relocation. In addition, for both conditions the relocated port must accommodate greater fluctuations in pool elevation than for existing conditions.

Arlington operates a marina and city park on the waterfront. Together, these facilities generate an estimated $110,000 per year in tourism. In addition, the Port has a gravel contract valued at $25,000 per year. Cargill AgHorizons owns and operates a grain elevator at the Port. They ship about four million bushels of grain annually. Based on comparisons with other grain elevators in the area, it is assumed that the Cargill elevator has gross annual revenue of $15 to $20 million.

Without mitigating measures, all gravel and grain contracts, as well as much tourism dollars would be lost under either drawdown scenario.

3.3.2 Port of Roosevelt, Washington

The Port of Roosevelt is located approximately 1.5 miles upstream of the Port of Arlington on the Washington side at RM 243. Compared to the Port of Arlington, it would face similar changes in water level.

The Port consists of a grain elevator, annex, tank, and barge loading facilities, with a gross annual revenue of around $14 million. The port would have to discontinue the use of these facilities under either drawdown scenario.

3.3.3 Boardman Park and Marina, Oregon

The Boardman Park and Marina complex is located at RM 268.3. For an average flow condition of 200,000 cfs, the water level would be about 227 feet NGVD under the natural river conditions scenario and 230 feet NGVD under the spillway drawdown scenario. Compared to existing conditions, these water levels would respectively result in 38- and 35-feet drops in the water surface elevation. In addition, for both conditions the relocated port must accommodate greater fluctuations in pool elevation than for existing conditions.

As a result, the park would lose the use of its marina facilities. These facilities consist of a waterfront park, camping facilities, a boat ramp, and docks. Together, the park and marina generate annual revenues of around $140,000. Park management predicts that about half of that revenue would be lost due to lack of tourism.

3.3.4 Port of Morrow, Oregon

Located just outside of the town of Boardman and approximately two miles upstream of the Boardman Park and Marina at RM 270.5, the Port of Morrow would experience a drop in water surface under either drawdown scenario similar to that of Boardman Park and the Marina. All of the Port's facilities would be inoperable at their current locations even if dredging took place to deepen the access channels, slips, and turning basin.

The Port's industrial park generates over $200 million dollars in direct business per year, and has recently signed an aggregate loading contract for $25 million. The total value of commodities shipped from the Port in 1996-97 is estimated at about $85 million. The Port's industrial park generates 1,809 jobs, with salaries and wages totaling $27 million. This accounts for 36 percent of the county's total employment. Port management states that nearly all of this income and employment would be lost if the Port were to shut down.

3.3.5 Hogue-Warner Grain Elevator, Irrigon, Oregon

Unlike many of the other facilities investigated, the Hogue-Warner elevator was built along the old navigation channel prior to construction of the dam. It is located at RM 278 on the Oregon side of the river. The elevator was not relocated when John Day Dam was constructed, but modifications were necessary in order to operate at the higher water surface elevation. The Hogue-Warner elevator would remain operational under either drawdown scenario, although modifications would be necessary.

Operated by Morrow County Grain Growers, Inc., the elevator produces $25 to $35 million in gross annual revenue, and ships out about 6.5 million bushels of grain. Facility management estimates that 20 percent of revenue would be lost if a 14 feet barge draft is maintained and more than 40 percent would be lost if the pre-dam seven feet draft channel is maintained.

3.3.6 Irrigon Park and Marina

The Irrigon Park and Marina complex is located between Boardman and Umatilla at RM 282. For an average flow condition of 200,000 cfs, the water level for both drawdown conditions would be about 243 feet NGVD. Compared to existing conditions, this water level would result in a 22 feet drop in water surface elevation for both drawdown conditions. In addition, the relocated port must accommodate greater fluctuations in pool elevation for both conditions versus existing conditions.

This reduced water surface elevation would result in complete drainage of the marina. All revenues from this public marina facility would be lost under either drawdown scenario.

3.3.7 Umatilla Park and Marina

Umatilla Park and Marina is the farthest upstream site evaluated. It is located approximately two miles downstream of McNary Dam at RM 290 on the Oregon side of the river. Because of its proximity to the dam, the marina would not experience as significant of a drop in water level compared to the downstream facilities. For an average flow condition of 200,000 cfs, the water level would be about 257 feet NGVD for both drawdown scenarios. This water level corresponds to the current minimum pool elevation for John Day Dam, but it is still an eight feet drop in water surface elevation compared to the normal pool elevation for the project of 265 feet, NGVD. In addition, for both drawdown conditions the relocated port must accommodate greater fluctuations in pool elevation than for existing conditions.

Water depth would not be sufficient within the marina to accommodate larger recreational crafts that currently utilize the facility. In addition, access to the river may be cut off. Thus, without some dredging, the marina would likely be inoperable. The gross annual revenue brought in by the park and marina is around $130,000. Park management estimates that nearly all of this income would be lost if the marina was closed.

3.3.8 Additional Facilities Affected

A number of other facilities along the John Day Reservoir, including recreation parks, boat ramps and treaty fishing sites, would also be severely impacted by the drawdown. Appendix A includes a partial list of those sites. An evaluation addressing the impacts on recreation sites is discussed separately in the Recreation Sites Impacts Section of the Engineering Appendix, and the impact evaluation for treaty fishing access sites is discussed separately in the Cultural Resources Section of the Engineering Appendix.

3.4 Modification for Commercial Ports and Marinas

Because each of the facilities mentioned above would be significantly impacted by the effects of the proposed drawdown scenarios, information was gathered regarding potential modification measures. In most cases, discussion centered on relocation of facilities closer to the proposed river channel. All facility managers indicated, however, that simply relocating would not be sufficient to recover a substantial percentage of the revenue and employment that would be lost.

According to the park and marina directors, most of the tourists who visit the area come for boating, fishing, and sailboarding. If the water surface were lowered, many areas of the river would be hazardous for boating and sailboarding due to shallow rocks and increased current velocities. They contend that most of the tourism industry would still be lost as a result of the proposed drawdown, even if their facilities were moved closer to the river.

The port directors were nearly unanimous in their contention that the proposed drawdown would greatly impact their industry and the local economy in general. Most port directors believe that even if their facilities were relocated for them at no cost, it would still not be profitable for a port to operate on a lowered open river waterway. Consequently, they would have to shut down their port operations. The port directors stated that post-drawdown port commerce would be impractical for the following reasons:

- Each port estimated that it would cost several million dollars to relocate its facilities and resume operations. A detailed estimate of modification costs is provided in Appendix A.
- Because of the large cargo volumes that can be transported by barge, the ports and barge lines currently can ship commodities for a much lower cost than other modes of transportation. Under the pre-dam channel configuration, barge capacities would be much smaller. As a result, it would be more expensive to ship by barge than by truck or rail.
- Even with a redesigned 14-feet channel, towboats would have to increase horsepower and steering capabilities due to higher current velocities and sharper channel bends. Also, it would require more time and fuel to navigate the river. Safety is also a major issue for barge traffic as it transitions from slackwater or canalized waterway to open river navigation. These factors would result in increased transportation costs, reducing the profit margins of all parties involved.
- Most farms in the area would be negatively impacted because of higher transportation costs. Farms are the ports' largest clients, and many of the ports could not operate without their business.

All of the sites evaluated provided estimated costs to relocate their facilities. Some sites also included the costs of other potential modification alternatives. This information is explained below and summarized in Appendix A. Most of the facility costs provided were original construction costs with year of construction. These costs were then adjusted to present-day values using the *Engineering News-Record* cost indices.

3.4.1 Port of Arlington, Oregon

The main facility at the Port of Arlington is the Cargill grain elevator. Cargill did not provide data on construction cost or year, so a value of $4 million was estimated for the elevator, based on a comparison with other similar facilities in the project area. The total cost to replace the port and marina facilities at Arlington would be approximately $5.3 million, not including infrastructure or removal of existing structures. Roughly 350,000 cubic yards of sediment and rock would have to be removed to create a similar marina. For both drawdown conditions, the relocated port must accommodate greater fluctuations in pool elevation than for existing conditions. Under either drawdown scenario, Port Management believes that the port would have to close and that relocation would not be a feasible alternative. The Port Director also thought it would be impractical to rebuild the waterfront park because of the greater distance between the town and the river.

3.4.2 Port of Roosevelt, Washington

Construction of facilities and infrastructure at the Port of Roosevelt would cost an estimated $6 million, not including removal costs. The Port Director estimates that due to increased transportation costs, around 25 to 30 percent of the port's business would be lost under the spillway drawdown scenario and that all business would be lost under a natural river conditions scenario. For both drawdown scenarios, the relocated port must accommodate greater fluctuations in pool elevation than for existing conditions. Facilities exist at the port for loading eight rail cars per day; however, they have not been used for more than 10 years due to the availability of less expensive barge transportation. Port Management suggested that these could be converted to load 50-car unit trains at an estimated cost of $1 to $4 million. The Port Director stated that it may be economically feasible to operate after a relocation or rail conversion, but it would be at a minimal profit.

3.4.3 Boardman Park and Marina, Oregon

The total cost to relocate Boardman Park and Marina was estimated to be $10 million, including infrastructure and dredging. For both drawdown conditions, the relocated port must accommodate greater fluctuations in pool elevation than for existing conditions. Park Management believes that 50 percent of the users would not return, even if the park were relocated, and therefore relocation alone would not be a feasible alternative. It was suggested that some other attraction would need to be built in order to draw tourists to the park. Possibilities put forth by Park Management were an indoor swimming pool and an 18-hole golf course.

3.4.4 Port of Morrow, Oregon

The cost to replace facilities located at the Port of Morrow was estimated to be $30.3 million, including infrastructure. Approximately 1.2 million cubic yards of rock and sediment would have to be removed to create similar access channels, slips, and a turning basin. Not included are costs to remove existing facilities. For both drawdown conditions, the relocated port must accommodate greater fluctuations in pool elevation than for existing conditions. The Port Director predicted that, even after relocation, the port would lose most of its grain contracts under the spillway drawdown scenario and all of its grain contracts under natural river conditions.

3.4.5 Hogue-Warner Grain Elevator, Irrigon, Oregon

The value of the Hogue-Warner Grain Elevator facilities is estimated to be $17.5 million. As discussed earlier, however, the Hogue-Warner grain elevator would not have to be completely replaced. Modifications could be made to make the facility operational under either drawdown scenario at an estimated cost of $250,000. For both drawdown conditions, the relocated grain elevator must accommodate greater fluctuations in pool elevation than for existing conditions. The Morrow County Grain Growers estimate that 40 percent of the grain elevator's business would be lost if the channel is returned to its pre-dam configuration, and 20 percent would be lost if a 14-feet channel is maintained. Another option discussed by Port Management would be the conversion to a rail facility at a cost of $5 to $8 million.

3.4.6 Irrigon Park and Marina

Accurate figures on original cost of construction of Irrigon Park and Marina could not be obtained, but the Port Director estimated that replacement would cost $5 million. For both drawdown conditions, the relocated port must accommodate greater fluctuations in pool elevation than for existing conditions. Park officials predicted that 50 percent of the tourism would be lost even with relocation. However, relocation would not be economically feasible due to the relatively small amount of income generated by the facility.

3.4.7 Umatilla Park and Marina

The value of the Umatilla Park and Marina was estimated to be approximately $2 million. As discussed earlier, this facility would not require relocation. However, an estimated 13,000 cubic yards (cy) of dredging and rock blasting would be necessary. For both drawdown conditions, the relocated port must accommodate greater fluctuations in pool elevation than for existing conditions. The Park Director predicted that 50 percent of tourism would be lost under either drawdown scenario. However, due to the relatively small amount of dredging required, it would be feasible to dredge and maintain the operational status of the marina.

4. FLOOD CONTROL CONSIDERATIONS

The impacts of flood control operations for both drawdown scenarios have also been investigated for this navigation report. HEC-UNET unsteady flow computer models were developed for both natural and spillway drawdown scenarios. Models simulating flood control operations for the 1974 and 1997 flood events were analyzed to study impacts with respect to the main Columbia River navigation channel and secondary navigation features. Both flood events had peak flows of approximately 600,000 cfs.

4.1 Natural River with Flood Control

If flood control operations were in place for this drawdown scenario for both the 1997 and 1974 floods, a pool would be created upstream of John Day Dam with a maximum water surface elevation of 227 feet NGVD. This would be about 55 feet higher then for a similar flood without flood control operations in place, and about 70 feet higher then for minimum operating flow conditions. For safe navigation on the Columbia River, this minimum operating flow condition is based on a discharge of 80,000 cfs. Further upstream, the elevation difference would progressively decrease for the two sets of operating conditions, with and without flood control. For Umatilla Park and Marina at RM 290, these differences in water surface elevation for flood control operations would be reduced to almost nothing.

Table 4-1 denotes for both drawdown scenarios three sets of water surface elevations for seven port locations along John Day Reservoir. Specifically, the elevation data sets in respective order include: (1) minimum operating pool elevations for navigation based on a discharge of 80,000 cfs, (2) maximum water surface elevations for 1997 flood without flood control operations, and (3) maximum water surface elevations for 1997 flood with flood control operations.

The three columns of elevation data in this table indicate that the final relocation design for the ports must consider a very wide fluctuation in water surface elevation. This pertains to both sets of operating conditions, with and without flood control, at the high end of the design range, versus the minimum operating pool based on 80,000 cfs at the low end of the design range.

Table 4-1. Water Surface Elevation Sets at Key Locations along John Day Reservoir Pertaining to Flood Control Operations

Location	River Mile	Minimum Operating Pool for Navigation, based on discharge of 80,000 cfs (ft, NGVD)	Maximum Pool for 1997 Flood without Flood Control Operations (ft, NGVD)	Maximum Pool for 1997 Flood Control Operations (ft, NGVD)
Natural River Drawdown				
Arlington	241	186	205	229
Roosevelt	243	186	207	229
Boardman Park & Marina	268	221	239	240
Port of Morrow	270	224	241	242
Hogue-Warner Elevator	278	233	251	251
Irrigon Marina	282	236	256	256
Umatilla Park & Marina	290	251	270	270
Spillway Drawdown				
Arlington	241	218	243	256
Roosevelt	243	218	243	256
Boardman Park & Marina	268	222	248	258
Port of Morrow	270	224	249	258
Hogue-Warner Elevator	278	233	254	260
Irrigon Marina	282	236	258	262
Umatilla Park & Marina	290	251	270	270

4.1.1 Main Navigation Channel

For flood control operations such as for the 1997 and 1974 flood events, the main navigation channel would have to be closed to barge traffic due to hazardous conditions. For the 1997 flood event at the John Day Dam forebay, the water surface elevation would be about 55 feet higher for flood control operations versus no flood control operations. For floods of this size, John Day Dam would require between 19 and 26 days of release at the maximum flow before the flood control volume is reduced to zero again. Barge operation stoppages of this duration would have a significant impact on commerce for the ports, related businesses, and also the barge lines.

4.1.2 Umatilla Park and Marina, Irrigon Park and Marina, Hogue-Warner Grain Elevator, Port of Morrow, and Boardman Park and Marina

These port locations on the Oregon side of the river are far enough upstream so that flood control operations will not greatly affect their facilities. As denoted in Table 4-1, the increases in water surface elevation for flood control operations for the 1997 flood event would vary from zero to one foot. The specific costs to relocate these five ports with flood control operations are about the same as for port relocation without flood control operations. However, the reduced barge traffic would impact revenues during these time periods.

4.1.3 Ports of Arlington and Roosevelt

Flood control measures would severely impact these two downstream ports. As denoted in Table 4-1, the water surface increase for flood control operations would vary between 22 and 24 feet for these two ports. Grain elevators and barge loading facilities must be located close to the water in order to operate efficiently. However, these structures would have to be located high enough to avoid flooding should these water surface fluctuations be anticipated for flood control operations. The Port Director at Roosevelt expressed the opinion that it would be possible to design facilities that could deal with such situations. He added, however, that for all practical purposes these two ports would be unable to remain in business. The specific costs to relocate these two facilities designed for flood control operations will be investigated in the next Phase 2 study.

4.2 Spillway Drawdown with Flood Control

If flood control operations were in place for this drawdown scenario for floods similar to those experienced in 1997 and 1974, a pool would be created upstream of John Day Dam with a maximum water surface elevation of 254 feet NGVD. This would be about 16 feet higher than for a similar flood without flood control operations in place, and about 39 feet higher than for minimum operating flow conditions. For safe navigation on the Columbia River, this minimum operating flow condition is based on a discharge of 80,000 cfs. Further upstream, the elevation difference would progressively decrease for the two sets of operating conditions, with and without flood control. For Umatilla Park and Marina at RM 290, these differences in water surface elevation for flood control operations would become negligible.

See Section 4.1 for a discussion of Table 4-1 regarding this drawdown scenario.

4.2.1 Main Navigation Channel

As with flood control operations under a natural river drawdown scenario, barge traffic would be closed during major floods. For the 1997 flood event at John Day Dam forebay, the water surface elevation would be about 16 feet higher for flood control operations versus no flood control operations. For floods of this size, John Day Dam would require between 19 and 26 days of release at the maximum flow before the flood control volume is reduced to zero again. Barge operation stoppages of this duration would have a significant impact on commerce for the ports, related businesses, and also the barge lines.

4.2.2 Umatilla Park and Marina, Irrigon Park and Marina, and Hogue-Warner Grain Elevator

Both Umatilla Park and Marina, and Irrigon Park and Marina are far enough upstream so that flood control operations will not greatly affect them. As denoted in Table 4-1, flood control operations of the 1997 flood event would result in no increase in water surface elevation at

Umatilla Park and Marina, and only a 4 feet increase at Irrigon Marina. The specific costs to relocate these two ports with flood control operations would be about the same as for port relocation without flood control operations. However, the relocation costs for these two facilities designed for flood control operations will be investigated in detail in the next Phase 2 study.

The Hogue-Warner Grain Elevator would be impacted to a somewhat greater extent by flood control operations. As denoted in Table 4-1, flood control operations of the 1997 flood event would result in a 6 feet increase at the Hogue-Warner Elevator. However, this facility would not be relocated, and hence no additional costs incurred, since it is not greatly affected by high water.

4.2.3 Ports of Arlington, Roosevelt, Morrow, and Boardman Park and Marina

Flood control operations would severely impact these four downstream ports. As denoted in Table 4-1, the water surface increase for flood control operations would vary between 11 and 13 feet for these four ports. Grain elevators and barge loading facilities must be located close to the water in order to operate efficiently. However, these structures would have to be located high enough to avoid flooding should these water surface fluctuations be anticipated for flood control operations. The specific costs to relocate these four facilities designed for flood control operations will be investigated in the next Phase 2 study.

5. COLUMBIA RIVER CHANNEL DESIGN ALTERNATIVES

Four different channel designs were analyzed, including the pre-dam channel design, the existing channel design, a revised navigation channel design, and a channel design based on input from the towboat operators. Table 5-1 denotes a summary of the channel design parameters for both drawdown scenarios. The parameters include depth and width, with advanced maintenance dredging shown in parenthesis under the second column. Channel alignments and profiles are shown in Appendices E and F.

All design work was based on guidance from U.S. Army Corps of Engineers EM 1110-2-1611, "Layout and Design of Shallow-Draft Waterways." The limiting design condition for depth was taken to be the 99 percent, five-day exceedance daily flow of 80,000 cfs. The limiting design condition for channel velocities was taken to be the median 5-day exceedance daily flow of 200,000 cfs. Channel alignments, widths, and depths were input into the commercial software program ArcInfo and used in conjunction with the Digital Terrain Model (DTM) and water surface profiles estimated from the HEC-RAS step-backwater hydraulic analysis.

Table 5-1. Channel Design Parameters.

Channel Design	Depth (ft)	Width (ft)
Natural River Drawdown		
Pre-dam	7	150
Existing	14 (+2)	250
Revised	14 (+2)	165, 260 /1
Towboaters' Input	14 (+2)	260, 350 /2
Spillway Drawdown		
Pre-dam	7	150, 250 /3
Existing	14 (+2)	250
Revised	14 (+2)	165, 260
Towboaters' Input	14 (+2)	260, 350

Notes: /1. 165 ft width for one-way traffic, 260 ft width for two-way traffic

/2. 260 ft width for the entire length of channel, except 350 ft wide stretch from Arlington to Boardman

/3. 250 ft width from John Day Dam to approximately RM 263, 150 ft width from RM 263 to McNary Dam

Table 5-2 denotes forebay elevations at John Day Dam for existing conditions and for both drawdown scenarios. The forebay elevations for the proposed drawdown scenarios do not consider flood control operations.

Table 5-2. John Day Dam Forebay Elevations.

Flow (cfs)	Forebay Elevation (feet, NGVD)		
	Existing	Spillway Drawdown	Natural River Drawdown
50,000	268	213.71	160.18
75,000	268	214.87	160.34
100,000	268	215.89	160.57
150,000	268	220.00	161.15
200,000	268	222.50	161.91
250,000	268	225.00	162.75
300,000	268	227.19	163.74
350,000	268	229.39	164.88
400,000	268	231.25	166.01
450,000	268	232.99	167.13
500,000	268	234.72	168.23
600,000	268	238.24	170.40
700,000	268	241.47	172.60
800,000	268	244.41	174.77
900,000	268	247.11	176.90
1,000,000	268	249.74	178.99
1,100,000	268	252.14	181.07
1,200,000	268	254.52	183.21
1,300,000	268	256.82	185.24
1,400,000	268	259.04	187.35
1,500,000	268	261.12	189.37
2,250,000	276.5	275.56	200.81

5.1 Pre-dam Channel Design

Prior to construction of John Day Dam, barge traffic along the river was achieved by means of a narrow, winding, 150 feet wide by 7 feet deep, navigation channel. Navigation through this channel was made extremely difficult and dangerous by the presence of strong currents, shallow rock formations, boulders, and stretches of shallow-water rapids. In addition, the channel was only wide enough to allow for one-way barge traffic. Towboat captains, therefore, had to coordinate their crossings so that one barge tow would have to pull off the channel and allow the other to pass. Barge capacities ranged from 700 to 1,000 tons compared to 3,500 to 4,250 tons per barge in use today. Also, only two barges per tow were possible, compared with 4 to 4.5 barges per tow today. Although this design would require the least amount of dredging, it would not provide a practical solution for the commercial shipping industry. Smaller volumes and greater travel times would increase the cost of barge shipping for all commodities.

Glen Comstock of Foss Maritime and Dan Craemer of Port of Morrow provided alignment of the pre-dam navigation channel. Mr. Craemer and Mr. Comstock are former towboat captains who navigated this stretch of the Columbia River between John Day and McNary Dams for many years prior to construction of John Day Dam. In addition, they provided valuable input for both drawdown scenarios. For the natural river drawdown scenario, their suggested alignment was used as the basis for design for the entire project length. For the spillway drawdown scenario, the depth created by the slackwater pool would be sufficient to maintain the existing 14 feet deep by 250 feet wide channel from John Day Dam upstream to about RM 263. This alignment for the spillway drawdown scenario would extend from RM 263 upstream to McNary Dam located at approximately RM 291, and would be based on the same alignment delineated for natural river conditions. Appendix B denotes the variable dredging effort required for each of the four separate channel designs for the two basic drawdown scenarios.

A constant width of 150 feet and a depth of seven feet are required for the pre-dam channel design. No advanced maintenance dredging was included in this analysis as it was not included in the original channel design. Therefore, all material dredged under this design was assumed to be sedimentary. The dredge material was assumed to be 80 percent silt to 20 percent sand and gravel from John Day Dam upstream for a distance of five miles and 20 percent silt to 80 percent sand and gravel was assumed for the rest of the upstream channel.

5.2 Existing Channel Alignment

The existing navigation channel was designed and implemented after John Day Reservoir was filled. Portland District, U.S. Army Corps of Engineers (CENWP) provided the current channel alignment in digital format. A constant width of 250 feet and a depth of 14 feet were used. An additional two feet of advance maintenance dredging was incorporated into the design, bringing the total dredging depth to 16 feet.

Under both drawdown alternatives, the channel would cross over dry land and several other stretches of extremely shallow water. Thus, the alignment was altered slightly in some reaches to produce a more feasible alignment that would bypass the dry land and shallow areas. However, at nearly 12 million cubic yards of dredging and blasting, this alignment remains the most impractical design of the four.

5.3 Revised Channel Design

Using bathymetric charts provided by the USGS for a flow rate of 156,000 cfs, a revised channel alignment was chosen. The goal was to design a channel that would require the least amount of dredging possible, while still maintaining an easily navigable waterway. Channel width was calculated assuming a total barge tow width of 85 feet and total barge tow length of 650 feet.

5.3.1 Channel Width in Straight Reaches

A minimum channel width of 260 feet is required for two-way traffic in straight segments for the barge tow dimensions given above. It was decided following discussions with barge line operators that two-way traffic is not imperative along the entire length of the channel. In order to minimize dredging in shallower areas, it would be possible to narrow the channel to 165 feet, as prescribed in the Engineering Manual (EM) for one-way barge traffic. It is noted that 165 feet is the minimum width required for one-way traffic. This design gives no guidance for situations where there are rocky bottoms and swift currents. For this reason, it is likely that a wider channel would be required.

5.3.2 Channel Width in Bends

Channel width in bends is a function of channel velocity, tow length, tow width, bend angle, and bend radius. Maximum channel velocities for a flow rate of 200,000 cfs were estimated from the hydraulic analysis. The maximum velocities addressed in the EM are six feet/s. Many stretches of the project area were found to have velocities that exceed this value. Some stretches of the project area have velocities as high as 10 feet/s. By varying the radius of curvature between 5,000 and 7,000 feet and extrapolating the data contained in EM 1110-2-1611, bend widths were obtained ranging from 260 to 400 feet.

5.4 Revised Channel Design Based on Input from Towboat Operators

Based on conversations with the towboat operators, a few additional considerations were added to the revised channel design. Many towboat operators stated that the stretch of river between Arlington and Boardman is consistently prone to extremely high wind speeds and shifting wind directions. The towboat operators' suggestion that this stretch of channel be widened to 350 feet was incorporated into the revised channel design. The towboat operators also requested that the entire channel be designed for two-way traffic, although it would not be absolutely necessary. Therefore, the width in the straight segments is kept a constant 260 feet except for the 350 feet-wide section between Arlington and Boardman. The width in bends varies from 260 to 400 feet.

6. DREDGING REQUIREMENTS

The USGS provided surface bed material gradation as shown in Appendix C. But no detailed information on the riverbed substratum was available. Based on comparisons of the 1935 and 1994 DTM's and on conversations with river users (including port and park directors, towboat operators, and local residents), it was assumed that solid rock lies beneath the riverbed sedimentary layer. In addition, much of the finer sediment presently in place would be washed away by natural current action once the water surface was lowered and river velocities increased. In order to determine dredging quantities for specific materials, it was assumed that within the channel template the following ratios would be present for all designs except pre-dam:

- From John Day Dam (RM 215.6) upstream to RM 221: 30 percent silt, 70 percent rock
- RM 221 to 256: 10 percent silt, 90 percent rock
- RM 256 to 291: 10 percent sand/gravel, 90 percent rock

The "rock" portion may include a large quantity of cobbles and boulders. A more detailed analysis, including extensive sediment borings, will be necessary to ascertain more accurately the quantities and types of materials to be dredged.

6.1 Initial Dredging

Based on the assumption that most of the channel excavation would be through rock, the channel banks were designed to be vertical. Dredging quantities were determined by overlaying the channel designs with their respective cross-section templates on the 1994 DTM. Table 6-1 displays quantities of material to be dredged for each of the four channel designs for both drawdown scenarios.

The pre-dam configuration would require the least amount of dredging, while the existing channel would require the most. The contractor Ogden Beeman & Associates estimated in its 1998 report to the Columbia River Towboater's Association that around 10 million cubic yards of material would have to be dredged for the existing channel to be maintained. This agrees closely with the nearly 12 million cubic yards estimated for this report. Profiles of the water surface, channel bottom, and river bottom, along with areas to be dredged, are presented in Appendices E and F.

Table 6-1. Initial Dredging Requirements.

Design	Dredging Volume (cubic yards)
Natural River Drawdown	
Pre-Dam	91,609
Existing	11,945,551
Revised	3,051,586
Revised with Towboaters' Input	4,459,764
Spillway Drawdown	
Pre-Dam	25,381
Existing	3,736,768
Revised	1,501,669
Revised with Towboaters' Input	1,794,773

6.2 Maintenance Dredging

Maintenance dredging requirements were also investigated as specified in the scope of work. Little or no maintenance dredging of consequence will be required under any of the channel designs, for the following reasons:

- Little evidence of significant sedimentation was observed.
- Increased channel velocities will prevent suspended sediments from settling.
- Most sediment within the main channel of the Columbia River will settle upstream of McNary Dam, where the velocities are low. As a result, the sediment budget for the project length will come almost entirely from runoff and tributaries below McNary Dam.

Although only small amounts of sedimentation would occur in the main channel, minor quantities of gravels, boulders, and rock fragments would be expected to unravel from adjacent banklines and surrounding areas. These materials would likely accumulate over time and could require periodic removal. Further analysis will be required in a Phase 2 study to more accurately determine the need for maintenance dredging.

6.3 Disposal Site Requirements

Upland disposal area capacity requirements were determined for each dredging reach. To calculate the area needed, a 15-feet disposal dike height was assumed. Bulking factors were applied based on the percentage of material dredged, using a factor of 1.2 for sand, 1.55 for silt, and 1.75 for rock. Disposal site areas were then calculated in terms of square feet and entered into the CENWP spreadsheet (see Appendix B). Table 6-2 denotes the approximate area required for each of the four designs for both drawdown scenarios.

Table 6-2. Approximate Disposal Site Areas Required for Initial Dredging.

Design	Area (acres)
Natural River Drawdown	
Pre-Dam	5
Existing	845
Revised	215
Revised with Towboaters' Input	315
Spillway Drawdown	
Pre-Dam	2
Existing	262
Revised	105
Revised with Towboaters' Input	126

7. CONCLUSIONS AND RECOMMENDATIONS

Modification for the proposed drawdown of the John Day Reservoir would be required to provide navigation comparable to the current level of commercial and recreational navigation between John Day and McNary Dams. Without dredging, the water surface elevation within the channel would drop below levels required for navigation throughout much of the river. Ports and marinas currently in operation would be left with no way to load barges, even if there were in existence a main navigation channel. Modification measures could be taken to contend with some impacts caused by the proposed drawdown. The main navigation channel could be redesigned and dredged to accommodate the barges in use today. In addition, ports and marinas could be relocated closer to the water. However, significant quantities of rock and gravel would have to be removed which may require blasting. Dredging and relocation of facilities could only be accomplished at great cost and over a significant period of time. Many Port Directors state that relocation of the port facilities is not feasible due to the associated high costs. In addition, the following issues would still need consideration:

- Higher current velocities and sharper turns would make navigation less safe, less efficient, more time consuming, and as a result, more expensive.
- Some reaches of the Columbia River consist of wide, shallow rapids. During periods of low flow, it may not be possible to maintain a 14 foot channel through some of these shallower areas, unless all flow could be diverted into the channel.
- Navigation through the John Day Reservoir is essential for all navigation interests upstream of McNary Dam.
- If navigation upstream of John Day Dam were reduced considerably, it would have a significant impact on the Port of Portland and all supporting industries.

Several studies on the impacts of a modal shift in commodities shipping from barge to truck or rail have been conducted and are summarized in Appendix G.

Many of the results presented in this investigation are based on a number of assumptions, and estimates were made from a limited amount of information. It is possible that profitable navigation could be achieved and maintained along the John Day Reservoir after the proposed drawdown, but a more comprehensive and thorough analysis is required.

8. SUMMARY

A navigation analysis was conducted to determine the impacts of the proposed drawdown of the John Day Reservoir with respect to the main Columbia River navigation channel and secondary features related to navigation between John Day and McNary Dams. Data from hydraulic models were used to determine post-drawdown water levels and current velocities. This information, along with input from river users, were used to develop and evaluate four separate channel designs for both drawdown scenarios, including spillway drawdown and natural river condition. The design configurations included the pre-dam design, the existing channel design, a revised design, and a revised design based on towboaters' recommendations. Quantities of material to be dredged were estimated to determine the feasibility of each of the channel designs. The pre-dam configuration would require the least amount of excavation with approximately 25,380 cubic yards for the spillway drawdown scenario and 92,000 cubic yards for the natural river drawdown scenario. The existing channel would require the most dredging with about 3.7 million cubic yards for the spillway drawdown scenario and 12 million cubic yards for the natural river drawdown scenario. The most practical design is the revised design. It would require approximately 1.5 million cubic yards under the spillway drawdown scenario and 3 million cubic yards under a natural river drawdown scenario.

Ports, marinas, and other major river users were contacted. Information obtained was used to estimate the potential losses for the ports and marinas, as well as to aid in determining possible modification measures. All of the ports and major marinas operating along the John Day Reservoir would be inoperable without modification measures following the proposed drawdown. Modification for the ports and marinas would involve relocation of facilities to the new shoreline. An estimated $44 million would be required to relocate the major port and marina facilities, which does not include the associated costs to dredge approximately 1.7 million cubic yards of material for this port relocation effort.

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Appendix A

Ports, Marinas, and Navigation Interests

John Day Dam Drawdown - Phase I Study
Economic Data for Ports and Marine Facilities on John Day Pool

	Facility	Year of Construction	Original Cost(xK)	Replacement Cost (xK)	Description
Port of Arlington	Terminal 1	No information available		$4,000 (est.)	Cargill grain elevator
Steve Anderson (541) 454-2513	Marina	1992	$600	$723	Marina would not be replaced
	City Park	1993	$96	$111	Park with floating dock and stage
	Boat ramp			$500	
Annual revenue:	Tourism:	$110,000			
	Terminal 1:	No data			
Annual volume:	4 million bushels/yr (Cargill)				
Potential loss of business:	$110,000 from tourism, 6 jobs lost				
	$25,000/yr gravel contract				
Notes:	Rail not an option; port would close if drawdown occurred				
	6 jobs would be lost				
	City park would close, impractical to rebuild				
Port of Roosevelt	Silo 1	1968	$300	$1,560	
Keith Keller (509) 384-5411	Barge load	1973	$275	$871	Barge loader and pilings
	Annex	1977	$500	$1,166	Annex and other bins
	Tank	1984	$246	$356	Metal tank
	Total			$6,000	
Annual revenue:	$14 million gross				
	$410,000 net				
Potential loss of business:	Spillway crest: 25%-30% grain volume				
	Natural river: all business				
Possible rail conversion:	$1-4 million				
Notes:	If converted to rail, 25-30% of volume would be lost				
Boardman Park & Marina	Wells			$150	
Ted Lieurance (541) 481-7217	Docks			$350	
	Pool			$2,000	Possible mitigation measure
				$250 per year	Pool maintenance
	Total		COE	$10,000	Including dredging
Annual revenue:	$140,000				
Potential loss of business:	50% of park's users				
Possible mitigation measures:	Build golf course, indoor swimming pool				
Notes:	Dredging to 14' required, rock bottom				

John Day Dam Drawdown - Phase I Study
Economic Data for Ports and Marine Facilities on John Day Pool

	Facility	Year of Construction	Original Cost(xK)	Replacement Cost (xK)	Description
Port of Morrow	Terminal 1	1992	$2,000	$2,409	Aggregate loading barge slip
Gary Neal (541) 481-7678	Terminal 2	1984	$2,300	$3,331	Longview fiber chip reloading dock
Dan Craemer (541) 922-3364	Terminal 3	1984	$2,000	$2,897	Container barge slip
	Terminal 4	1991	$500	$621	Face dock
	Terminal 5	1993	$1,000	$1,153	Tidewater chip reload dock
	Terminal 6	1982	$7,000	$10,990	Messner Cove grain terminal
	Terminal 7	1998	$900	$913	Aggregate loading facility
	Infrastructure			$8,000	
Potential loss of business:	50 million tons of aggregate, $25 million in royalties				
	Spillway crest - most grain contracts				
	Natural river - all grain contracts				
	$200 million in direct business activity per year				
Notes:	1,095 direct jobs, 714 indirect				
	$27 million in salaries per year				
	1996-97 value of cargo shipped: $85 million				
	36% of county's total employment				
Hogue-Warner Grain Elevator	Storage 1	1954	$1,000	$9,562	725,000 bushel storage facility
John Ripple (800) 452-7396	Storage 2	1969	$1,000	$4,732	300,000 bushel storage facility
	Storage 3	1981	$2,000	$3,398	500,000 bushel storage, truck dumper
	Total			$250	To modify structures for drawdown
Annual revenue:	$25-35 million gross, $650,000 net				
Annual volume:	6.5 million bushels of grain				
Potential loss of business:	6' channel - 40%				
	14' channel - 20%				
Possible rail conversion:	$5-8 million				
Notes:	Built before dam; with minor modifications could operate after drawdown				
	60 employees				
Irrigon Park & Marina	Marina	1967	COE		Marina is right next to old channel
Burl Cooley (541) 922-3137	Improvement	1970	COE		Only deepening would be necessary
	Boat Ramp			$250 (est.)	
	Docks			$450 (est.)	
	Total			$5,000	Including dredging
Annual revenue:	$3285				
Potential loss of business:	50% of park users				

John Day Dam Drawdown - Phase I Study
Economic Data for Ports and Marine Facilities on John Day Pool

	Facility	Year of Construction	Original Cost(xK)	Replacement Cost (xK)	Description
Umatilla Park & Marina	Marina	1968	$185	$2,000	Total, including dredging
Susan Daggett (541) 922-3224	Boat ramp			$500 (est.)	
	Docks			$500 (est.)	
Annual revenue:	$130,000 gross				
Potential loss of business:	50% of park users				
Notes:	Dredging required to 20'				
Additional Facilities Impacted	Roosevelt Park				
	Roosevelt treaty fishing site				
	LePage Park - John Day River				
	Albert Philippi Park - John Day River				
	Rock Creek Park				
	Blalock Canyon boat ramp				
	Sundale Park				
	Quesnel Park				
	Crow Butte State Park				
	Boardman treaty fishing site				
	Plymouth Park				
	Aluminum plant				
	Tour boats				
	All upstream ports				
	Loss of much business in Port of Portland				

Columbia River Navigation Interests

Columbia River Towboaters Association
Chairman: Jerry Grossnickle
(503) 656-8288

Pacific Northwest Grain and Feed Association
Executive Director: Glenn Vanselow
(360) 699-4666

Pacific Northwest Grain and Feed Association
Executive Vice President: Jonathan Schlueter
(503) 227-0234

Columbia River Alliance
Executive Director: Bruce Lovelin
(503) 224-4337

Appendix B

U.S. Army Corps of Engineers Spreadsheet

John Day Drawdown - Phase I Study
Natural River Drawdown
Task 6 - Navigation Analysis
Foster Wheeler Environmental Corporation

BDIF	XL	DESC1	UOM	QUANTITY	CONTINGENCY	COST ($)
Work Breakdown Str.	0	Template of Drawdown-DAM REMOVAL	LS	1		
DA	1	TEMPLATE OF ONE DAM	LS	1		
DA02	2	RELOCATIONS	LS	1		
DA03	2	RESERVOIRS	LS	1		
DA04	2	DAMS	LS	1		
DA05	2	LOCK S	LS	1		
DA06	2	FISH AND WILDLIFE FACILITIES	LS	1		
DA07	2	POWER PLANTS	LS	1		
DA08	2	ROADS, RAILROADS, & BRIDGES	LS	1		
	2	CHANNELS	LF	398600	0.1	
DA090115	3	MECHANICAL DREDGING				
	4	PRE-DAM CONFIGURATION	CY	91609		
	5	RM 216-217	CY	14574		
	5	RM 220-221	CY	1358		
	5	RM 225-226	CY	1315		
	5	RM 228-229	CY	2851		
	5	RM 239-240	CY	5518		
	5	RM 249-250	CY	11278		
	5	RM 259-260	CY	23022		
	5	RM 266-268	CY	9278		
	5	RM 285-286.5	CY	22367		
	5	RM 288-289	CY	47		
		SILT/CLAY	CY	27066		
		SAND/GRAVEL	CY	64543		
		ROCK BLASTING	CY	0		
	4	EXISTING CONFIGURATION	CY	11945551		
	5	RM 216-218	CY	678746		
	5	RM 219-220	CY	144606		
	5	RM 221-225	CY	620358		
	5	RM 226-227.5	CY	45788		
	5	RM 228.5-230	CY	53473		
	5	RM 231-231.5	CY	151		
	5	RM 232-233	CY	149610		
	5	RM 234.5-237.5	CY	410801		
	5	RM 238.5-242	CY	1105779		
	5	RM 243.5-247	CY	1292782		
	5	RM 248-251.5	CY	896084		
	5	RM 252-255.5	CY	1557741		
	5	RM 256.5-270	CY	751485		
	5	RM 263.5-270.5	CY	2339729		
	5	RM 272-272.5	CY	37591		
	5	RM 274-275	CY	136817		
	5	RM 276.5-277.5	CY	89023		
	5	RM 279.5-280	CY	29365		
	5	RM 281-282	CY	378266		
	5	RM 284-287	CY	696354		
	5	RM 287.5-291	CY	531000		
		SILT/CLAY	CY	860263		
		SAND/GRAVEL	CY	498963		
		ROCK BLASTING	CY	10586325		

BDIF	XL	DESC1	UOM	QUANTITY	CONTINGENCY	COST ($)
	4	FOSTER WHEELER ENVIRONMENTAL DESIGN	CY	3051586		
	5	RM 216-218	CY	130464		
	5	RM 219-220	CY	2370		
	5	RM 222.5-225	CY	31956		
	5	RM 227.5-229	CY	44947		
	5	RM 230.5-231	CY	1790		
	5	RM 232-233	CY	36063		
	5	RM 234.5-235.5	CY	70150		
	5	RM 238-241	CY	230811		
	5	RM 243-247	CY	160160		
	5	RM 249-250	CY	246728		
	5	RM 253-256.5	CY	80588		
	5	RM 258-260	CY	53324		
	5	RM 264-269	CY	634849		
	5	RM 270-271	CY	5365		
	5	RM 276.5-277.5	CY	7087		
	5	RM 281-282	CY	54575		
	5	RM 284-291	CY	1260359		
		SILT/CLAY	CY	122111		
		SAND/GRAVEL	CY	209615		
		ROCK BLASTING	CY	2719860		
	4	TOWBOATERS' DESIGN	CY	4459764		
	5	RM 216-218	CY	218769		
	5	RM 220-220.5	CY	7759		
	5	RM 223-225	CY	63567		
	5	RM 227-228	CY	8236		
	5	RM 228.5-229	CY	42853		
	5	RM 231-233	CY	39356		
	5	RM 234.5-235.5	CY	74213		
	5	RM 238-241	CY	386361		
	5	RM 243-247	CY	284437		
	5	RM 249-260	CY	762466		
	5	RM 264-271	CY	1152247		
	5	RM 276.5-278	CY	23443		
	5	RM 280.5-282	CY	73440		
	5	RM 284-291	CY	1322617		
		SILT/CLAY	CY	234107		
		SAND/GRAVEL	CY	257175		
		ROCK BLASTING	CY	3968482		
DA090120	3	DISPOSAL AREAS				
	4	PRE-DAM CONFIGURATION	SF	214926		
	5	RM 216-217	SF	34192		
	5	RM 220-221	SF	3186		
	5	RM 225-226	SF	3085		
	5	RM 228-229	SF	6689		
	5	RM 239-240	SF	12945		
	5	RM 249-250	SF	26460		
	5	RM 259-260	SF	54014		
	5	RM 266-268	SF	21767		
	5	RM 285-286.5	SF	52477		
	5	RM 288-289	SF	111		

John Day Drawdown - Phase I Study
Natural River Drawdown
Task 6 - Navigation Analysis
Foster Wheeler Environmental Corporation

BDIF	XL	DESC1	UOM	QUANTITY	CONTINGENCY	COST ($)
	4	EXISTING CONFIGURATION	SF	36824818		
	5	RM 216-218	SF	2092386		
	5	RM 219-220	SF	445782		
	5	RM 221-225	SF	1912392		
	5	RM 226-227.5	SF	141151		
	5	RM 228.5-230	SF	164844		
	5	RM 231-231.5	SF	466		
	5	RM 232-233	SF	461207		
	5	RM 234.5-237.5	SF	1266387		
	5	RM 238.5-242	SF	3408809		
	5	RM 243.5-247	SF	3985287		
	5	RM 248-251.5	SF	2762378		
	5	RM 252-255.5	SF	4802083		
	5	RM 256.5-270	SF	2316621		
	5	RM 263.5-270.5	SF	7212736		
	5	RM 272-272.5	SF	115881		
	5	RM 274-275	SF	421769		
	5	RM 276.5-277.5	SF	274434		
	5	RM 279.5-280	SF	90525		
	5	RM 281-282	SF	1166089		
	5	RM 284-287	SF	2146666		
	5	RM 287.5-291	SF	1636927		
	4	FOSTER WHEELER ENVIRONMENTAL DESIGN	SF	9361017		
	5	RM 216-218	SF	400211		
	5	RM 219-220	SF	7269		
	5	RM 222.5-225	SF	98027		
	5	RM 227.5-229	SF	137880		
	5	RM 230.5-231	SF	5491		
	5	RM 232-233	SF	110625		
	5	RM 234.5-235.5	SF	215192		
	5	RM 238-241	SF	708034		
	5	RM 243-247	SF	491304		
	5	RM 249-250	SF	756860		
	5	RM 253-256.5	SF	247212		
	5	RM 258-260	SF	163576		
	5	RM 264-269	SF	1947456		
	5	RM 270-271	SF	16459		
	5	RM 276.5-277.5	SF	21740		
	5	RM 281-282	SF	167415		
	5	RM 284-291	SF	3866266		
	4	TOWBOATERS' DESIGN	SF	13709376		
	5	RM 216-218	SF	672498		
	5	RM 220-220.5	SF	23853		
	5	RM 223-225	SF	195407		
	5	RM 227-228	SF	25316		
	5	RM 228.5-229	SF	131731		
	5	RM 231-233	SF	120980		
	5	RM 234.5-235.5	SF	228132		
	5	RM 238-241	SF	1187679		
	5	RM 243-247	SF	874364		
	5	RM 249-260	SF	2343830		
	5	RM 264-271	SF	3542023		
	5	RM 276.5-278	SF	72063		
	5	RM 280.5-282	SF	225756		
	5	RM 284-291	SF	4065742		

John Day Drawdown - Phase I Study
Natural River Drawdown
Task 6 - Navigation Analysis
Foster Wheeler Environmental Corporation

BDIF	XL	DESC1	UOM	QUANTITY	CONTINGENCY	COST ($)
	2	PORTS AND RECREATIONAL FACILITIES			0.2	
	3	MITIGATION COSTS				
	4	PORT OF ARLINGTON	LS	5334000		
	5	CARGILL GRAIN ELEVATOR	LS	4000000		*
	5	MARINA	LS	723000		
	5	CITY PARK	LS	111000		
	5	BOAT RAMP	LS	500000		
	4	BOARDMAN PARK & MARINA	LS	2500000		
	5	WELLS	LS	150000		
	5	DOCKS	LS	350000		
	5	POOL (NEW BUILD)	LS	2000000		
	4	HOGUE-WARNER GRAIN ELEVATOR				
	5	OPTION 1 - REPLACE FACILITIES	LS	17692000		
	6	GRAIN SILO 1	LS	9562000		
	6	GRAIN SILO 2	LS	4732000		
	6	GRAIN SILO 3	LS	3398000		
	5	OPTION 2 - MODIFY EXISTING	LS	250000		
	6	TOTAL	LS	250000		
	4	IRRIGON MARINA	LS	700000		
		BOAT RAMP & DOCKS	LS	700000		
	4	PORT OF MORROW	LS	30314000		
	5	AGGREGATE LOADING BARGE SLIP	LS	2409000		
	5	LONGVIEW CHIP RELOAD DOCK	LS	3331000		
	5	CONTAINER BARGE SLIP	LS	2897000		
	5	FACE DOCK	LS	621000		
	5	TIDEWATER CHIP RELOAD DOCK	LS	1153000		
	5	MESSNER COVE GRAIN TERMINAL	LS	10990000		
	5	AGGREGATE LOADING FACILITY	LS	913000		
	5	INFRASTRUCTURE	LS	8000000		
	4	PORT OF ROOSEVELT	LS	3953000		
	5	GRAIN SILO	LS	1560000		
	5	BARGE LOADER & PILINGS	LS	871000		
	5	ANNEX, BINS	LS	1166000		
	5	METAL TANK	LS	356000		
	5	ENTIRE PORT	LS	6000000		
	4	UMATILLA PARK & MARINA	LS	1000000		
		BOAT RAMP & DOCKS	LS	1000000		
	3	MECHANICAL DREDGING				
	4	PORT OF ARLINGTON	CY	350000		
	5	MARINA	CY	350000		
	4	BOARDMAN PARK & MARINA	CY	60000		
	5	MARINA	CY	60000		
	4	IRRIGON MARINA	CY	30000		
	5	MARINA	CY	30000		
	4	PORT OF MORROW	CY	1187413		
	5	BARGE SLIP 1	CY	166238		
	5	CHIP RELOAD	CY	213734		
	5	CONTAINER TERMINAL	CY	178112		
	5	GRAIN RELOAD	CY	94993		
	5	GRAVEL RELOAD	CY	118741		
	5	TURNING BASIN	CY	415595		

John Day Drawdown - Phase I Study
Natural River Drawdown
Task 6 - Navigation Analysis
Foster Wheeler Environmental Corporation

BDIF	XL	DESC1	UOM	QUANTITY	CONTINGENCY	COST ($)
	4	PORT OF ROOSEVELT	CY	67500		
	5	MARINA	CY	7500		
	5	ACCESS CHANNEL	CY	60000		
	4	UMATILLA PARK & MARINA	CY	13000		
	5	MARINA	CY	13000		
	3	DISPOSAL AREAS				
	4	PORT OF ARLINGTON	SF	1008000		
	4	BOARDMAN PARK & MARINA	SF	172800		
	4	IRRIGON MARINA	SF	86400		
	4	PORT OF MORROW	SF	3419749		
	4	PORT OF ROOSEVELT	SF	194400		
	4	UMATILLA PARK & MARINA	SF	37440		
		LUMP SUMS ESTIMATED BY PORT/MARINA MANAGEMENT OR BY APPLYING ENR COST INDEX *VALUE OF CARGILL GRAIN ELEVATOR ESTIMATED BY KEN SODERLIND, CENWP				
DA14	2	RECREATION FACILITIES	LS	1		
DA18	2	CULTURAL RESOURCE PRESERVATION	LS	1		
DA19	2	BUILDINGS, GROUNDS, & UTILITIES	LS	1		

John Day Drawdown - Phase I Study
Spillway Crest Drawdown
Task 6 - Navigation Analysis
Foster Wheeler Environmental Corporation

BDIF	XL	DESC1	UOM	QUANTITY	CONTINGENCY	COST ($)
Work Breakdown Str.	0	Template of Drawdown-DAM REMOVAL	LS	1.0000		
DA	1	TEMPLATE OF ONE DAM	LS	1.0000		
DA02	2	RELOCATIONS	LS	1.0000		
DA03	2	RESERVOIRS	LS	1.0000		
DA04	2	DAMS	LS	1.0000		
DA05	2	LOCKS	LS	1.0000		
DA06	2	FISH AND WILDLIFE FACILITIES	LS	1.0000		
DA07	2	POWER PLANTS	LS	1.0000		
DA08	2	ROADS, RAILROADS, & BRIDGES	LS	1.0000		
	2	CHANNELS	LF	398600	0.1	
DA090115	3	MECHANICAL DREDGING				
	4	PRE-DAM CONFIGURATION	CY	25381		
	5	RM 216- 217	CY	2636		
	5	RM 267.5- 268	CY	628		
	5	RM 285- 289	CY	22117		
		SILT/CLAY	CY	6658		
		SAND/GRAVEL	CY	18723		
		ROCK BLASTING	CY	0		
	4	EXISTING CONFIGURATION	CY	3736768		
	5	RM 216- 217	CY	9014		
	5	RM 244.5- 246	CY	320517		
	5	RM 250- 251	CY	3437		
	5	RM 252.5- 253	CY	3988		
	5	RM 254- 255	CY	1694		
	5	RM 258.5- 260	CY	129841		
	5	RM 264- 271	CY	1340532		
	5	RM 272- 272.5	CY	38849		
	5	RM 274- 275	CY	120316		
	5	RM 276- 277.5	CY	68622		
	5	RM 279- 282	CY	457378		
	5	RM 284- 291	CY	1242581		
		SILT/CLAY	CY	35498		
		SAND/GRAVEL	CY	339981		
		ROCK BLASTING	CY	3361289		
	4	FOSTER WHEELER ENVIRONMENTAL DESIGN	CY	1501669		
	5	RM 216- 217	CY	10119		
	5	RM 251- 253	CY	1837		
	5	RM 255- 256	CY	215		
	5	RM 264- 266	CY	47084		
	5	RM 267- 269	CY	130582		
	5	RM 270- 271	CY	968		
	5	RM 276- 278	CY	9072		
	5	RM 281- 282	CY	50030		
	5	RM 284- 291	CY	1251760		

BDIF	XL	DESC1	UOM	QUANTITY	CONTINGENCY	COST ($)
		SILT/CLAY	CY	3219		
		SAND/GRAVEL	CY	148971		
		ROCK BLASTING	CY	1349478		
	4	TOWBOATERS' DESIGN	CY	1794773		
	5	RM 216- 217	CY	11922		
	5	RM 254- 255.5	CY	27417		
	5	RM 264- 266	CY	86276		
	5	RM 268- 271	CY	321398		
	5	RM 276- 277	CY	27279		
	5	RM 281- 282	CY	49851		
		RM 284- 291	CY	1270629		
		SILT/CLAY	CY	3577		
		SAND/GRAVEL	CY	178285		
	5	ROCK BLASTING	CY	1612911		
DA090120	3	DISPOSAL AREAS				
	4	PRE-DAM CONFIGURATION	SF	59017		
	5	RM 216- 217	SF	6129		
	5	RM 267.5- 268	SF	1460		
	5	RM 285- 289	SF	51428		
	4	EXISTING CONFIGURATION	SF	11421460		
	5	RM 216- 217	SF	27552		
	5	RM 244.5- 246	SF	979661		
	5	RM 250- 251	SF	10504		
	5	RM 252.5- 253	SF	12189		
	5	RM 254- 255	SF	5178		
	5	RM 258.5- 260	SF	396860		
	5	RM 264- 271	SF	4097346		
	5	RM 272- 272.5	SF	118744		
	5	RM 274- 275	SF	367747		
	5	RM 276- 277.5	SF	209744		
	5	RM 279- 282	SF	1397979		
	5	RM 284- 291	SF	3797957		
	4	FOSTER WHEELER ENVIRONMENTAL DESIGN	SF	4581616		
	5	RM 216- 217	SF	30874		
	5	RM 251- 253	SF	5606		
	5	RM 255- 256	SF	656		
	5	RM 264- 266	SF	143655		
	5	RM 267- 269	SF	398409		
	5	RM 270- 271	SF	2954		
	5	RM 276- 278	SF	27680		
	5	RM 281- 282	SF	152643		
	5	RM 284- 291	SF	3819140		

John Day Drawdown - Phase I Study
Spillway Crest Drawdown
Task 6 - Navigation Analysis
Foster Wheeler Environmental Corporation

BDIF	XL	DESC1	UOM	QUANTITY	CONTINGENCY	COST ($)
	4	TOWBOATERS' DESIGN	SF	5475746		
	5	RM 216- 217	SF	36374		
	5	RM 254- 255.5	SF	83649		
	5	RM 264- 266	SF	263224		
	5	RM 268- 271	SF	980566		
	5	RM 276- 277	SF	83228		
	5	RM 281- 282	SF	152091		
	5	RM 284- 291	SF	3876614		
	2	PORTS AND RECREATIONAL FACILITIES			0.2	
	3	MITIGATION COSTS				
	4	PORT OF ARLINGTON	LS	5334000		
	5	CARGILL GRAIN ELEVATOR	LS	4000000		
	5	MARINA	LS	723000		
	5	CITY PARK	LS	111000		
	5	BOAT RAMP	LS	500000		
	4	BOARDMAN PARK & MARINA	LS	2500000		
	5	WELLS	LS	150000		
	5	DOCKS	LS	350000		
	5	POOL (NEW BUILD)	LS	2000000		
	4	HOGUE-WARNER GRAIN ELEVATOR				
	5	OPTION 1 - REPLACE FACILITIES	LS	17692000		
	6	GRAIN SILO 1	LS	9562000		
	6	GRAIN SILO 2	LS	4732000		
	6	GRAIN SILO 3	LS	3398000		
	5	OPTION 2 - MODIFY EXISTING	LS	250000		
	6	TOTAL	LS	250000		
	4	IRRIGON MARINA	LS	700000		
		BOAT RAMP & DOCKS	LS	700000		
	4	PORT OF MORROW	LS	30314000		
	5	AGGREGATE LOADING BARGE SLIP	LS	2409000		
	5	LONGVIEW CHIP RELOAD DOCK	LS	3331000		
	5	CONTAINER BARGE SLIP	LS	2897000		
	5	FACE DOCK	LS	621000		
	5	TIDEWATER CHIP RELOAD DOCK	LS	1153000		
	5	MESSNER COVE GRAIN TERMINAL	LS	10990000		
	5	AGGREGATE LOADING FACILITY	LS	913000		
	5	INFRASTRUCTURE	LS	8000000		
	4	PORT OF ROOSEVELT	LS	3953000		
	5	GRAIN SILO	LS	1560000		
	5	BARGE LOADER & PILINGS	LS	871000		
	5	ANNEX, BINS	LS	1166000		
	5	METAL TANK	LS	356000		
	5	ENTIRE PORT	LS	6000000		
	4	UMATILLA PARK & MARINA	LS	1000000		
		BOAT RAMP & DOCKS	LS	1000000		

John Day Drawdown - Phase I Study

Spillway Crest Drawdown

Task 6 - Navigation Analysis

Foster Wheeler Environmental Corporation

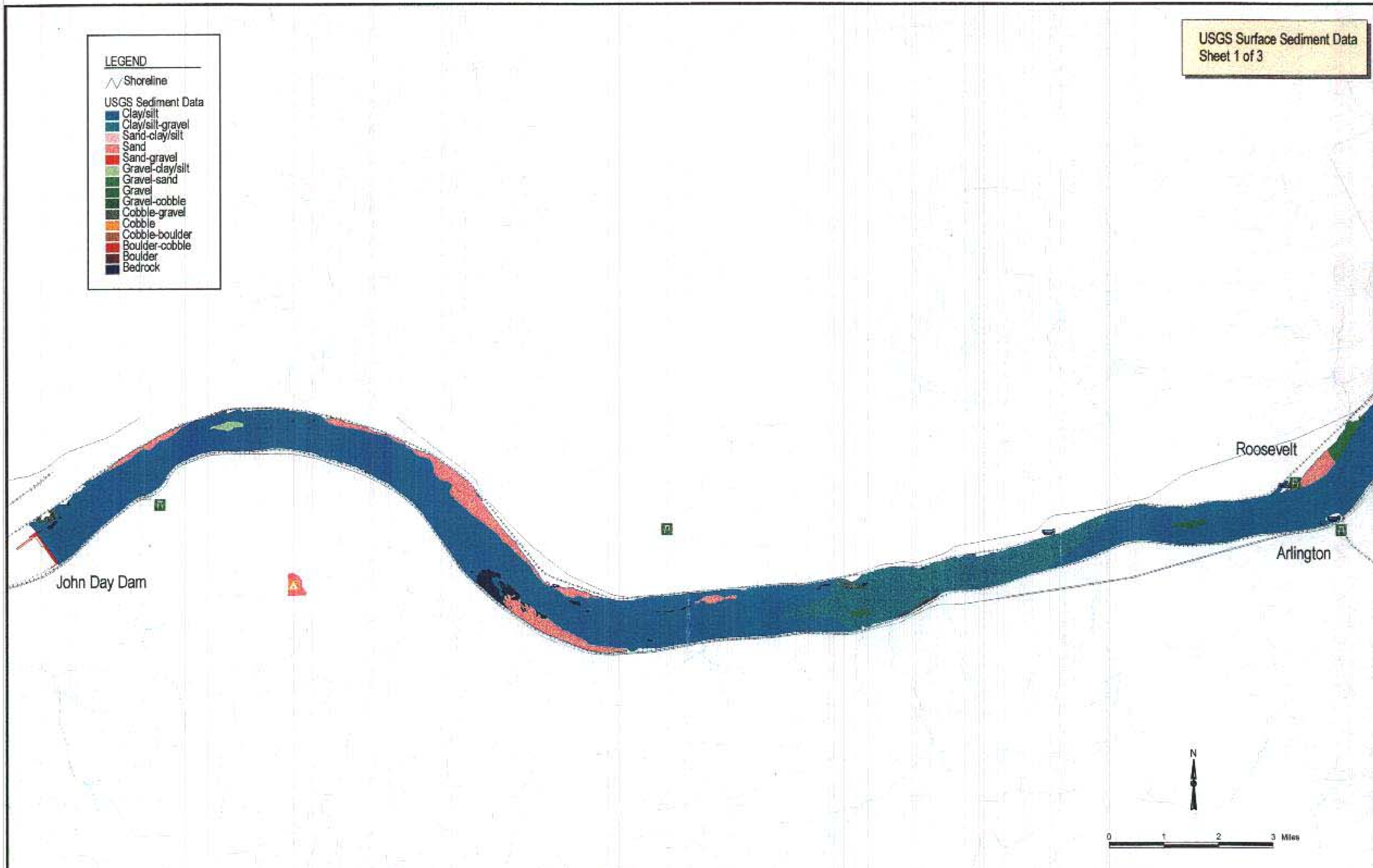
BDIF	XL	DESC1	UOM	QUANTITY	CONTINGENCY	COST ($)
	3	MECHANICAL DREDGING				
	4	PORT OF ARLINGTON	CY	350000		
	5	MARINA	CY	350000		
	4	BOARDMAN PARK & MARINA	CY	60000		
	5	MARINA	CY	60000		
	4	IRRIGON MARINA	CY	30000		
	5	MARINA	CY	30000		
	4	PORT OF MORROW	CY	1187413		
	5	BARGE SLIP 1	CY	166238		
	5	CHIP RELOAD	CY	213734		
	5	CONTAINER TERMINAL	CY	178112		
	5	GRAIN RELOAD	CY	94993		
	5	GRAVEL RELOAD	CY	118741		
	5	TURNING BASIN	CY	415595		
	4	PORT OF ROOSEVELT	CY	67500		
	5	MARINA	CY	7500		
	5	ACCESS CHANNEL	CY	60000		
	4	UMATILLA PARK & MARINA	CY	13000		
	5	MARINA	CY	13000		
	3	DISPOSAL AREAS				
	4	PORT OF ARLINGTON	SF	1008000		
	4	BOARDMAN PARK & MARINA	SF	172800		
	4	IRRIGON MARINA	SF	86400		
	4	PORT OF MORROW	SF	3419749		
	4	PORT OF ROOSEVELT	SF	194400		
	4	UMATILLA PARK & MARINA	SF	37440		
		LUMP SUMS ESTIMATED BY PORT/MARINA MANAGEMENTOR BY APPLYING ENR COST INDEX				
DA14	2	RECREATION FACILITIES	LS	1.0000		
DA18	2	CULTURAL RESOURCE PRESERVATION	LS	1.0000		
DA19	2	BUILDINGS, GROUNDS, & UTILITIES	LS	1.0000		

Appendix C

U.S.G.S. Surface Sediment Data

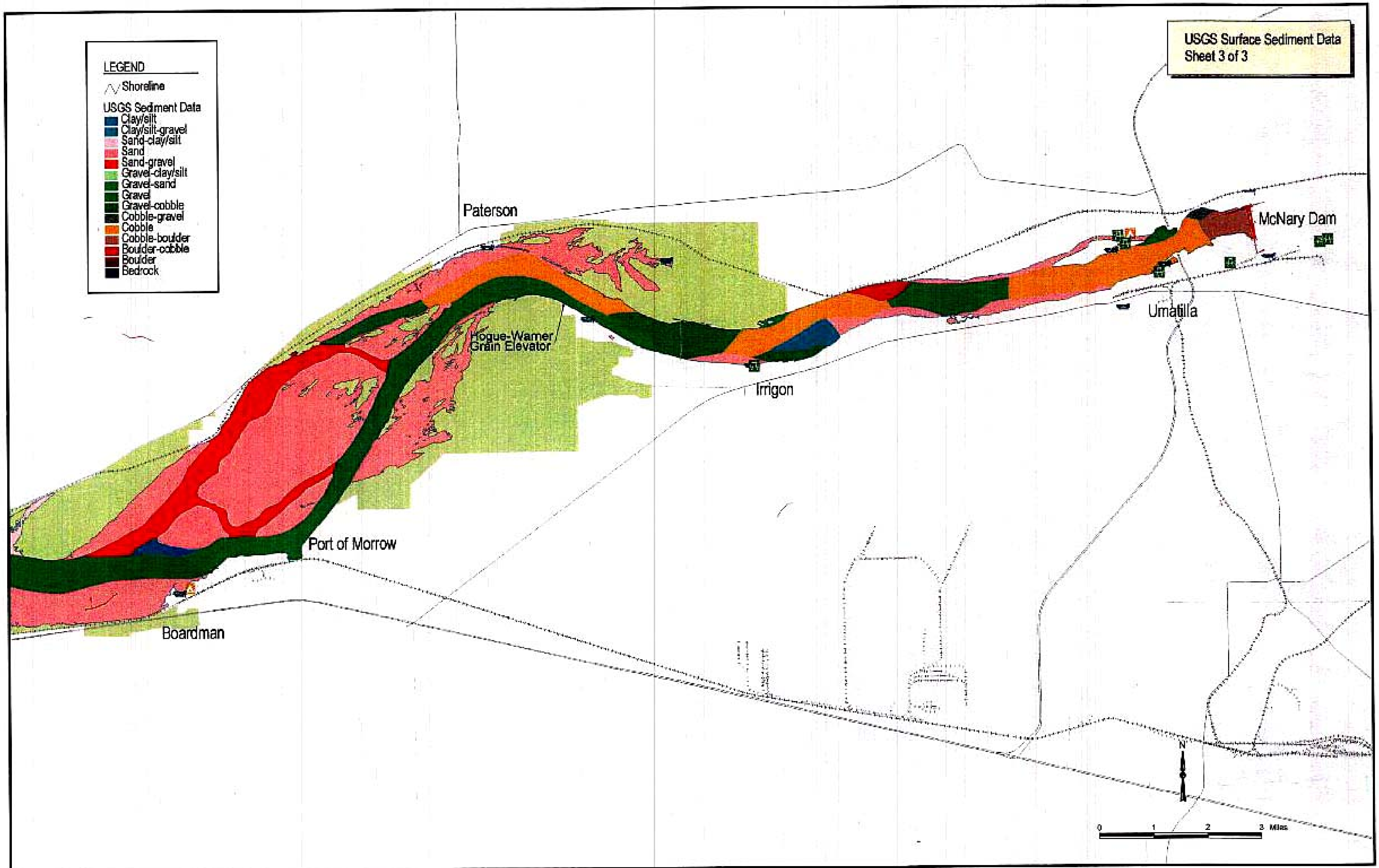
APPENDIX C USGS Surface Sediment Data

List of Plates



USGS Surface Sediment Data
Sheet 1 of 3
LEGEND
Shoreline
USGS Sediment Data
Clay/silt
Clay/silt-gravel
Sand-clay/silt
Sand
Sand-gravel
Gravel-clay/silt
Gravel-sand
Gravel
Gravel-cobble
Cobble-gravel
Cobble
Cobble-boulder
Boulder-cobble
Boulder
Bedrock
John Day Dam
Roosevelt
Arlington
N
0 1 2 3 Miles


LEGEND
Shoreline
USGS Sediment Data
Clay/silt
Clay/silt-gravel
Sand-clay/silt
Sand
Sand-gravel
Gravel-clay/silt
Gravel-sand
Gravel
Gravel-cobble
Cobble-gravel
Cobble
Cobble-boulder
Boulder-cobble
Boulder
Bedrock
USGS Surface Sediment Data
Sheet 2 of 3
Boardman
N
0 1 2 3 Miles



USGS Surface Sediment Data
Sheet 3 of 3
LEGEND
Shoreline
USGS Sediment Data
Clay/silt
Clay/silt-gravel
Sand-clay/silt
Sand
Sand-gravel
Gravel-clay/silt
Gravel-sand
Gravel
Gravel-cobble
Cobble-gravel
Cobble
Cobble-boulder
Boulder-cobble
Boulder
Bedrock
Paterson
McNary Dam
Umatilla
Hogue-Warner Grain Elevator
Irrigon
Port of Morrow
Boardman
N
0 1 2 3 Miles

Appendix D

Barge Fleet Data

John Day Dam Drawdown - Phase I Study

Channel and Barge Fleet Information

Current configuration		Source 1	Source 1	Source 2	Source 2	Source 3	Source 4	Source 4
channel:	width:	250'						
	depth:	14'						
	length:		76.4 miles					
barges:	width:	42'	84'	42'	42'	43'	42'	42'
	length:	266'	286'	242'	272'	250'	150'	273'
	draft:	13.5'	13.5'	13.5'	13.5'		9'	12'
	capacity:		3,500 tons	3,750 tons		4,250 tons		
towboat:	width:			18'	24'			
	length:			104'	104'	100'	69'	100'
	horsepower:			3,000	5,000		1,200	3,000
	4 or 4.5 barges per tow							

Source 1 - Larry Johnson, Foss Maritime
Source 2 - Skip Hart, Tidewater Barge
Source 3 - Dan Craemer, Port of Morrow
Source 4 - Glenn Comstock, Foss Maritime

Pre-dam configuration		Source 1	Source 1	Source 2	Source 2	Source 3	Source 3	Source 4	Source 4
channel:	width:		100' - 150'	150'					
	depth:	7'		7'		7'			
	length:								
barges:	width:	35'	40'	40'	35'	30'		40'	
	length:	150'	165'	220'	205'	160'		200'	240'
	*draft:	5'	7'	7'	7'	5'	6'	6.5'	6.5'
	capacity:	800 tons	1,000 tons			750 tons	1,000 tons	700 tons	1,000 tons
towboat:	width:								
	length:	100'				80'		80'	
	horsepower:	1,800				700	1,000	1,800	
	barges/tow:	2				1			

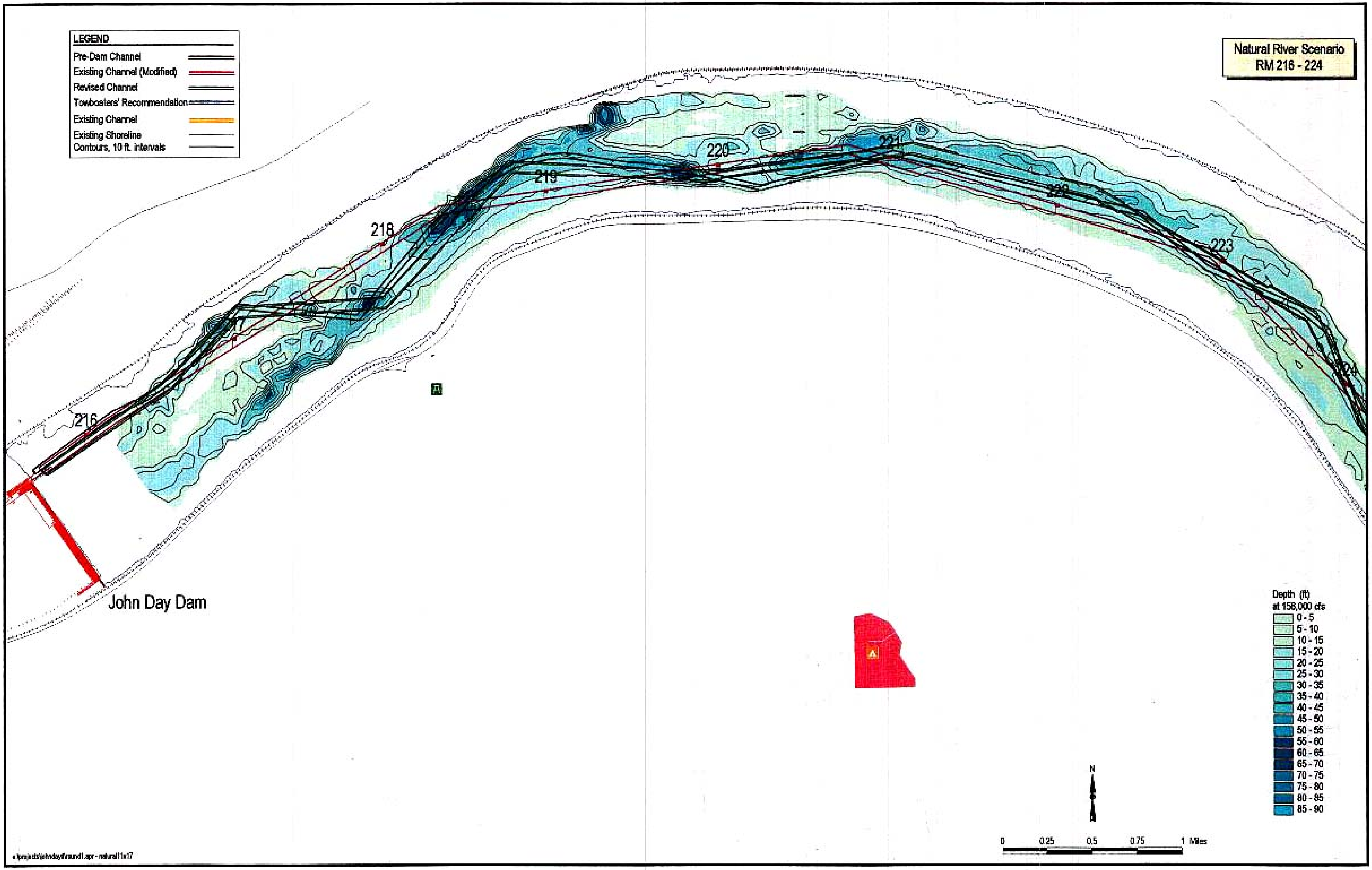
Source 1 - Dan Craemer, Port of Morrow
Source 2 - Bill Johnson, (541) 922-3282
Source 3 - Skip Hart, Tidewater Barge
Source 4 - Glenn Comstock, Foss Maritime
*Note - Sources 1&2 state that 7' draft was preferred, achieved during higher flow periods

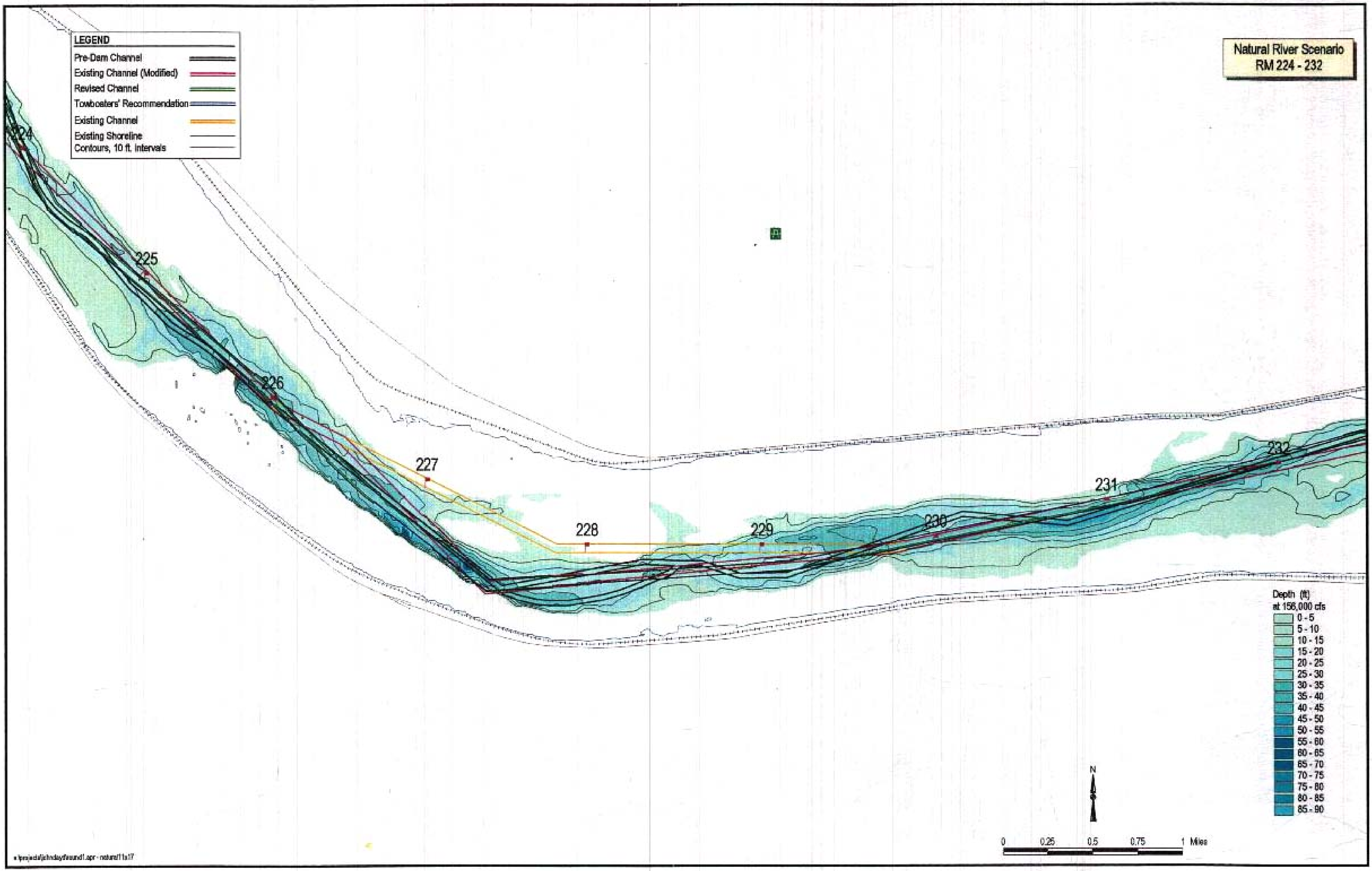
Appendix E

Channel Designs – Natural River Drawdown

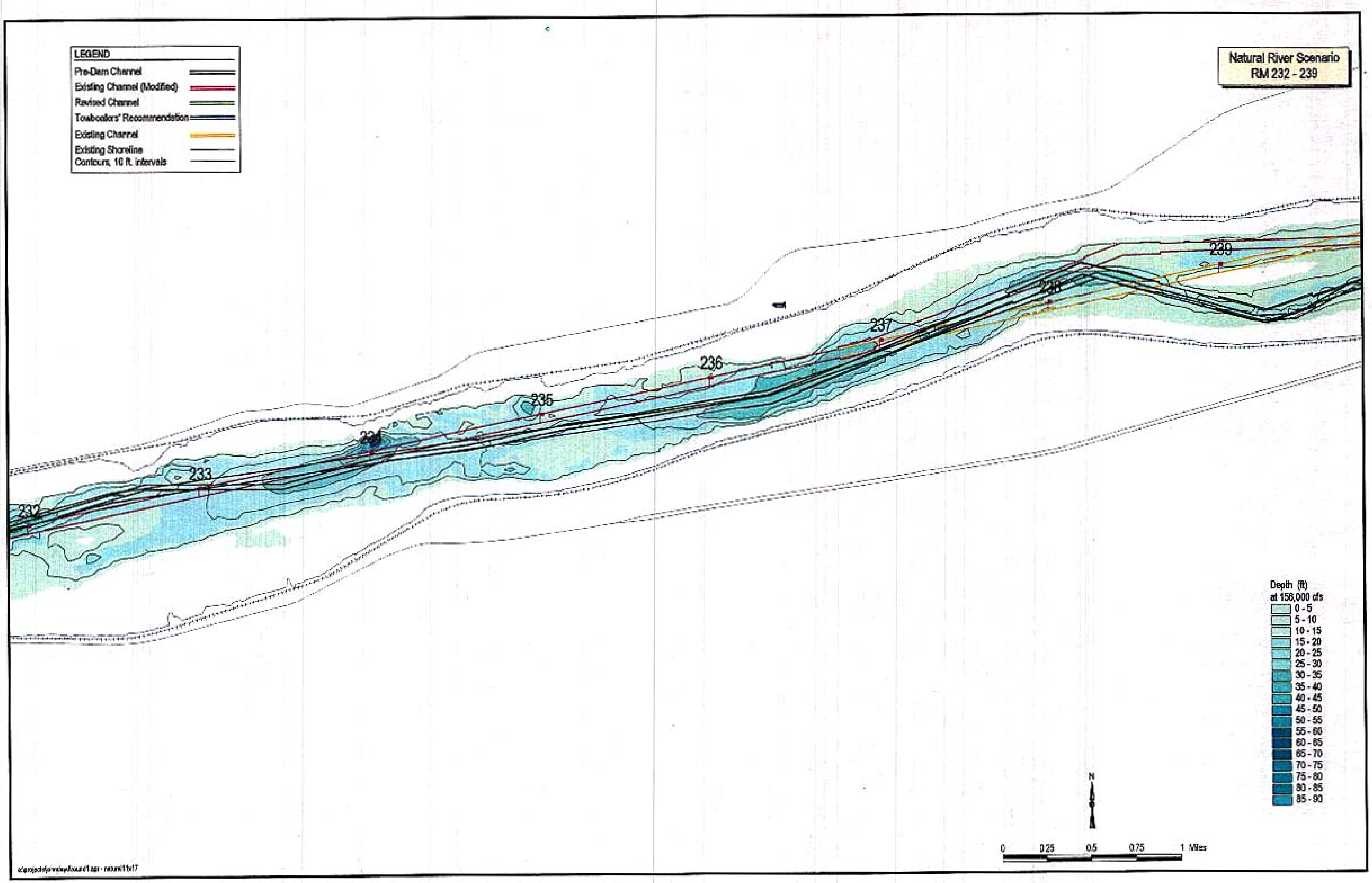
APPENDIX E Channel Designs – Natural River Drawdown

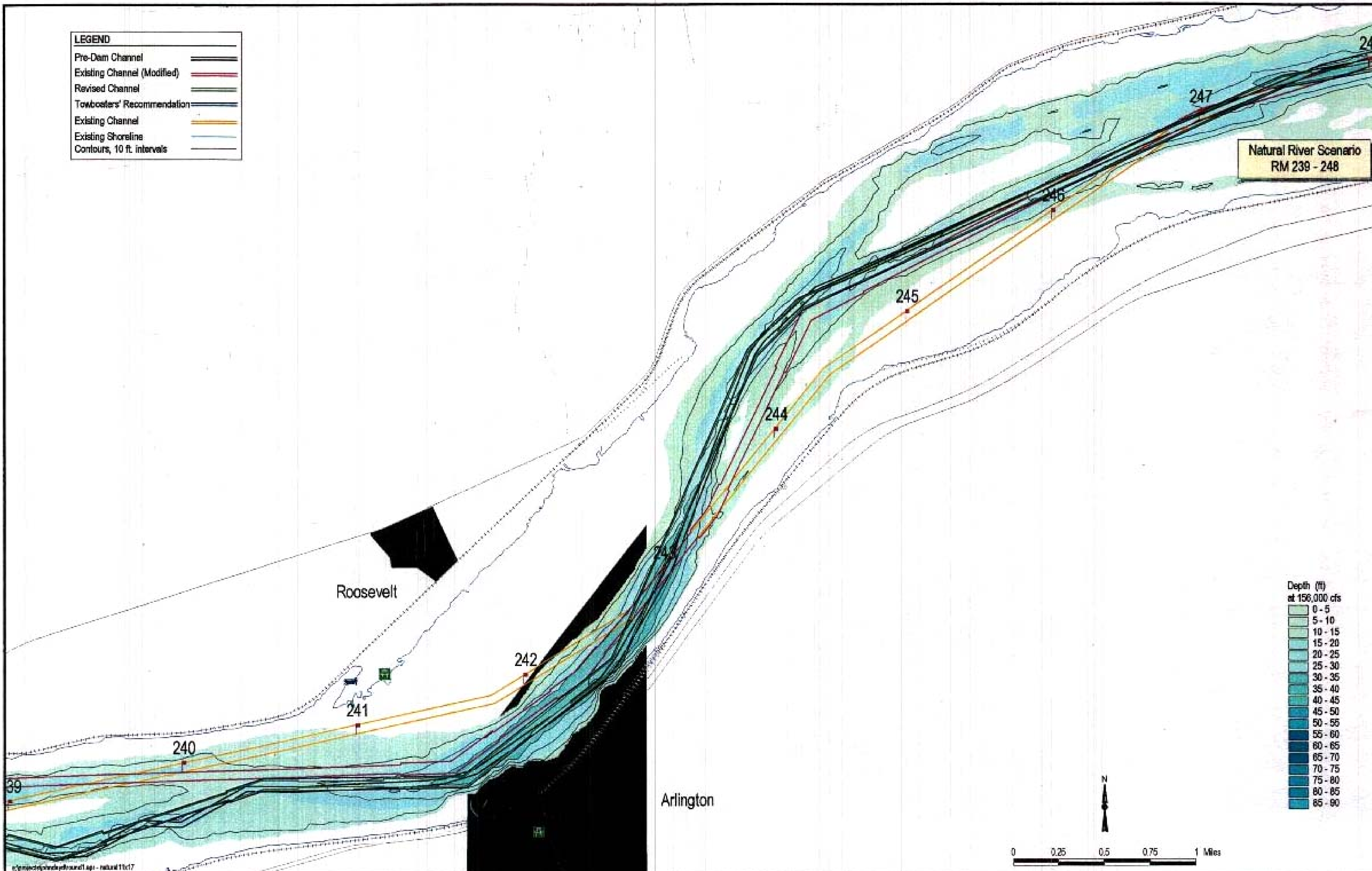
List of Plates


LEGEND
Pre-Dam Channel
Existing Channel (Modified)
Revised Channel
Towboaters' Recommendation
Existing Channel
Existing Shoreline
Contours, 10 ft. intervals
Natural River Scenario
RM 216 - 224
216
218
219
220
221
222
223
John Day Dam
Depth (ft)
at 158,000 cfs
0 - 5
5 - 10
10 - 15
15 - 20
20 - 25
25 - 30
30 - 35
35 - 40
40 - 45
45 - 50
50 - 55
55 - 60
60 - 65
65 - 70
70 - 75
75 - 80
80 - 85
85 - 90
N
0
0.25
0.5
0.75
1 Miles

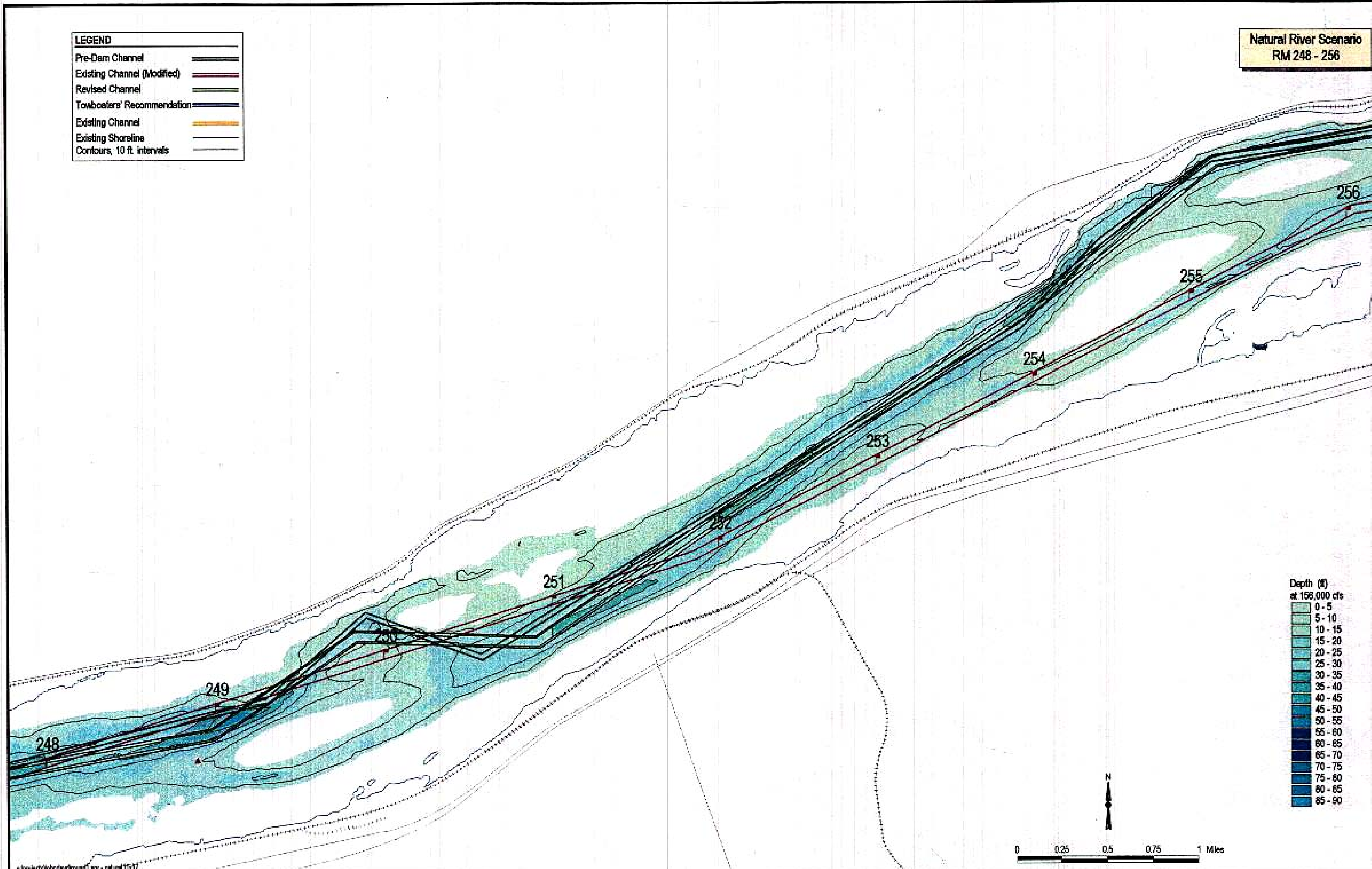


LEGEND
Pre-Dam Channel
Existing Channel (Modified)
Revised Channel
Towboaters' Recommendation
Existing Channel
Existing Shoreline
Contours, 10 ft. Intervals
Natural River Scenario
RM 224 - 232
224
225
226
227
228
229
230
231
232
Depth (ft)
at 156,000 cfs
0 - 5
5 - 10
10 - 15
15 - 20
20 - 25
25 - 30
30 - 35
35 - 40
40 - 45
45 - 50
50 - 55
55 - 60
60 - 65
65 - 70
70 - 75
75 - 80
80 - 85
85 - 90
N
0
0.25
0.5
0.75
1 Miles

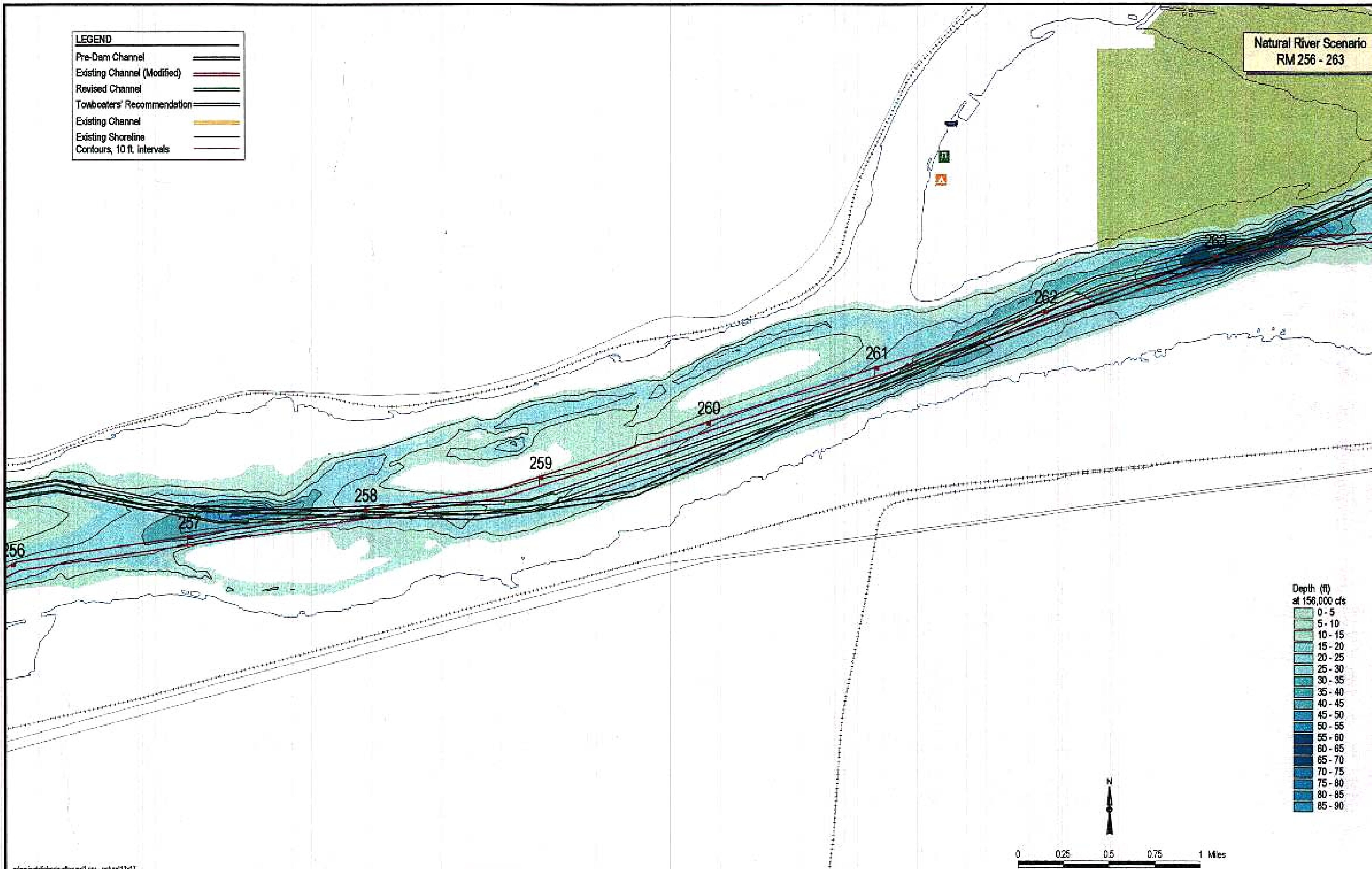

LEGEND
Pre-Dam Channel
Existing Channel (Modified)
Revised Channel
Towboaters' Recommendation
Existing Channel
Existing Shoreline
Contours, 10 ft. intervals
Natural River Scenario
RM 232 - 239
232
233
234
235
236
237
238
239
Depth (ft)
at 156,000 cfs
0 - 5
5 - 10
10 - 15
15 - 20
20 - 25
25 - 30
30 - 35
35 - 40
40 - 45
45 - 50
50 - 55
55 - 60
60 - 65
65 - 70
70 - 75
75 - 80
80 - 85
85 - 90
N
0
0.25
0.5
0.75
1 Miles

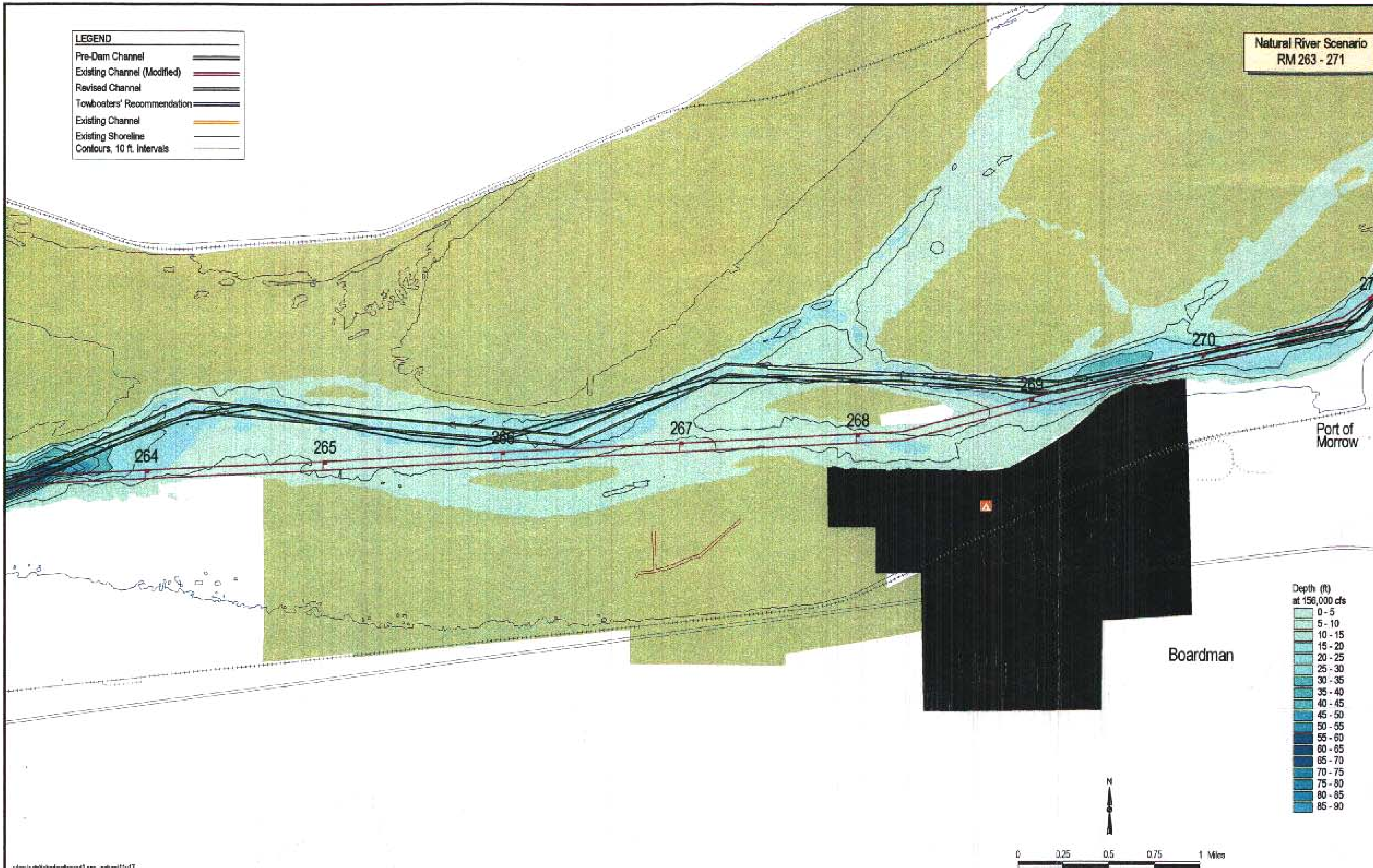


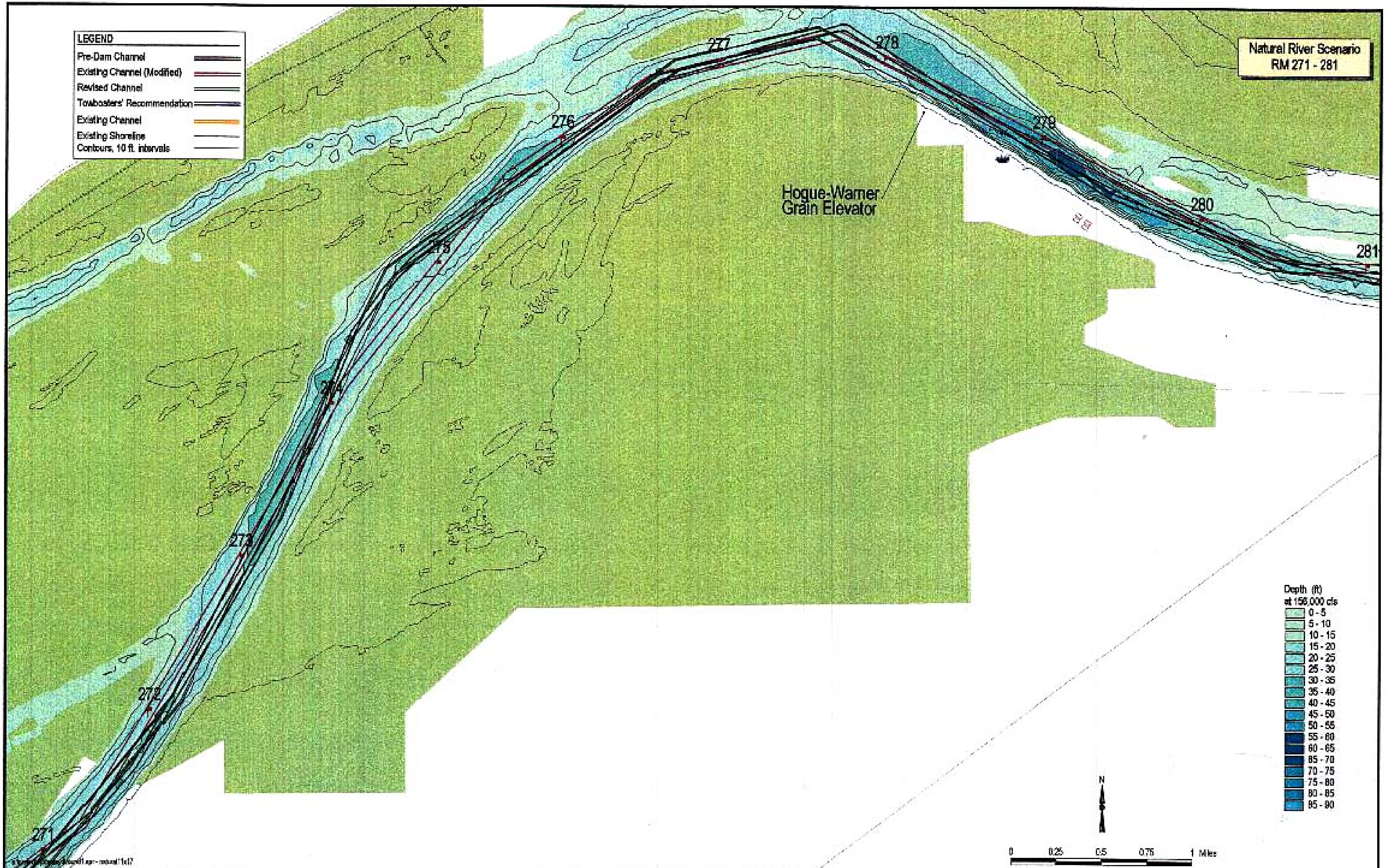
LEGEND
Pre-Dam Channel
Existing Channel (Modified)
Revised Channel
Towboaters' Recommendation
Existing Channel
Existing Shoreline
Contours, 10 ft. intervals
Natural River Scenario
RM 239 - 248
239
240
241
242
243
244
245
246
247
248
Roosevelt
Arlington
Depth (ft)
at 156,000 cfs
0 - 5
5 - 10
10 - 15
15 - 20
20 - 25
25 - 30
30 - 35
35 - 40
40 - 45
45 - 50
50 - 55
55 - 60
60 - 65
65 - 70
70 - 75
75 - 80
80 - 85
85 - 90
N
0
0.25
0.5
0.75
1 Miles

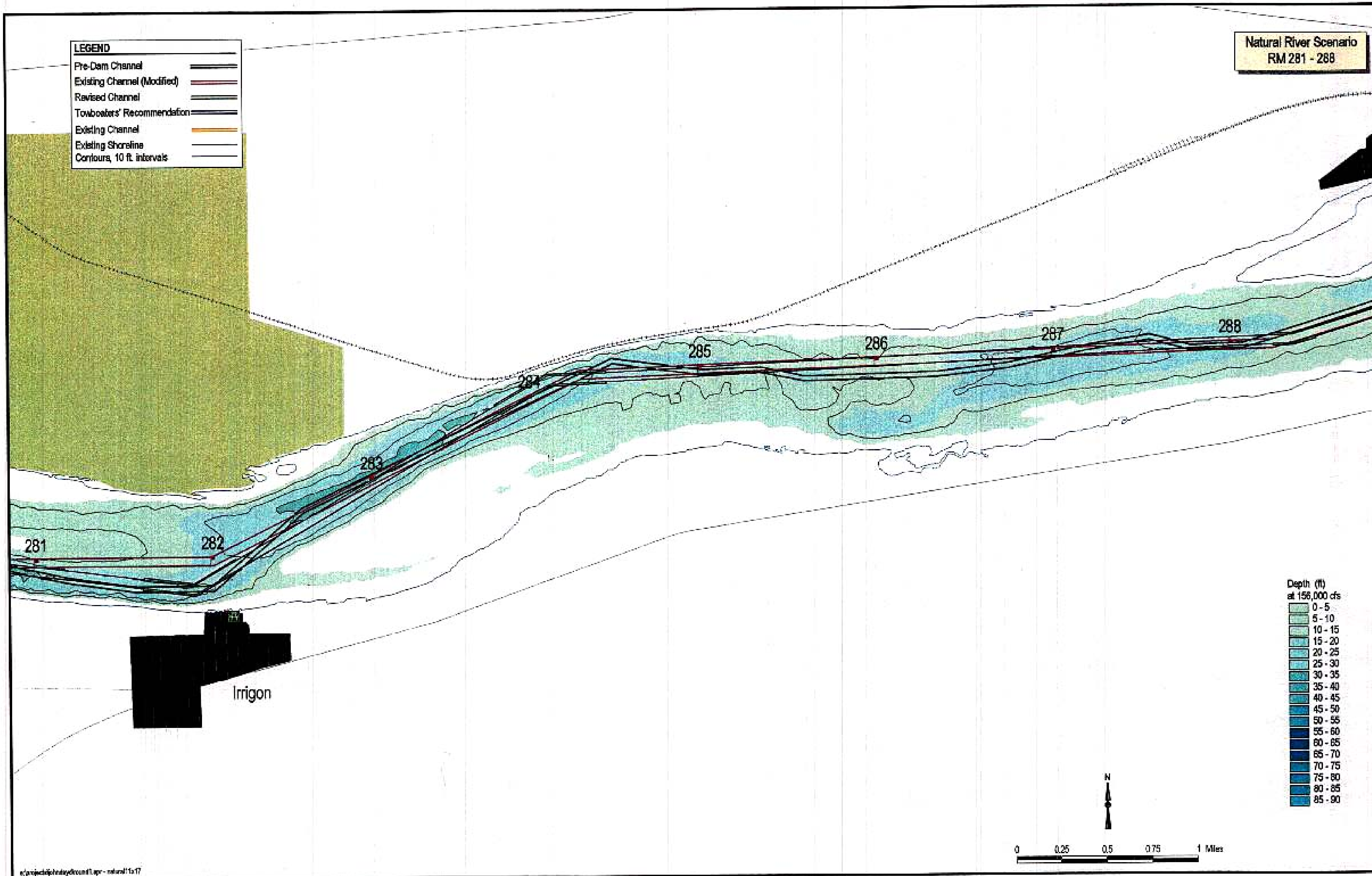


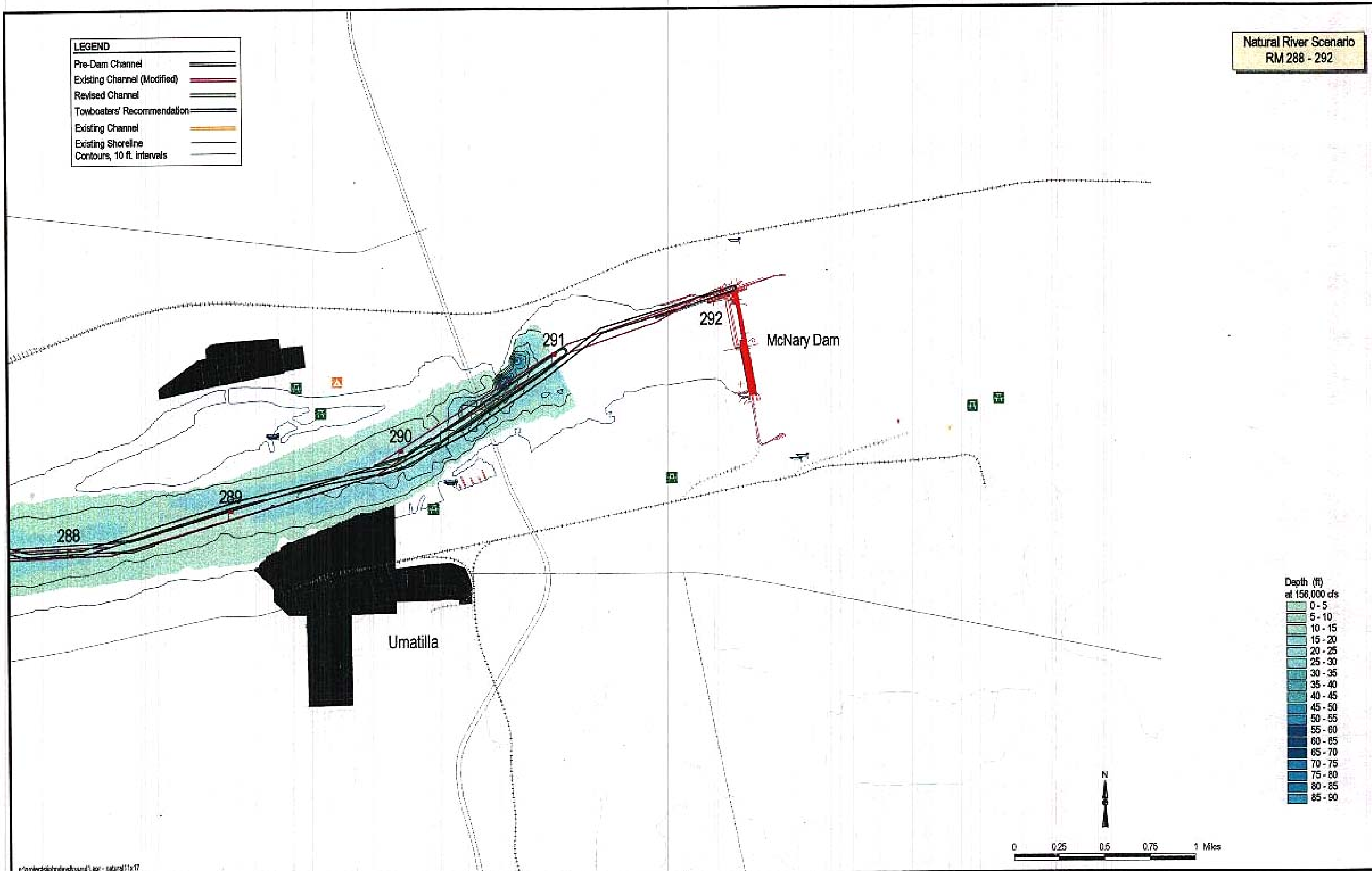
LEGEND
Pre-Dam Channel
Existing Channel (Modified)
Revised Channel
Towboaters' Recommendation
Existing Channel
Existing Shoreline
Contours, 10 ft. intervals
Natural River Scenario
RM 248 - 256
248
249
250
251
252
253
254
255
256
Depth (ft)
at 156,000 cfs
0 - 5
5 - 10
10 - 15
15 - 20
20 - 25
25 - 30
30 - 35
35 - 40
40 - 45
45 - 50
50 - 55
55 - 60
60 - 65
65 - 70
70 - 75
75 - 80
80 - 85
85 - 90
N
0
0.25
0.5
0.75
1 Miles


LEGEND
Pre-Dam Channel
Existing Channel (Modified)
Revised Channel
Towboaters' Recommendation
Existing Channel
Existing Shoreline
Contours, 10 ft. intervals
Natural River Scenario
RM 256 - 263
256
257
258
259
260
261
262
263
Depth (ft)
at 156,000 cfs
0 - 5
5 - 10
10 - 15
15 - 20
20 - 25
25 - 30
30 - 35
35 - 40
40 - 45
45 - 50
50 - 55
55 - 60
60 - 65
65 - 70
70 - 75
75 - 80
80 - 85
85 - 90
N
0
0.25
0.5
0.75
1 Miles

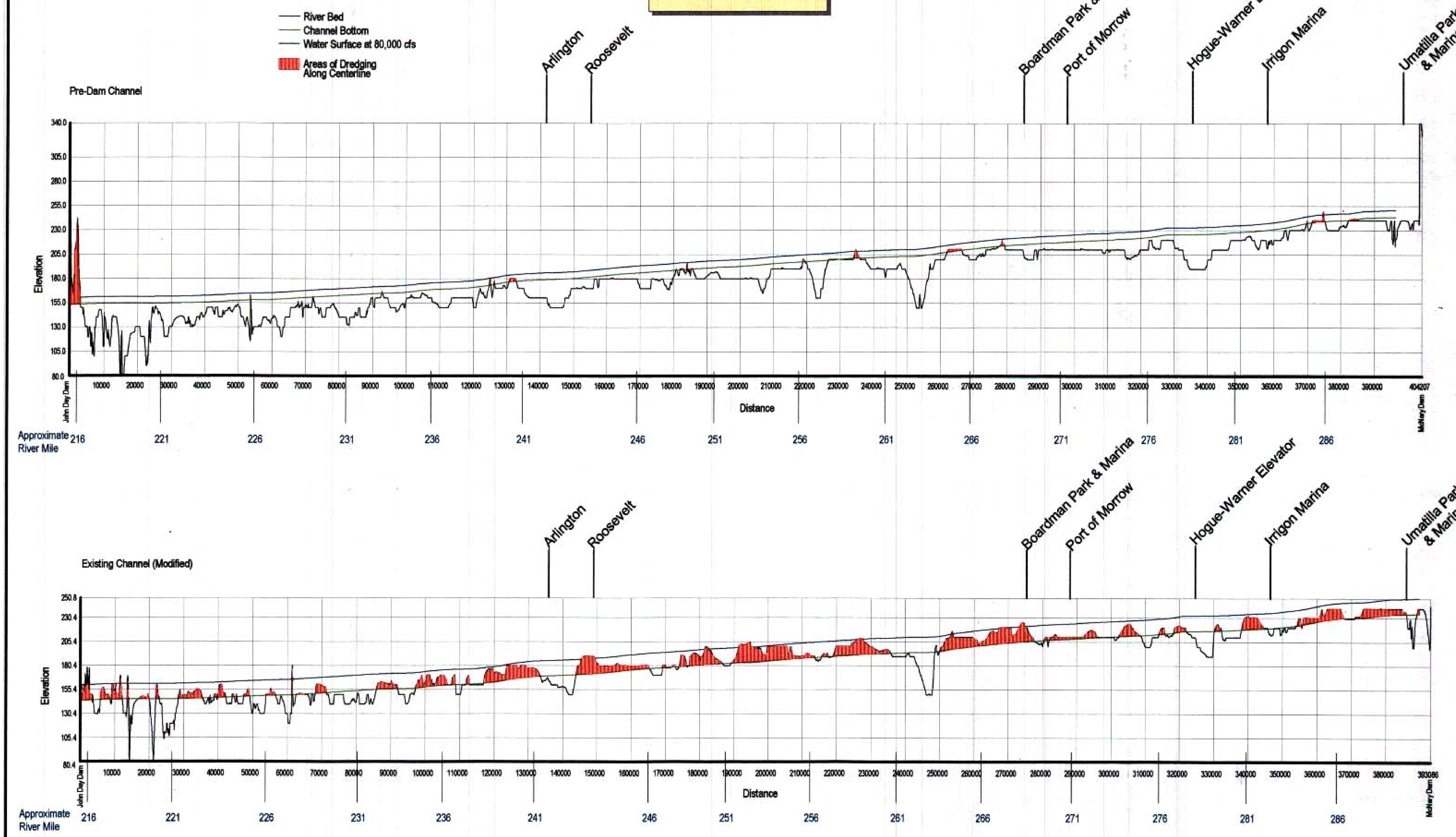

LEGEND
Pre-Dam Channel
Existing Channel (Modified)
Revised Channel
Towboaters' Recommendation
Existing Channel
Existing Shoreline
Contours, 10 ft. Intervals
Natural River Scenario
RM 263 - 271
264
265
266
267
268
269
270
271
Port of Morrow
Boardman
Depth (ft) at 156,000 cfs
0 - 5
5 - 10
10 - 15
15 - 20
20 - 25
25 - 30
30 - 35
35 - 40
40 - 45
45 - 50
50 - 55
55 - 60
60 - 65
65 - 70
70 - 75
75 - 80
80 - 85
85 - 90
N
0
0.25
0.5
0.75
1 Miles

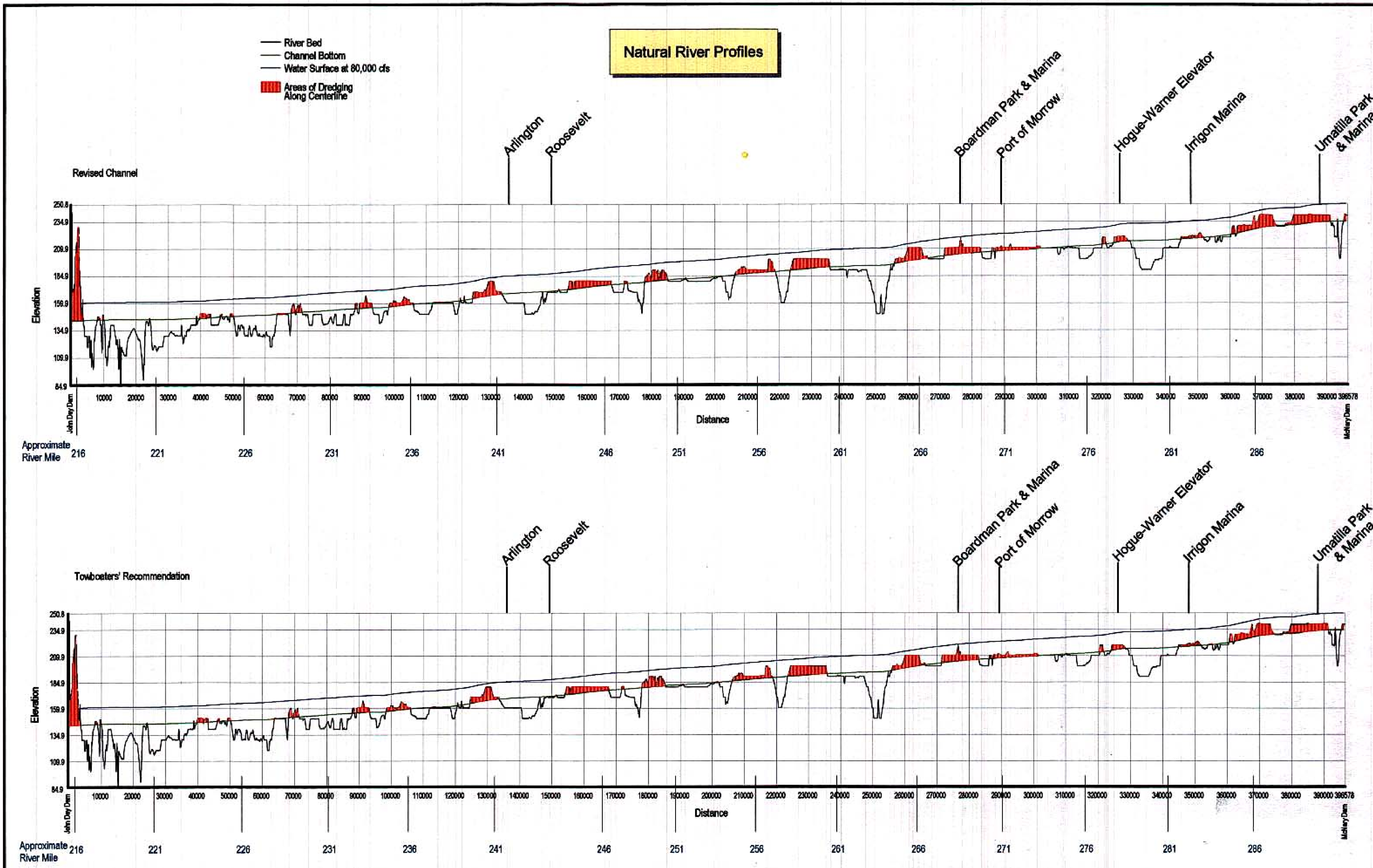

LEGEND
Pre-Dam Channel
Existing Channel (Modified)
Revised Channel
Towboaters' Recommendation
Existing Channel
Existing Shoreline
Contours, 10 ft. intervals
Natural River Scenario
RM 271 - 281
Hogue-Warner
Grain Elevator
271
272
273
274
275
276
277
278
279
280
281
Depth (ft)
at 156,000 cfs
0 - 5
5 - 10
10 - 15
15 - 20
20 - 25
25 - 30
30 - 35
35 - 40
40 - 45
45 - 50
50 - 55
55 - 60
60 - 65
65 - 70
70 - 75
75 - 80
80 - 85
85 - 90
N
0
0.25
0.5
0.75
1 Miles


Natural River Scenario
RM 281 - 288
LEGEND
Pre-Dam Channel
Existing Channel (Modified)
Revised Channel
Towboaters' Recommendation
Existing Channel
Existing Shoreline
Contours, 10 ft. intervals
281
282
283
284
285
286
287
288
Irrigon
Depth (ft)
at 156,000 cfs
0 - 5
5 - 10
10 - 15
15 - 20
20 - 25
25 - 30
30 - 35
35 - 40
40 - 45
45 - 50
50 - 55
55 - 60
60 - 65
65 - 70
70 - 75
75 - 80
80 - 85
85 - 90
N
0
0.25
0.5
0.75
1 Miles


Natural River Scenario
RM 288 - 292
LEGEND
Pre-Dam Channel
Existing Channel (Modified)
Revised Channel
Towboaters' Recommendation
Existing Channel
Existing Shoreline
Contours, 10 ft. intervals
288
289
290
291
292
McNary Dam
Umatilla
Depth (ft)
at 156,000 cfs
0 - 5
5 - 10
10 - 15
15 - 20
20 - 25
25 - 30
30 - 35
35 - 40
40 - 45
45 - 50
50 - 55
55 - 60
60 - 65
65 - 70
70 - 75
75 - 80
80 - 85
85 - 90
N
0
0.25
0.5
0.75
1 Miles

Natural River Profiles



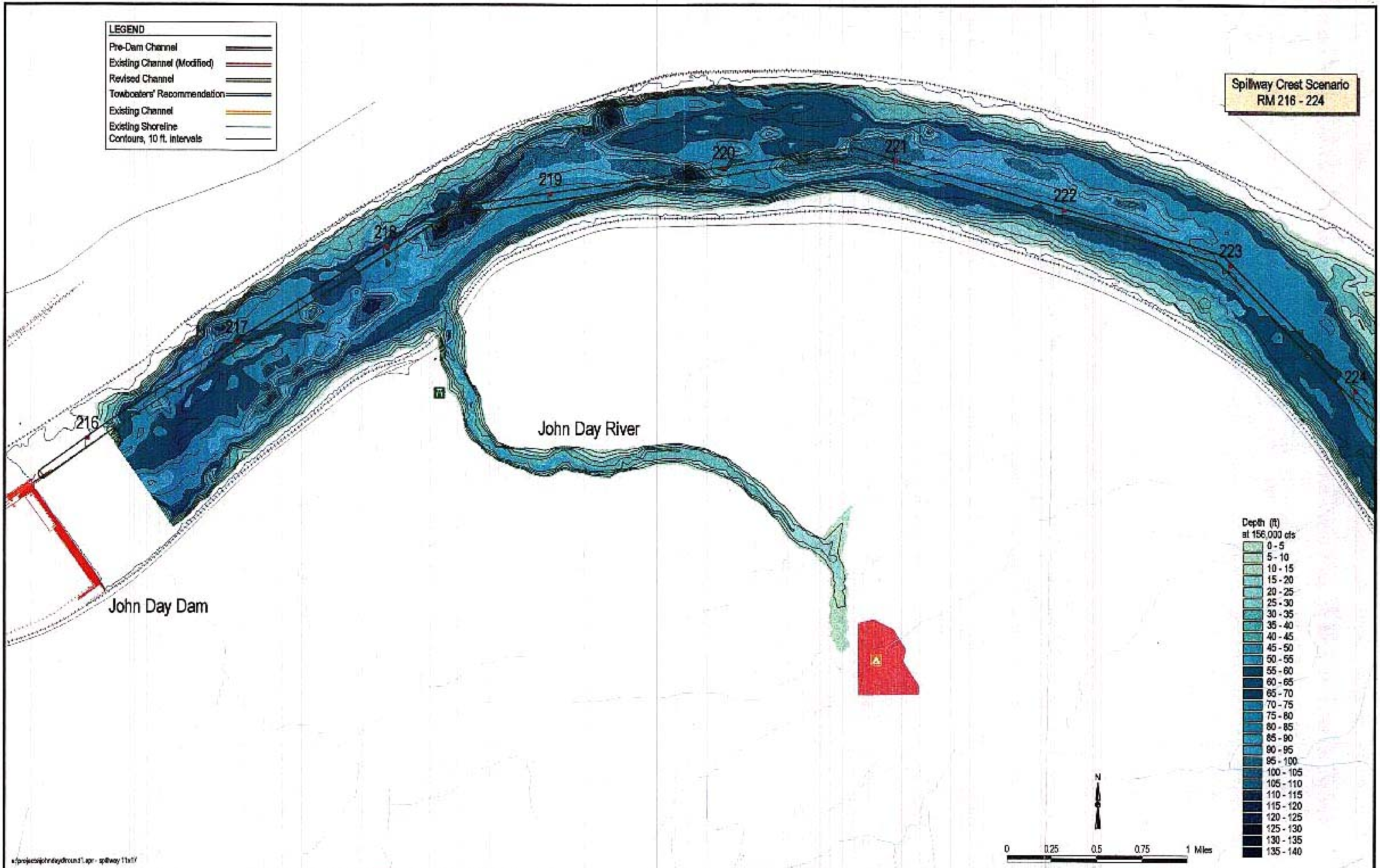

Natural River Profiles
River Bed
Channel Bottom
Water Surface at 80,000 cfs
Areas of Dredging Along Centerline
Revised Channel
Arlington
Roosevelt
Boardman Park & Marina
Port of Morrow
Hogue-Warner Elevator
Irrigon Marina
Umatilla Park & Marina
Elevation
250.8
234.9
209.9
184.9
159.9
134.9
109.9
84.9
Distance
John Day Dam
McNary Dam
Approximate River Mile
216
221
226
231
236
241
246
251
256
261
266
271
276
281
286
Towboaters' Recommendation

Appendix F

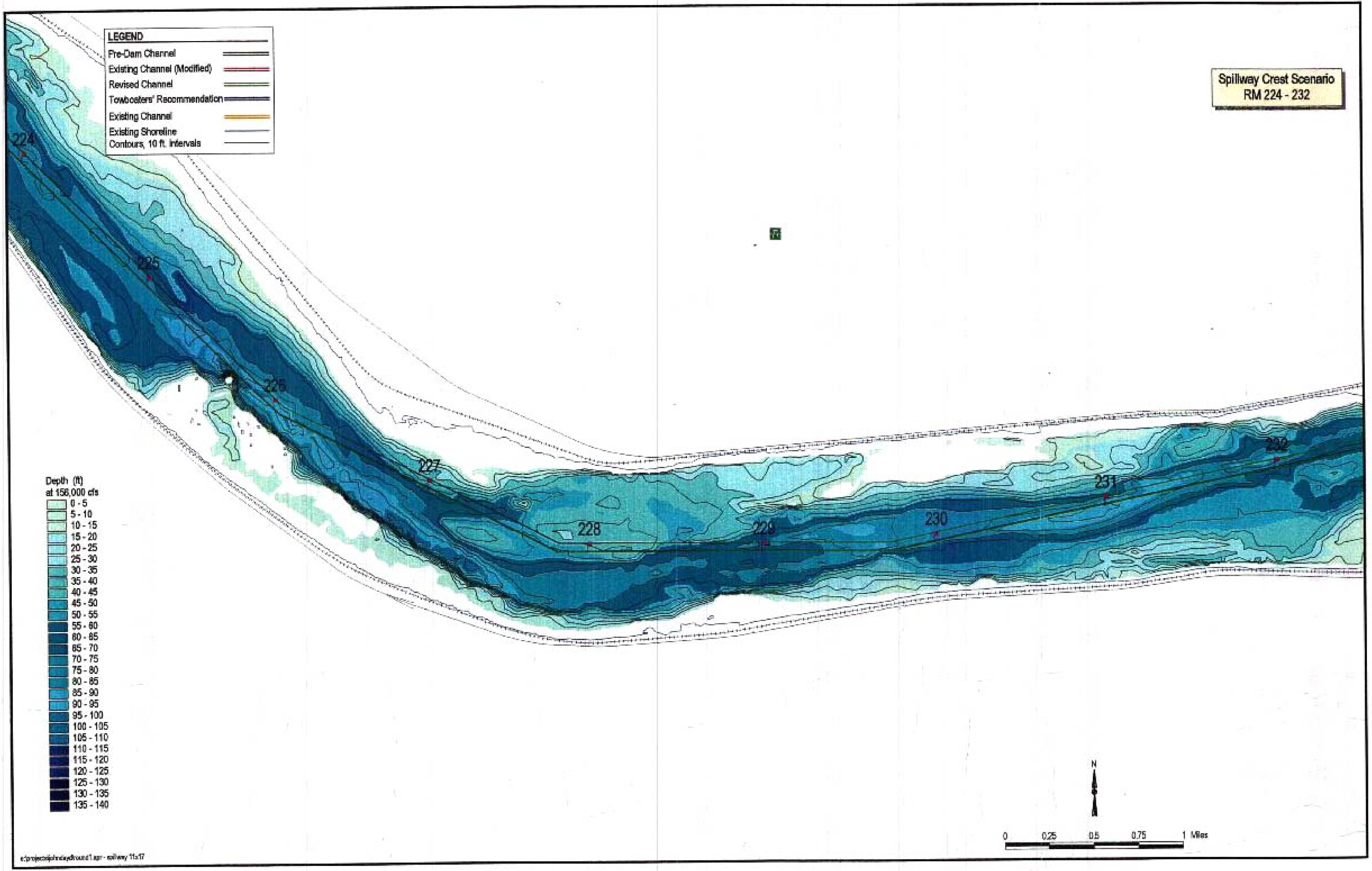
Channel Designs – Spillway Drawdown

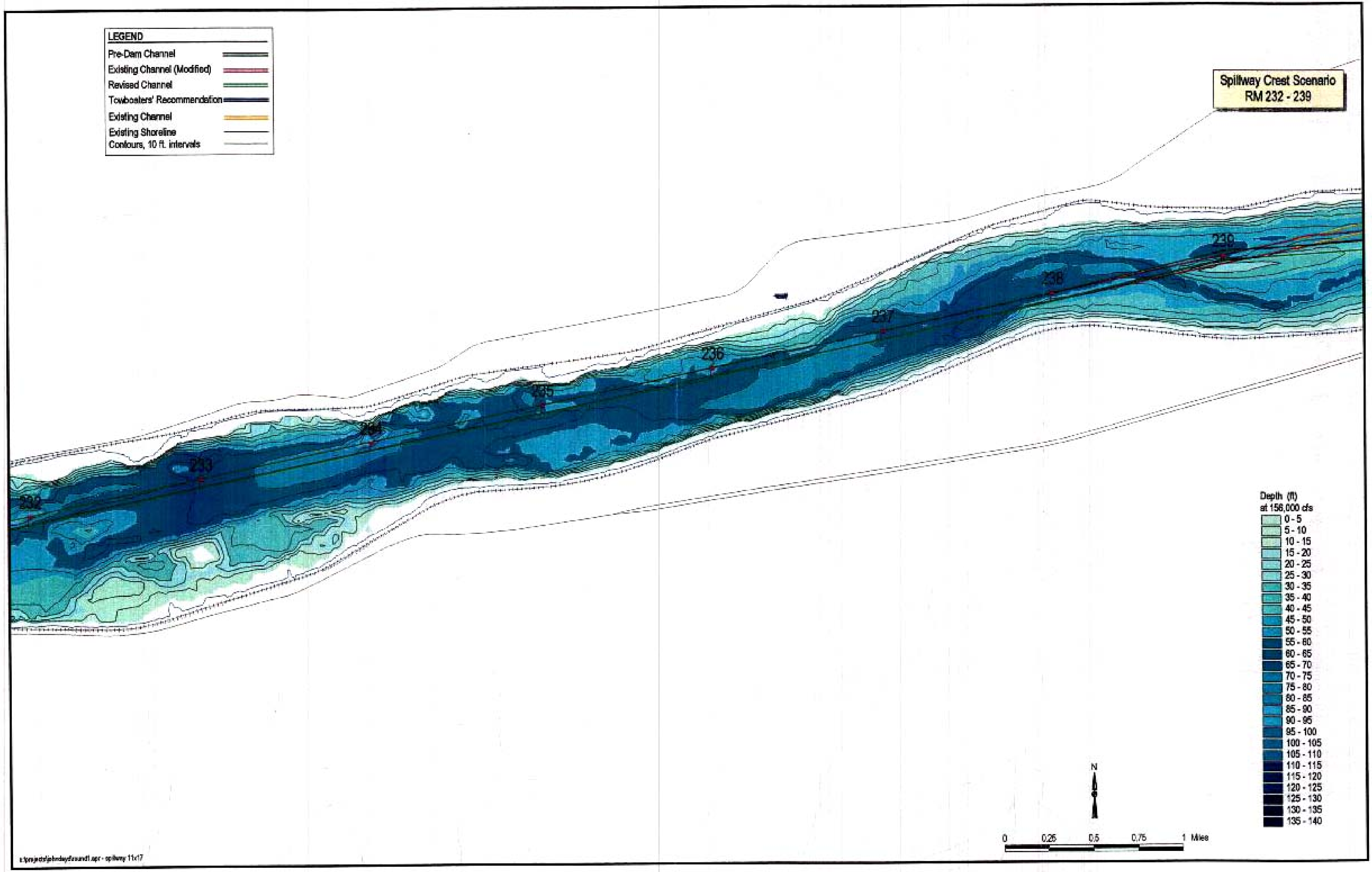
APPENDIX F Channel Designs – Spillway Drawdown

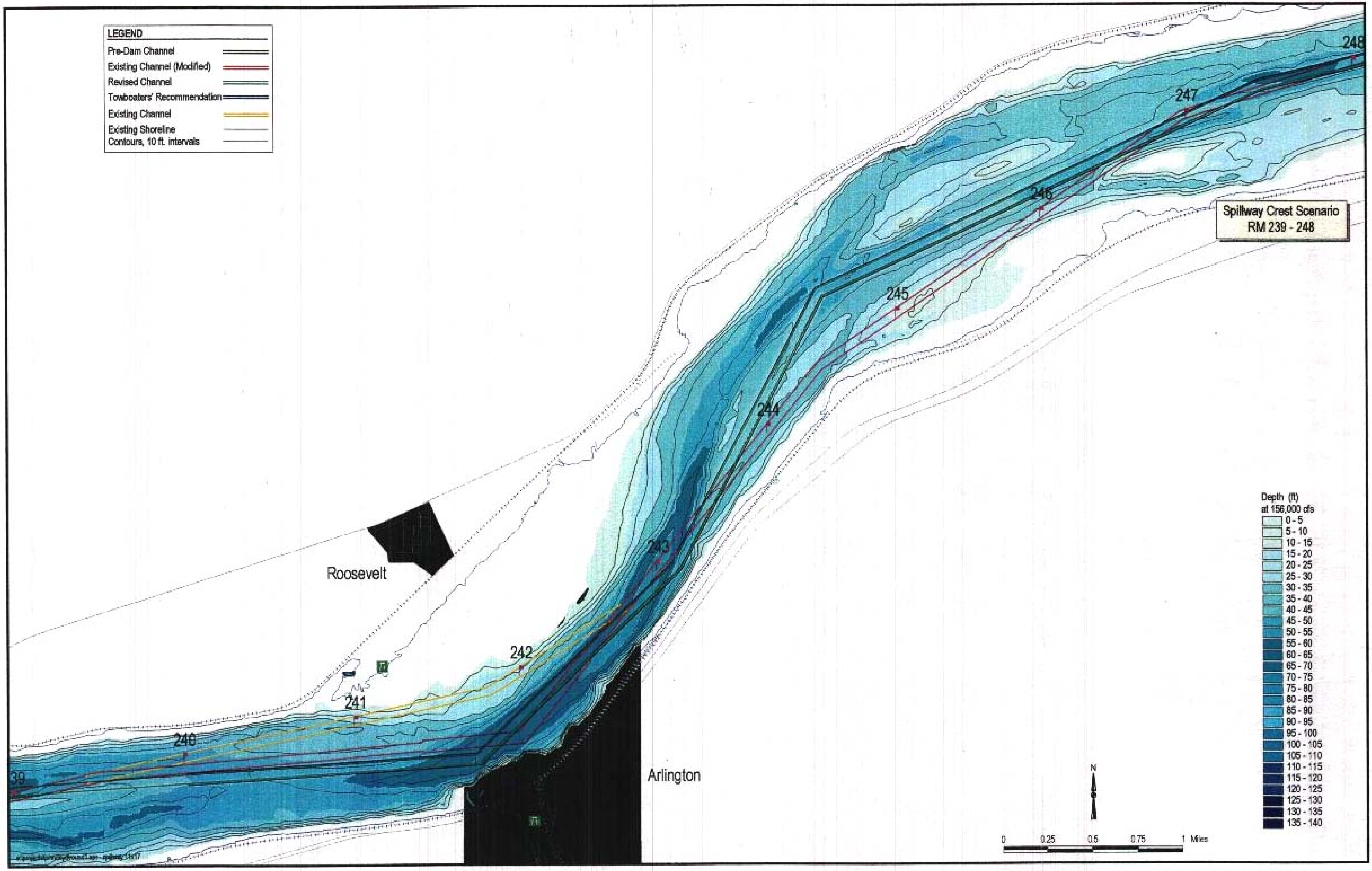
List of Plates

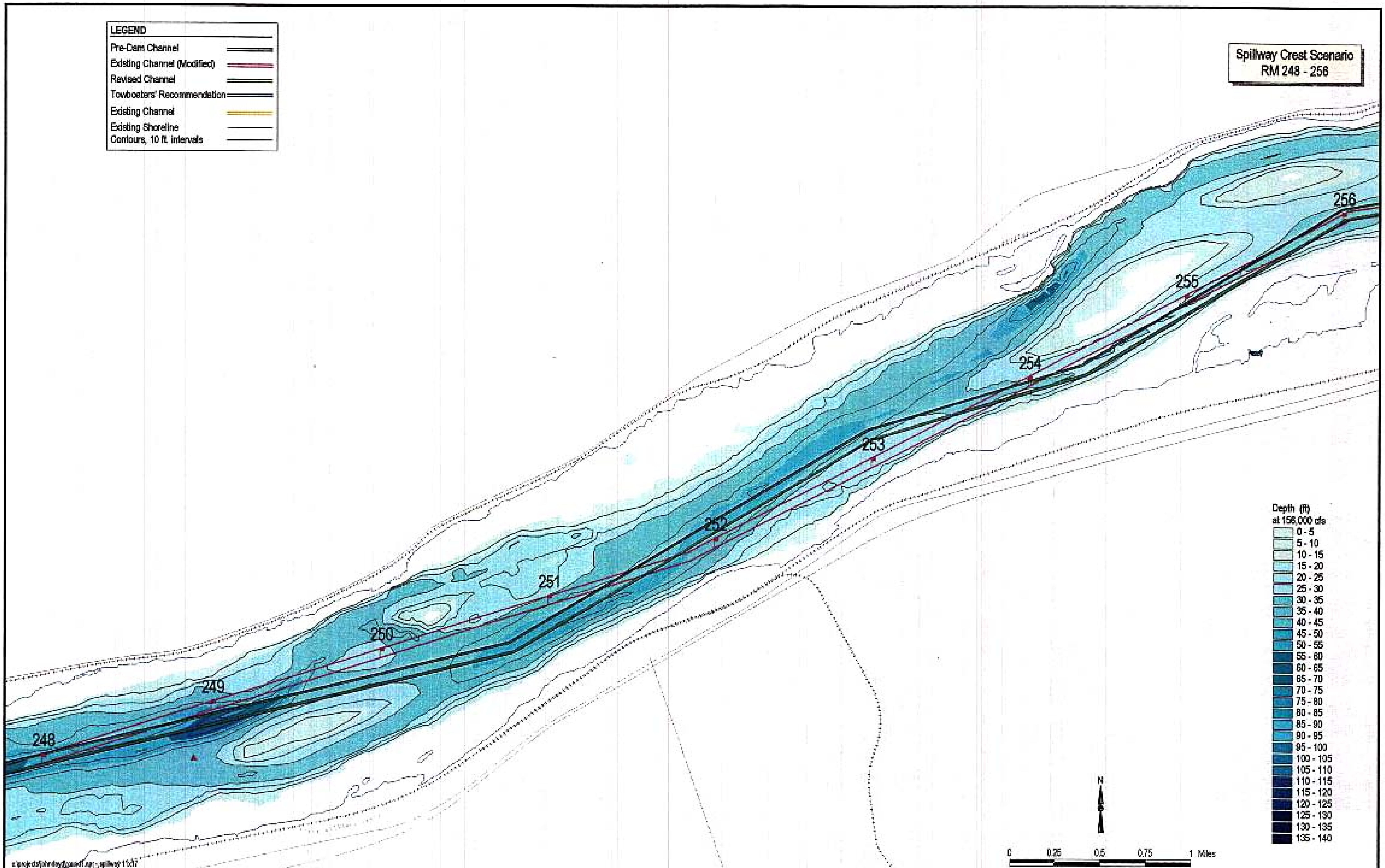


LEGEND
Pre-Dam Channel
Existing Channel (Modified)
Revised Channel
Towboaters' Recommendation
Existing Channel
Existing Shoreline
Contours, 10 ft. intervals
Spillway Crest Scenario
RM 216 - 224
216
217
218
219
220
221
222
223
224
John Day River
John Day Dam
Depth (ft)
at 156,000 cfs
0 - 5
5 - 10
10 - 15
15 - 20
20 - 25
25 - 30
30 - 35
35 - 40
40 - 45
45 - 50
50 - 55
55 - 60
60 - 65
65 - 70
70 - 75
75 - 80
80 - 85
85 - 90
90 - 95
95 - 100
100 - 105
105 - 110
110 - 115
115 - 120
120 - 125
125 - 130
130 - 135
135 - 140
N
0
0.25
0.5
0.75
1 Miles

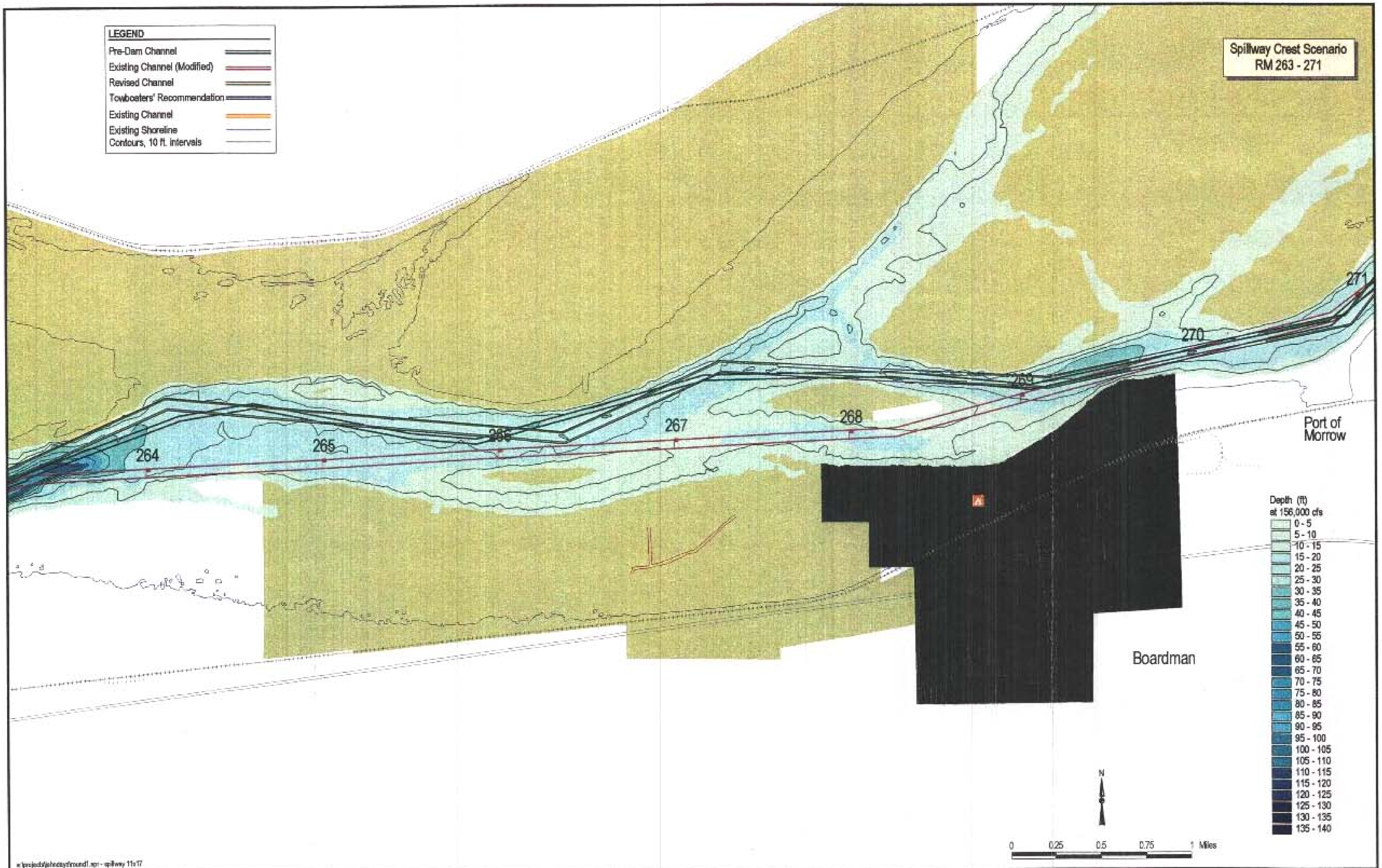

LEGEND
Pre-Dam Channel
Existing Channel (Modified)
Revised Channel
Towboaters' Recommendation
Existing Channel
Existing Shoreline
Contours, 10 ft. intervals
Spillway Crest Scenario
RM 224 - 232
224
225
226
227
228
229
230
231
232
Depth (ft)
at 156,000 cfs
0 - 5
5 - 10
10 - 15
15 - 20
20 - 25
25 - 30
30 - 35
35 - 40
40 - 45
45 - 50
50 - 55
55 - 60
60 - 65
65 - 70
70 - 75
75 - 80
80 - 85
85 - 90
90 - 95
95 - 100
100 - 105
105 - 110
110 - 115
115 - 120
120 - 125
125 - 130
130 - 135
135 - 140
N
0
0.25
0.5
0.75
1 Miles
e:\projects\johnday\round1.apr - spillway 11x17

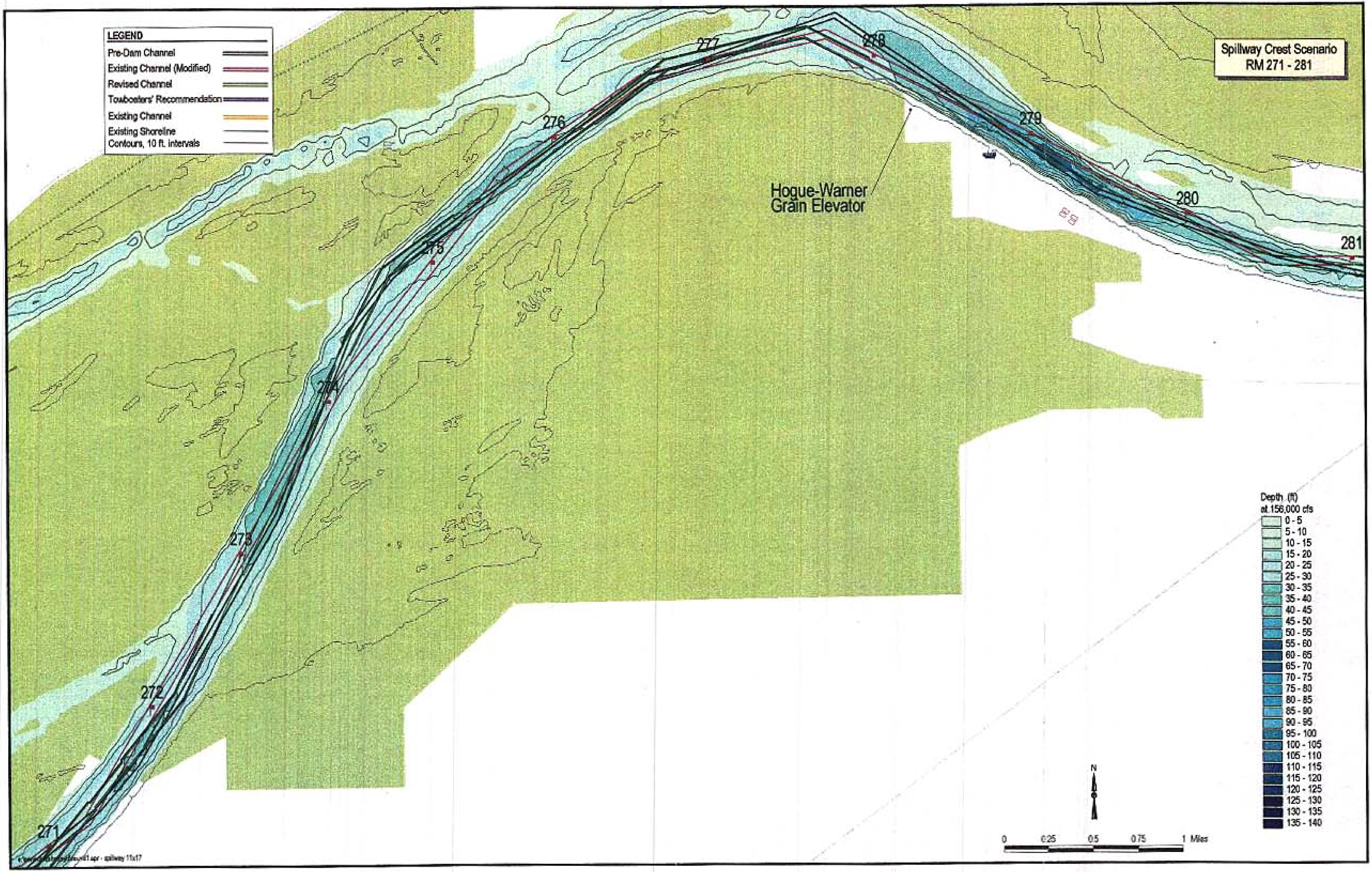

LEGEND
Pre-Dam Channel
Existing Channel (Modified)
Revised Channel
Towboaters' Recommendation
Existing Channel
Existing Shoreline
Contours, 10 ft. intervals
Spillway Crest Scenario
RM 232 - 239
232
233
234
235
236
237
238
239
Depth (ft)
at 156,000 cfs
0 - 5
5 - 10
10 - 15
15 - 20
20 - 25
25 - 30
30 - 35
35 - 40
40 - 45
45 - 50
50 - 55
55 - 60
60 - 65
65 - 70
70 - 75
75 - 80
80 - 85
85 - 90
90 - 95
95 - 100
100 - 105
105 - 110
110 - 115
115 - 120
120 - 125
125 - 130
130 - 135
135 - 140
N
0
0.25
0.5
0.75
1 Miles

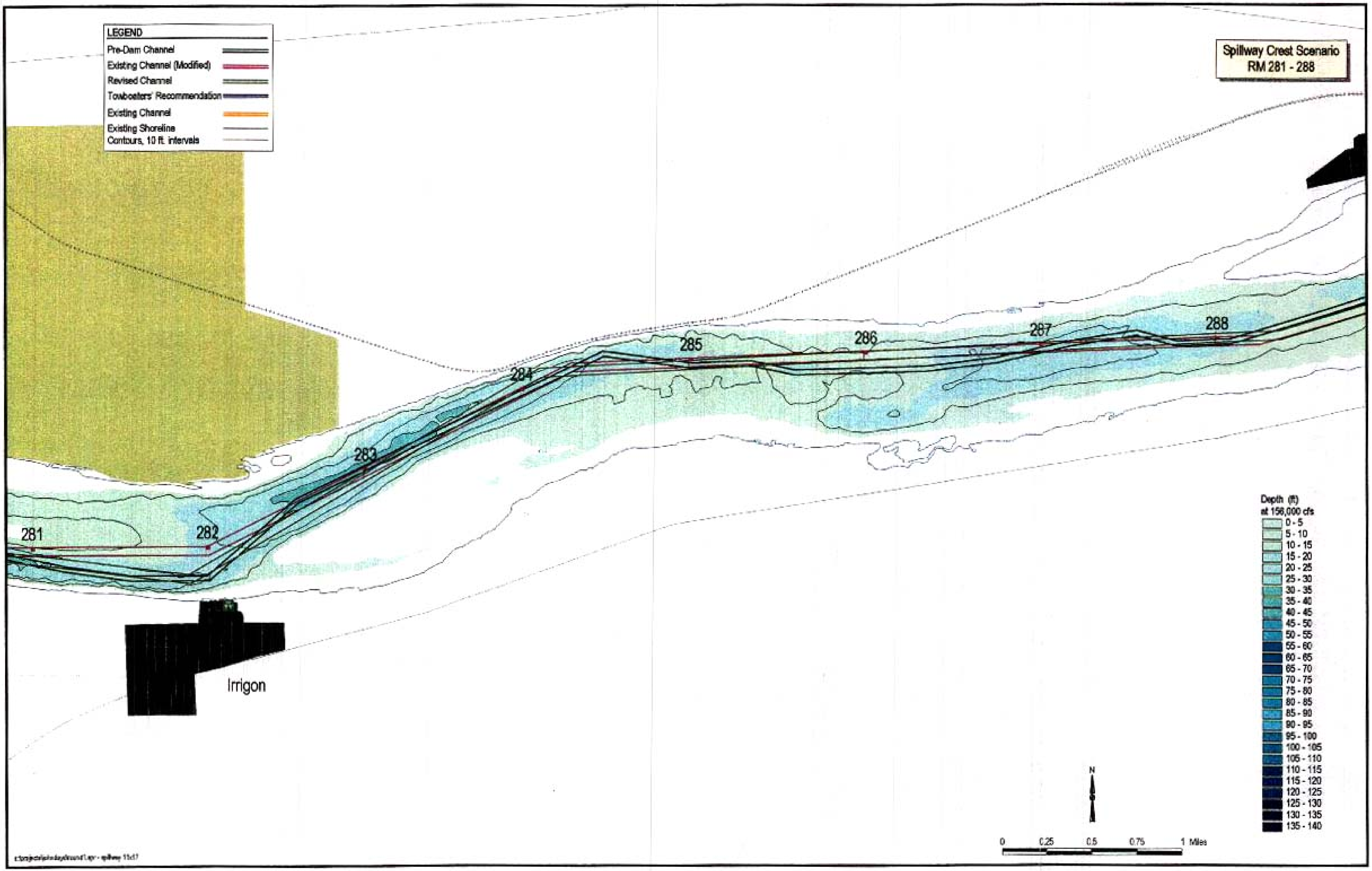

LEGEND
Pre-Dam Channel
Existing Channel (Modified)
Revised Channel
Towboaters' Recommendation
Existing Channel
Existing Shoreline
Contours, 10 ft. intervals
Spillway Crest Scenario
RM 239 - 248
Roosevelt
Arlington
240
241
242
243
244
245
246
247
248
Depth (ft)
at 156,000 cfs
0 - 5
5 - 10
10 - 15
15 - 20
20 - 25
25 - 30
30 - 35
35 - 40
40 - 45
45 - 50
50 - 55
55 - 60
60 - 65
65 - 70
70 - 75
75 - 80
80 - 85
85 - 90
90 - 95
95 - 100
100 - 105
105 - 110
110 - 115
115 - 120
120 - 125
125 - 130
130 - 135
135 - 140
N
0 0.25 0.5 0.75 1 Miles


LEGEND
Pre-Dam Channel
Existing Channel (Modified)
Revised Channel
Towboaters' Recommendation
Existing Channel
Existing Shoreline
Contours, 10 ft. intervals
Spillway Crest Scenario
RM 248 - 256
248
249
250
251
252
253
254
255
256
Depth (ft)
at 156,000 cfs
0 - 5
5 - 10
10 - 15
15 - 20
20 - 25
25 - 30
30 - 35
35 - 40
40 - 45
45 - 50
50 - 55
55 - 60
60 - 65
65 - 70
70 - 75
75 - 80
80 - 85
85 - 90
90 - 95
95 - 100
100 - 105
105 - 110
110 - 115
115 - 120
120 - 125
125 - 130
130 - 135
135 - 140
N
0 0.25 0.5 0.75 1 Miles

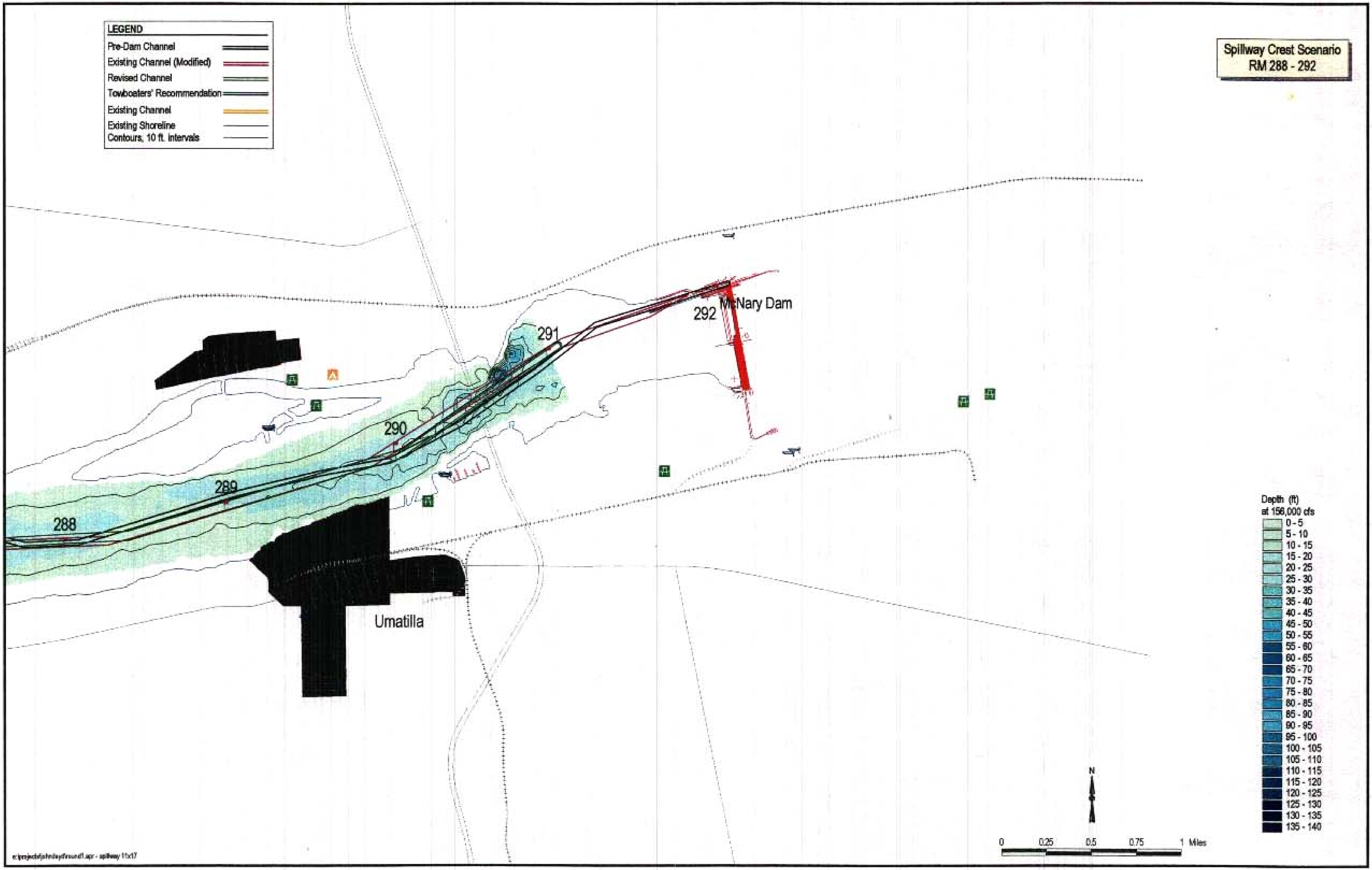
LEGEND
Pre-Dam Channel
Existing Channel (Modified)
Revised Channel
Towboaters' Recommendation
Existing Channel
Existing Shoreline
Contours, 10 ft. intervals
Spillway Crest Scenario
RM 256 - 263
256
257
258
259
260
261
262
263
Depth (ft)
at 156,000 cfs
0 - 5
5 - 10
10 - 15
15 - 20
20 - 25
25 - 30
30 - 35
35 - 40
40 - 45
45 - 50
50 - 55
55 - 60
60 - 65
65 - 70
70 - 75
75 - 80
80 - 85
85 - 90
90 - 95
95 - 100
100 - 105
105 - 110
110 - 115
115 - 120
120 - 125
125 - 130
130 - 135
135 - 140
N
0
0.25
0.5
0.75
1 Miles


LEGEND
Pre-Dam Channel
Existing Channel (Modified)
Revised Channel
Towboaters' Recommendation
Existing Channel
Existing Shoreline
Contours, 10 ft. intervals
Spillway Crest Scenario
RM 263 - 271
264
265
266
267
268
269
270
271
Port of
Morrow
Boardman
Depth (ft)
at 156,000 cfs
0 - 5
5 - 10
10 - 15
15 - 20
20 - 25
25 - 30
30 - 35
35 - 40
40 - 45
45 - 50
50 - 55
55 - 60
60 - 65
65 - 70
70 - 75
75 - 80
80 - 85
85 - 90
90 - 95
95 - 100
100 - 105
105 - 110
110 - 115
115 - 120
120 - 125
125 - 130
130 - 135
135 - 140
N
0
0.25
0.5
0.75
1 Miles

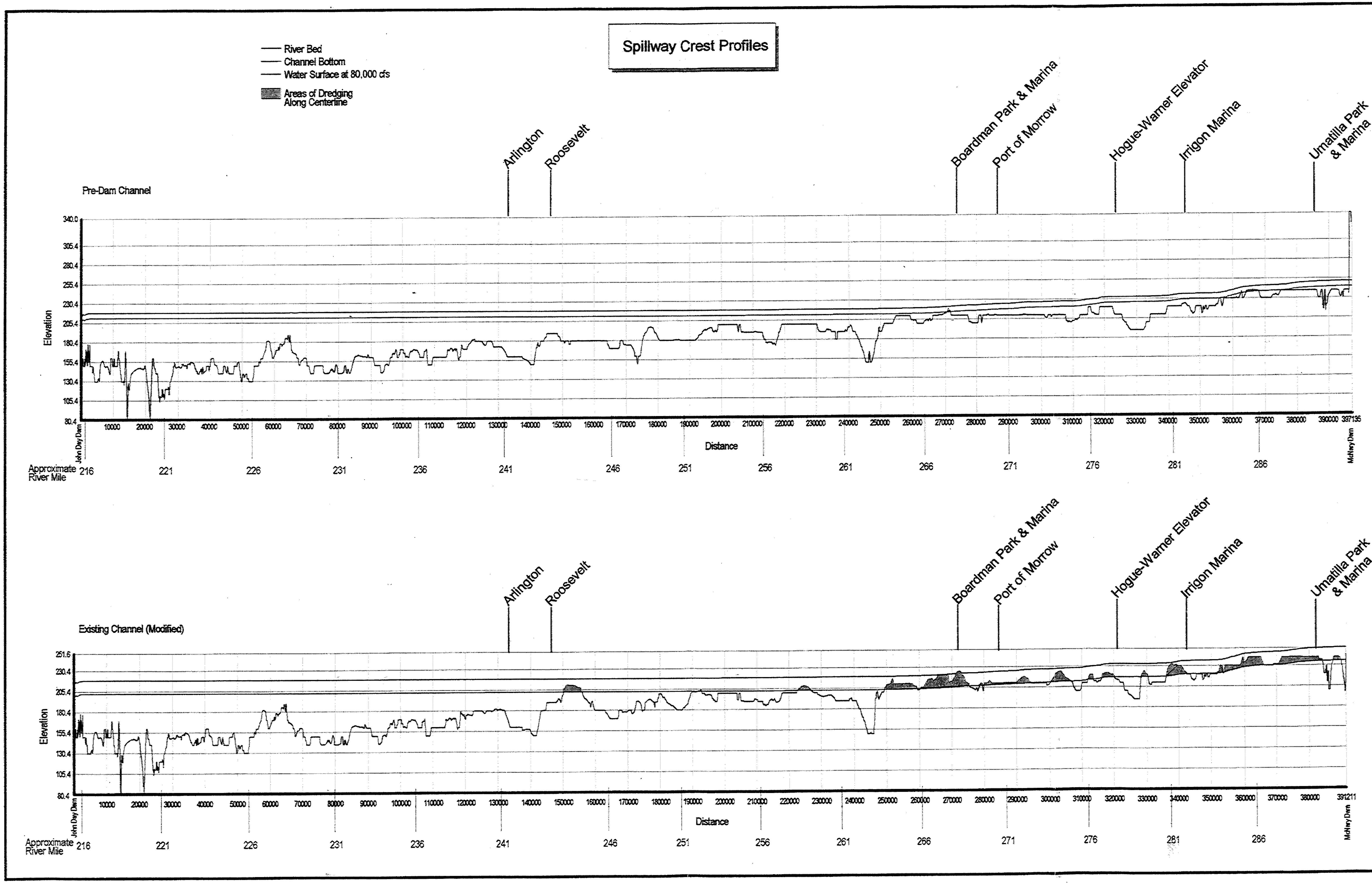

LEGEND
Pre-Dam Channel
Existing Channel (Modified)
Revised Channel
Towboaters' Recommendation
Existing Channel
Existing Shoreline
Contours, 10 ft. intervals
Spillway Crest Scenario
RM 271 - 281
271
272
273
274
275
276
277
278
279
280
281
Hogue-Warner
Grain Elevator
Depth (ft)
at 156,000 cfs
0 - 5
5 - 10
10 - 15
15 - 20
20 - 25
25 - 30
30 - 35
35 - 40
40 - 45
45 - 50
50 - 55
55 - 60
60 - 65
65 - 70
70 - 75
75 - 80
80 - 85
85 - 90
90 - 95
95 - 100
100 - 105
105 - 110
110 - 115
115 - 120
120 - 125
125 - 130
130 - 135
135 - 140
N
0
0.25
0.5
0.75
1 Miles



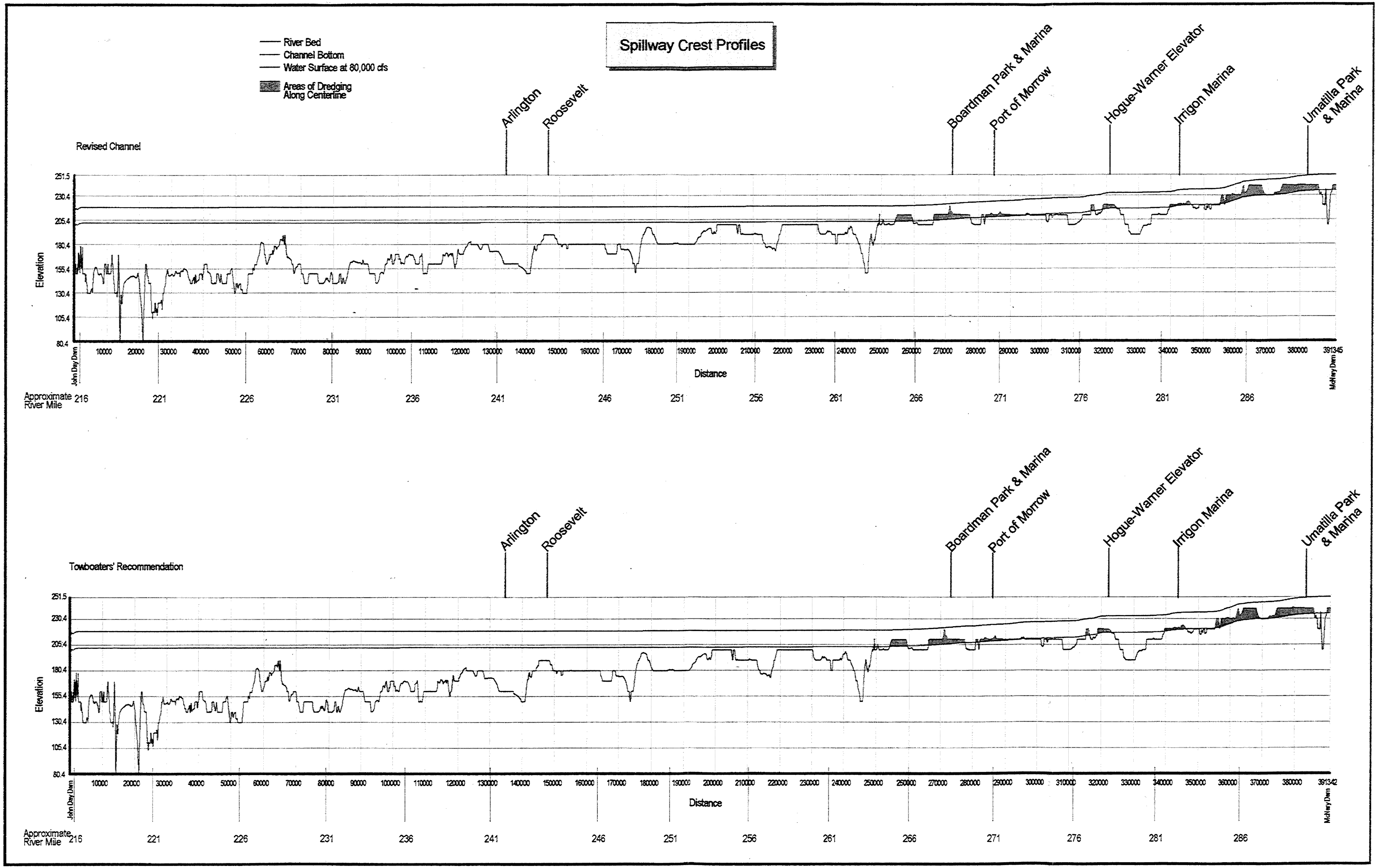
LEGEND
Pre-Dam Channel
Existing Channel (Modified)
Revised Channel
Towboaters' Recommendation
Existing Channel
Existing Shoreline
Contours, 10 ft. intervals
Spillway Crest Scenario
RM 281 - 288
281
282
283
284
285
286
287
288
Irrigon
Depth (ft)
at 156,000 cfs
0 - 5
5 - 10
10 - 15
15 - 20
20 - 25
25 - 30
30 - 35
35 - 40
40 - 45
45 - 50
50 - 55
55 - 60
60 - 65
65 - 70
70 - 75
75 - 80
80 - 85
85 - 90
90 - 95
95 - 100
100 - 105
105 - 110
110 - 115
115 - 120
120 - 125
125 - 130
130 - 135
135 - 140
N
0 0.25 0.5 0.75 1 Miles



LEGEND
Pre-Dam Channel
Existing Channel (Modified)
Revised Channel
Towboaters' Recommendation
Existing Channel
Existing Shoreline
Contours, 10 ft. intervals
Spillway Crest Scenario
RM 288 - 292
288
289
290
291
292
McNary Dam
Umatilla
Depth (ft)
at 156,000 cfs
0 - 5
5 - 10
10 - 15
15 - 20
20 - 25
25 - 30
30 - 35
35 - 40
40 - 45
45 - 50
50 - 55
55 - 60
60 - 65
65 - 70
70 - 75
75 - 80
80 - 85
85 - 90
90 - 95
95 - 100
100 - 105
105 - 110
110 - 115
115 - 120
120 - 125
125 - 130
130 - 135
135 - 140
N
0
0.25
0.5
0.75
1 Miles



Spillway Crest Profiles
River Bed
Channel Bottom
Water Surface at 80,000 cfs
Areas of Dredging Along Centerline
Pre-Dam Channel
Existing Channel (Modified)
Arlington
Roosevelt
Boardman Park & Marina
Port of Morrow
Hogue-Warner Elevator
Irrigon Marina
Umatilla Park & Marina
Elevation
Distance
John Day Dam
McNary Dam
Approximate River Mile
216
221
226
231
236
241
246
251
256
261
266
271
276
281
286
340.0
305.4
280.4
255.4
230.4
205.4
180.4
155.4
130.4
105.4
80.4
251.6
397135
391211



Spillway Crest Profiles
River Bed
Channel Bottom
Water Surface at 80,000 cfs
Areas of Dredging Along Centerline
Revised Channel
Arlington
Roosevelt
Boardman Park & Marina
Port of Morrow
Hogue-Warner Elevator
Irrigon Marina
Umatilla Park & Marina
Elevation
251.5
230.4
205.4
180.4
155.4
130.4
105.4
80.4
John Day Dam
McNary Dam
Distance
391345
Approximate River Mile
216
221
226
231
236
241
246
251
256
261
266
271
276
281
286
Towboaters' Recommendation
Arlington
Roosevelt
Boardman Park & Marina
Port of Morrow
Hogue-Warner Elevator
Irrigon Marina
Umatilla Park & Marina
Elevation
Distance
391342
Approximate River Mile

Appendix G

Miscellaneous Data from Previous Studies

John Day Drawdown - Phase I Study
Modal Shift Impacts and General Columbia River Statistics

Barge/Rail/Truck Comparison	**Source 1**	**Source 2**	**Source 3**	
Transport distance, 1 ton commodity, 1 gallon fuel				
Barge:	514	514		miles
Rail car:	202	202		miles
Truck:	59.2	59		miles
Yearly traffic if barges removed				
Barge:	0	0	0	
Rail cars:	+150,000	+120,000	+300,000	
Trucks:	+900,000	+700,000		
Number of units required to equal one barge load				
Barge:	1			
Rail cars:	35	37.5	35	
Trucks:	166	150	116	
Cost per bushel of grain from Lewiston to Portland				
Barge:	$0.19			
Rail car:	$0.38			
Truck:	$0.54			
Hydrocarbon emissions ratios				
Barge:		1		
Rail car:		5		
Truck:		7.14		
Carbon monoxide emissions				
Barge:		1		
Rail car:		3.2		relative mass of pollutant emitted
Truck:		9.1		
Nitrous oxide emissions				
Barge:		1		
Rail car:		3.4		
Truck:		20		
Percent of total volume of wheat transported by:				
Barge:			55	
Rail car:			40	
Truck:			5	
Columbia & Snake River Statistics				
Towboat industry employment:	600			
Towboat fleet:	45			
Barge fleet:	175			
Volume transported annually				
Grain:	6	5.7		million tons
Petroleum:	500			million gallons
Forest products:	3	1.8		million tons
Vegetables:	52,000			tons
Containers:	50,000			
Fertilizer:	400,000			tons
Salmon fry:	20			million tons
Number of ports:		36		
% of US export of wheat from here:		40%		
Value of yearly cargo:		$2.2		billion
Portland/Lewiston jobs influenced:		51,000		
Business revenues earned:		$723		million
Paid in local taxes:		$48		million

Source 1 - Pamphlet published by Port of Morrow
Source 2 - Pamphlet published by Columbia/Snake River Marketing Group
Source 3 - Report issued by Pacific Northwest Grain & Feed Association