SECTION 7: RECOMMENDED PLAN

7.1 CONSTRUCTED IMPROVEMENT

Recommended improvements are discussed by basins in the following subsections. Figure 7.1 and 7.2 show improvement locations, general line sizing, and project numbers. Project sizing is based on flows associated with the 25 year, 24 hour storm event for projected future conditions unless otherwise stated. Project prioritization is discussed in general and relative terms. Opinions of probable cost are also included.

Design, layout, quantities, and costs presented here are preliminary; projects will be refined as engineering design proceeds. Engineering design typically includes detailed survey work (including subsurface utilities), precise locations of catch basins and lines, verification of hydraulic adequacy for the designed slope and materials selected; as well as preparation of detailed materials lists and costs, and detailed bid documents.

7.1.1 Basin C1

Project #1: replace existing 30" culvert across Dichter Drive with new 36" culvert. Pipe material needs to be smooth bore, not corrugated, to provide adequate hydraulics. Sizing is based on 50-year event (92.1 cfs) for future conditions. The project has low priority; however, it should be incorporated into any future plan for improving Dichter Drive.

Table 7.1: Project #1 Opinion of Probable Cost
" No Name" Creek Culvert on Dichter Drive - Basin C1

Item	Quantity	Unit	Unit Cost	Extension
36" Storm Drain Piping	50	LF	$110	$5,500
Headwall (Concrete)	2	LS	$6,000	$12,000
Outfall Rip Rap	1	LS	$1,000	$1,000
Construction Subtotal				**$18,500**
Contingencies				$1,850
Engineering				$3,700
Legal and Administration				$925
Permitting and Easements (allowance)				$4,000
Project Total				**$28,975**

Project #2: replace existing 12" culvert (P4) near south end of Pennsylvania Avenue with new 12" culvert. The project is low priority; however, it should be incorporated with plans for development of the corner lot, street improvements, or development of area immediately south and tributary to it. The discharge is currently in a wet, brushy area: development of the lot may require construction of a drain way to maintain flow to P3.

Table 7.2: Project #2 Opinion of Probable Cost
Replacement of Existing Pipe P4 - Basin C1

Item	Quantity	Unit	Unit Cost	Extension

12" Storm Drain Piping	50	LF	$40	$2,000
Misc. Resurfacing and Ditching	1	LS	$1,500	$1,500
Construction Subtotal				**$3,500**
Contingencies				$350
Engineering				$700
Legal and Administration				$175
Permitting and Easements (allowance)				$4,000
Project Total				**$8,725**

7.1.2 Basin V2

Project #3: replace and upgrade storm drainage along Pennsylvania Avenue. Project sizing is: 12" from N3 to south, 12" from N3 to N9, and 15" from N3 north to Highway 101. Sizing is based on 5.5 cfs capacity at the terminus. Some ditch excavation will be needed to direct discharged flow east along the highway ROW toward the wetlands associated with Vosburg Creek. The project is medium priority based on current system performance. Currently, water tends to sheet down the roadway or wash gravel across the roadway surface. The sections downstream of N2 are the most critical because of known (small) pipe diameters, questions regarding the condition (or even existence) of some of the pipes, and the apparent plug in the line at N8.

Table 7.3: Project #3 Opinion of Probable Cost
Pennsylvania Avenue Improvements - Basin V2

Item	Quantity	Unit	Unit Cost	Extension
12" Storm Drain Piping	500	LF	$40	$20,000
15" Storm Drain Piping	380	LF	$50	$19,000
Catch Basin	11	EA	$1,100	$12,100
Outfall Rip Rap	1	LS	$300	$300
Misc. Resurfacing and Ditching	1	LS	$10,000	$10,000
Construction Subtotal				**$61,400**
Contingencies				$6,140

Engineering	$12,280
Legal and Administration	$3,070
Project Total	**$82,890**

7.1.3 Basin V3

Project #4: replace storm drainage across DuBois Street. P10 is replaced with an 21" line and P9 is replaced with a 30" line. Sizing of the 30" line is based on a capacity of 39.3 cfs (flow from V5, V6, and one-half of V3). Pipe material needs to be smooth bore to provide adequate hydraulics. Priority is currently low; however, improvements to DuBois Street should include the project. The lines are currently 3/4 filled in with accumulated sediment. Clearing the lines alone will provide considerable capacity for growth in Basins V3, V5, and V6.

Table 7.4: Project #4 Opinion of Probable Cost
DuBois Street P9 and P10 replacement - Basin V3

Item	Quantity	Unit	Unit Cost	Extension
21" Storm Drain Piping	20	LF	$60	$1,200
30" Storm Drain Piping	80	LF	$85	$6,800
Outfall Rip Rap	1	LS	$400	$400
Misc. Resurfacing and Ditching	1	LS	$1,500	$1,500
Construction Subtotal				**$9,900**
Contingencies				$990
Engineering				$1,980
Legal and Administration				$495
Project Total				**$13,365**

Project #5: replace storm drainage across DuBois Street. P8 is replaced with a 24" line. Sizing is based on a capacity of 16.2 cfs (V6 plus one-half of V3).Priority is low; the project should be included in any improvements to Du Bois Street.

Table 7.5: Project #5 Opinion of Probable Cost
DuBois Street P8 replacement - Basin V3

Item	Quantity	Unit	Unit Cost	Extension
24" Storm Drain Piping	70	LF	$65	$4,550
Outfall Rip Rap	1	LS	$400	$400
Misc. Resurfacing and Ditching	1	LS	$1,500	$1,500
Construction Subtotal				**$6,450**
Contingencies				$645
Engineering				$1,290
Legal and Administration				$323
Project Total				**$8,708**

7.1.4 Basin V5

Project #7: install new culvert on 3rd Street between Rowe Street and Vosburg Street. Runoff currently washes across the roadway surface causing erosion and creating potholes. Priority is medium; however, low cost and ease of construction suggests it be considered as a near-term improvement to minimize maintenance needs.

Table 7.6: Project #7 Opinion of Probable Cost
3rd Street culvert - Basin V5

Item	Quantity	Unit	Unit Cost	Extension
12" Storm Drain Piping	40	LF	$40	$1,600
Misc. Resurfacing and Ditching	1	LS	$500	$500
Construction Subtotal				**$2,100**
Contingencies				$210
Engineering				$420
Legal and Administration				$105
Project Total				**$2,835**

7.1.5 Basin V6

Project #6: install culvert on 4th Street, south of Vosburg Street. Sizing is based on a capacity of 5.7 cfs. Runoff currently washes across roadway creating mud and potholes. The area is currently undeveloped and 4th St., in this area, is more of a dirt track than a developed roadway. Priority is currently low; however, the project should be included with road improvements on 4th Street.

Table 7.7: Project #6 Opinion of Probable Cost
4th Street culvert - Basin V6

Item	Quantity	Unit	Unit Cost	Extension
15" Storm Drain Piping	40	LF	$50	$2,000
Misc. Resurfacing and Ditching	1	LS	$500	$500
Construction Subtotal				**$2,500**
Contingencies				$250
Engineering				$500
Legal and Administration				$125
Permitting and Easements (allowance)				$4,000
Project Total				**$7,375**

7.1.6 Basin N1

Project #8: new storm drain on Rowe Street between 2nd Street and Hospital Road. Rowe Street is steep and highly eroded. The City is planning a street improvement and should incorporate the recommended improvements. The project includes ditch and culverts on the north-east side of Rowe Street and intakes and pipe on the southwest side of Rowe Street. Flow from the northeast side of Rowe will be directed to the southwest side, near Hospital Road. Discharge is to Basin N1. The project is high priority.

Table 7.8: Project #8 Opinion of Probable Cost
Rowe Street improvements - Basin N1

Item	Quantity	Unit	Unit Cost	Extension
12" Storm Drain Piping	380	LF	$40	$15,200
Catch Basin	4	EA	$1,100	$4,400
Outfall Rip Rap	1	LS	$300	$300
Misc. Resurfacing and Ditching	1	LS	$3,000	$3,000
Construction Subtotal				**$22,900**
Contingencies				$2,290
Engineering				$4,580
Legal and Administration				$1,145
Project Total				**$30,915**

7.1.7 Basin N3

Project #11: storm drain improvements along Highway 101. Project includes intakes and 15" pipeline along the south side of Highway 101 from Hospital Road to N7 on the northwest side of Hall St. Sizing is based on 10.1 cfs at the terminus. Project is currently low priority but may be needed as tributary properties on either side of Hospital Road are developed.

Table 7.9: Project #11 Opinion of Probable Cost
Highway 101 drainage improvements - Basin N3

Item	Quantity	Unit	Unit Cost	Extension
15" Storm Drain Piping	250	LF	$50	$12,500
Catch Basin	4	EA	$1,100	$4,400
Misc. Resurfacing	1	LS	$5,000	$5,000
Construction Subtotal				**$21,900**
Contingencies				$2,190
Engineering				$2,190
Legal and Administration				$4,380
Permitting and Easements (allowance)				$2,000
Project Total				**$32,660**

7.1.8 Basin N5

Project #19: cut ditch along "City" roadway. Basin N5 currently drains to and across Basin N4. According to locals, considerable water comes down the roadway and ponds on the flat area of Basin N4. The roadway is dirt/gravel and a ditch could be cut between it and the railroad ROW to direct surface water to intake N3. Approximately 500 LF of ditching is required. An opinion of probable cost for the project is $1,500. Because of the low cost and the continuing nature of the problem, the project is considered high priority and should be implemented soon. The project will not intercept flow off the west side of the roadway or off the adjacent private property.

7.1.9 Basin G1

Project #9: replace existing storm drainage on 3rd Street between Rowe Street and Hall Street with a new catch basin and 12" line. This project is being constructed as part of a current development project.

Project #10; replace 48" culvert on Gervais Creek at 3rd Street. A capacity of 177 cfs is needed to accommodate the 50-year flow event. The existing culvert (P2) is in extremely poor condition and needs to be replaced. 3rd Street at this location is a steep, rough, overgrown track that is accessed off Fir Street. Currently, water flows around the pipe as well as through it. The consequent erosion and undermining of the roadway will eventually lead to a washout of the roadway in the vicinity of the creek. An 8" City water line passes over the culvert within the roadway. The waterline is one of two that connect the northeast and southwest halves of the City and is therefore an essential component of the (overall) water system and its hydraulic capabilities. The project is very high priority and should be implemented as soon as possible.

Table 7.10: Project #10 Opinion of Probable Cost
Gervais Creek P2 culvert replacement - Basin G1

Item	Quantity	Unit	Unit Cost	Extension
48" Storm Drain Piping	50	LF	$250	$12,500
Headwall (Concrete)	2	LS	$8,000	$16,000
Outfall Rip Rap	1	LS	$1,000	$1,000

Misc. Resurfacing and Ditching	1	LS	$3,000	$3,000
Construction Subtotal				**$32,500**
Contingencies				$3,250
Engineering				$6,500
Legal and Administration				$1,625
Permitting and Easements (allowance)				$5,000
Project Total				**$48,875**

Project #13: Alder Street drainage improvements. Alder Street, between 3rd St. and 4th St., is a steep street that exhibits severe, water related damage that is attributable, at least is part, to new construction and extension of Alder Street southeast of 4th Street. Paving of the (newer) Alder Street terminates just north of 4th Street; water sheets off the pavement portions and has highly eroded the lower street. The project includes a 12" line to convey flows from both sides of Alder Street at 4th Street. The 12" line transitions to 15" at a juncture with P3. Resulting flow is to be directed down the 3rd Street ROW to Gervais Creek. The City plans on improving Alder Street soon; this storm drain project is considered high priority and should be included in the street improvement project.

Table 7.11: Project #13 Opinion of Probable Cost
Alder Street drainage improvements - Basin G1

Item	Quantity	Unit	Unit Cost	Extension
12" Storm Drain Piping	480	LF	$40	$19,200
15" Storm Drain Piping	50	LF	$50	$2,500
Catch Basin	4	EA	$1,100	$4,400
Outfall Rip Rap	1	LS	$300	$300
Misc. Resurfacing and Ditching	1	LS	$7,000	$7,000
Construction Subtotal				**$33,400**
Contingencies				$3,340
Engineering				$6,680
Legal and Administration				$1,670
Project Total				**$45,090**

7.1.10 Basin G2

Project #12: reroute Gervais Creek along Rorvic Street. The existing diversion of Gervais Creek via a 36" pipeline that passes under several buildings and the associated basement flooding are discussed in Section 2.6. Relocation of the creek has been considered by the City, but no coherent vision of what it will entail has been developed. The idea of "opening up" the creek has been suggested; this suggestion is incorporated in one of the alternatives developed below (Alternative 1).

Alternative 1 (see Figure 7.3 and Photo Plate 7.1) was developed to include sections of open creek and canals where practicable. Routing along the south side of Rorvik Street will only eliminate on-street parking (on the south side) and would maintain two-way traffic on Rorvik Street, The design would not impact downtown businesses or properties. Gervais Creek would be reconstructed for approximately 280 lineal feet upstream of a new intake located near 1st Street. The canal or channel sections are envisioned as rectangular concrete structures. An allowance is provided for landscape/architectural finishes and protective railing. A small bridge will maintain walkway access across Rorvik Street. The crossing on Highway 101 and the railway will be jacked rather than open cut. Open cutting would be considerably less expensive; however, ODOT does not, typically, allow for it on a highway. The outlet will be located in the wetlands/marsh adjacent to Nehalem Bay.

The 48" diameter of the pipeline segments are sized based on minimum hydraulic requirements. With a 9 foot flow differential, the design provides for the 50-year, 177 cfs event. Final design should consider tidal effects and surcharge capabilities at the inlet to assure hydraulic capabilities. If ODOT requires construction to incorporate fish passage, the diameter could increase substantially to accommodate bedding materials to simulate a natural stream. The pipeline, and channel sections, will be relatively deep (approximately 15 feet) to clear north-south sanitary sewer lines located on Highway 101 and at 1st Street, and to maintain the pipe slope out to Nehalem Bay. There is also a sanitary sewer, that runs along the improvement location on Rorvik Street, that will need to be relocated.

An opinion of probable cost for Alternative 1 is presented in Table 7.12.

Table 7.12: Project #12 Opinion of Probable Cost
Gervais Creek relocation, Alternative 1 - Basin G2

Item	Quantity	Unit	Unit Cost	Extension
12" Storm Drain Piping	50	LF	$40	$2,000
48" Storm Drain Piping	485	LF	$200	$97,000
Catch Basin	3	EA	$1,100	$3,300
Headwall (Concrete)	2	LS	$8,000	$16,000
Channel (Concrete)	215	CY	$600	$129,000
Pipe Jacking	140	LF	$1,000	$140,000
Sanitary Sewer Relocation	290	LF	$80	$23,200
Outfall Rip Rap	1	LS	$1,500	$1,500
Misc. Resurfacing and Ditching	1	LS	$25,000	$25,000
Protective Railings	370	LF	$35	$12,950
Bridge (walking - approx. 10 LF)	1	LS	$10,000	$10,000
Streambed Construction	280	LF	$200	$56,000
Misc. Landscaping	1	LS	$30,000	$30,000
Construction Subtotal				**$545,950**
Contingencies				$54,595
Engineering				$109,190
Legal and Administration				$27,298
Permitting and Easements (allowance)				$10,000
Project Total				**$747,033**

Alternative 2 (see Figure 7.4) is similar to Alternative 1 except there are no channels, only pipe. Since the 48" diameter pipe is fully covered and will not impact surface features, it is located further toward the center of the street to avoid sidewalks and utilities, thereby reducing construction costs.

An opinion of probable cost for Alternative 2 is presented in Table 7.13.

Table 7.13: Project #12 Opinion of Probable Cost
Gervais Creek relocation, Alternative 2 - Basin G2

Item	Quantity	Unit	Unit Cost	Extension
12" Storm Drain Piping	50	LF	$40	$2,000
48" Storm Drain Piping	485	LF	$200	$97,000
Catch Basin	3	EA	$1,100	$3,300
Headwall (Concrete)	2	LS	$8,000	$16,000
Pipe Jacking	140	LF	$1,000	$140,000
Sanitary Sewer Relocation	20	LF	$80	$1,600
Outfall Rip Rap	1	LS	$1,500	$1,500
Misc. Resurfacing and Ditching	1	LS	$10,000	$10,000
Streambed Construction	280	LF	$200	$56,000
Construction Subtotal				**$327,400**
Contingencies				$32,740
Engineering				$65,480
Legal and Administration				$16,370
Permitting and Easements (allowance)				$10,000
Project Total				**$451,990**

Both alternatives involve a long, deep, large diameter pipeline. The discharge end would be open and could be accessed by adventurous persons; this could be a liability issue for the City. The channel alternative also has potential hazard issues associated with the deep (15 foot) channels near the roadway.

While the channel alternative, with appropriate design and landscaping, could be an attractive design element in the downtown, the creek itself will more likely be heard rather than seen. A larger, wider canal is certainly possible; however, costs would increase considerably and Rorvik Street would probably be reduced to a one-way street. Rorvik Street, as a one-way street, would complicate downtown circulation patterns.

Both alternatives involve crossing a state highway and railway; work in a designated flood zone and wetlands; and work on a stream that may have, or have had, migrating species, including salmonids and endangered species. Permitting and regulatory coordination will likely be needed with: ODOT, Port of Tillamook Bay (railroad), Division of State Lands (DSL), Corps of Engineers, NOAA Fisheries, U.S. Fish and Wildlife, Oregon Department of Fish and Wildlife

(ODF&W), FEMA, and DEQ. As part of the process, ODF&W will evaluate Gervais Creek to determine what fish are, or were likely to have been, present and the evaluation will extend all the way upstream. The City maintains a diversion dam on Gervais Creek and also has water rights on the creek. The dam is a barrier to fish passage and, as such, it could be drawn into the overall permit process and negotiations. Agencies may request the City give up some portion, or all, of the water rights on Gervais Creek as a type of mitigation for the project. Provision of fish passage, in general, could significantly impact project cost.

Because of the complexity of the project, a predesign report (or preliminary engineering report) should be prepared prior to the final determination to proceed and application for funding assistance. The predesign report should include:

- General surveying and mapping of the desired route(s) including subsurface utilities. Review property ownership and easement requirements.
- Development of design parameters.
- Plan and profile sketches of proposed alternative(s).
- Begin initial discussion/negotiations will all regulatory agencies. likely to be involved. In particular, coordinate with ODF&W to obtain a determination from them on fish presence and passage requirements, and with ODOT. Also note other agency requirements. Summarize permitting requirements and costs.
- Revise plan and profile sketches to incorporate agency concerns and requirements.
- Develop a new Opinion of Probable Cost.
- Based on revised costs and project issues (such as provision of fish passage), discuss funding options, project eligibility, and the implementation process.

A budget allowance of $20,000 is reasonable based on the above described scope of work and the alternatives developed in this master plan. Development and exploration of other alternatives, if desired, will increase the cost.

Project #14: new storm drainage along Gregory Street and 2nd Street. Project replaces and extends highly deficient existing storm drainage system. Intercepts flow down both sides of Gregory Streets at the southeast side of 3rd Street including flows from local spring(s). Line sizing is 15" to 2nd Street and 18" along 2nd Street. Sizing is based on a capacity of 11.64 cfs at the terminus. Flow is directed to Gervais Creek and effectively reduces the impact of storm water flows on lower areas of Basin G2. The project is moderate in priority.

Table 7.14: Project #14 Opinion of Probable Cost
Gregory Street and 2nd Street improvements - Basin G2

Item	Quantity	Unit	Unit Cost	Extension
15" Storm Drain Piping	405	LF	$50	$20,250
18" Storm Drain Piping	300	LF	$55	$16,500
Catch Basin	8	EA	$1,100	$8,800
Outfall Rip Rap	1	LS	$300	$300
Misc. Resurfacing and Ditching	1	LS	$5,000	$5,000
Construction Subtotal				**$50,850**
Contingencies				$5,085
Engineering				$10,170
Legal and Administration				$2,543
Project Total				**$68,648**

Project #15: storm drainage improvements along Gregory Street and 1st Street. Currently there is a low point approximately midway between Rector Street and Gregory Street on 1st Street. Flow is directed to N9 and then to P34. P34 passes under a house and other building and discharges to the Gervais Creek line behind The Wheeler Station. Gregory Street shows considerable erosion along its sides, and washing of gravel into the street. Project piping is 15" diameter. Sizing is based on a capacity of 6.05 cfs at the terminus. The project redirects flow, that would have entered N9 (and P34), down 1st Street to Gregory Street and ties in to the 36" line (Gervais Creek). Construction requires relatively deep manholes at Gregory and 1st Street to overcome the adverse grade. There is a 12" line and catch basin extended across Gregory Street and 1st Street. The project is medium in priority.

Table 7.15: Project #15 Opinion of Probable Cost
Gregory Street and 1st Street improvements - Basin G2

Item	Quantity	Unit	Unit Cost	Extension
12" Storm Drain Piping	100	LF	$40	$4,000
15" Storm Drain Piping	320	LF	$50	$16,000
Manhole	3	EA	$3,500	$10,500
Catch Basin	5	EA	$1,100	$5,500
Misc. Resurfacing and Ditching	1	LS	$5,000	$5,000
Construction Subtotal				**$41,000**
Contingencies				$4,100
Engineering				$8,200
Legal and Administration				$2,050
Project Total				**$55,350**

Project #16: new culvert across Rector Street at 1st Street. Project intercepts flow from Rector Street and 1st Street and conveys it to new intake associated with Project #15. Project is of low priority.

Table 7.16: Project #16 Opinion of Probable Cost
Rector Street at 1st Street culvert - Basin G2

Item	Quantity	Unit	Unit Cost	Extension
12" Storm Drain Piping	60	LF	$40	$2,400
Catch Basin	2	EA	$1,100	$2,200
Misc. Resurfacing and Ditching	1	LS	$2,500	$2,500
Construction Subtotal				**$7,100**
Contingencies				$710
Engineering				$1,420
Legal and Administration				$355

Project Total	**$9,585**

Project #17: new storm drainage along Rector Street. New 12" line intercepts flow on both sides of Rector Street and transports it down Rector Street to tie-in to the existing storm drainage along Highway 101. The project is moderate in priority.

Table 7.17: Project #17 Opinion of Probable Cost
Rector Street drainage improvements - Basin G2

Item	Quantity	Unit	Unit Cost	Extension
12" Storm Drain Piping	150	LF	$40	$6,000
Catch Basin	3	EA	$1,100	$3,300
Misc. Resurfacing	1	LS	$4,000	$4,000
Construction Subtotal				**$13,300**
Contingencies				$1,330
Engineering				$2,660
Legal and Administration				$665
Project Total				**$17,955**

Project #18: replace storm drain at Pine Street and 2nd Street. Future street improvements in this vicinity should include replacement of the existing storm drainage with a 12" line and catch basin. The project is low in priority.

Table 7.18: Project #18 Opinion of Probable Cost
Pine street at 2nd street drainage improvements - Basin G2

Item	Quantity	Unit	Unit Cost	Extension
12" Storm Drain Piping	45	LF	$40	$1,800
Catch Basin	1	EA	$1,100	$1,100

Misc. Resurfacing and Ditching	1	LS	$1,000	$1,000
Construction Subtotal				**$3,900**
Contingencies				$390
Engineering				$780
Legal and Administration				$195
Project Total				**$5,265**

7.1.11 Basin Z2

Project #22: new storm drainage along 3rd Street. Project upgrades existing drainage and provides for development south of Spruce Street between 3rd Street and 4th Street. The proposed 12" line transitions to 15" on the north side of Spruce Street. Sizing is based on a capacity of 4 cfs at the terminus. The project is low in priority with the exception of the crossing of Hemlock Street. Hemlock Street improvements are discussed in Section 7.2.

Table 7.19: Project #22 Opinion of Probable Cost
3rd Street drainage improvements - Basin Z2

Item	Quantity	Unit	Unit Cost	Extension
12" Storm Drain Piping	550	LF	$40	$22,000
15" Storm Drain Piping	350	LF	$50	$17,500
Catch Basin	7	EA	$1,100	$7,700
Outfall Rip Rap	1	LS	$500	$500
Misc. Resurfacing and Ditching	1	LS	$6,000	$6,000
Construction Subtotal				**$53,700**
Contingencies				$5,370
Engineering				$10,740
Legal and Administration				$2,685
Project Total				**$72,495**

Project #23: new storm drainage along 4th Street. This project is intended as a partial replacement of pipes P23 and P24, which drain much of the basin, and to

provide for development in the area south of Spruce Street. Pipe P23 is deep (approximately 8 feet) and its condition and precise location are not known (with the exception of its ends). Location and construction suggest it predates the fill and development currently in place. Based on sizing (24") and observed flow through P24, it appears to still function as an area drain; abandonment of P23 is not recommended as part of this project. Surface water in the general vicinity of N3, N4, and N5 should be directed to the new line along 4th Street. The 24" line along 4th Street begins where the 15" and 18" lines connect (at Spruce Street). The 18" line along Spruce Street is for future development. The project is moderate in priority with the exception the 18" crossing of the 4th Street and the 24" crossing of Hemlock Street. Sizing is based on a capacity of 43 cfs at the terminus (based on a rough estimate of up to 26 cfs from Z2 and one-half the flow associated with Z1 on the assumption of partial blockage on N1 and rerouting of flows via the 18" line). These improvements are discussed in Section 7.2.

Table 7.20: Project #23 Opinion of Probable Cost
4th Street drainage improvements - Basin Z2

Item	Quantity	Unit	Unit Cost	Extension
15" Storm Drain Piping	175	LF	$50	$8,750
18" Storm Drain Piping	250	LF	$55	$13,750
24" Storm Drain Piping	350	LF	$90	$31,500
Catch Basin	7	EA	$1,100	$7,700
Outfall Rip Rap	1	LS	$700	$700
Misc. Resurfacing and Ditching	1	LS	$8,000	$8,000
Construction Subtotal				**$70,400**
Contingencies				$7,040
Engineering				$14,080
Legal and Administration				$3,520
Project Total				**$95,040**

Project #24: replacement of pipe P24 across Hemlock Street between 3rd Street and 4th Street. Pipe P24 is functional; however, the pipe end has been partially crushed and discharge from the pipe has severely eroded the bank. Replacement is essential for preserving Hemlock Street and, on that basis, the project is high

priority; however, the project should be coordinated with other recommendations. Sizing is based on matching the existing pipeline. Project #23 is intended to be the major drain for Basin Z2. See Section 7.2 for further discussion of Hemlock Street.

Table 7.21: Project #24 Opinion of Probable Cost
Hemlock Street P24 replacement - Basin Z2

Item	Quantity	Unit	Unit Cost	Extension
24" Storm Drain Piping	50	LF	$90	$4,500
Outfall Rip Rap	1	LS	$700	$700
Misc. Resurfacing and Ditching	1	LS	$1,000	$1,000
Construction Subtotal				**$6,200**
Contingencies				$620
Engineering				$1,240
Legal and Administration				$310
Project Total				**$8,370**

7.1.12 Basin Z3

Project #20: upgrade of storm drain along Spruce Street between 1st Street and Highway 101. Sizing is based on a capacity of 6.7 cfs at the terminus. Project is currently low priority. Improvements to 1st Street or extensive upstream development could be a basis for construction.

Table 7.22: Project #20 Opinion of Probable Cost
Spruce Street P5 replacement - Basin Z3

Item	Quantity	Unit	Unit Cost	Extension
12" Storm Drain Piping	250	LF	$40	$10,000
Catch Basin	2	EA	$1,100	$2,200

Misc. Resurfacing and Ditching	1	LS	$2,500	$2,500
Construction Subtotal				**$14,700**
Contingencies				$1,470
Engineering				$2,940
Legal and Administration				$735
Project Total				**$19,845**

Project #21: upgrade of storm drainage along Highway 101 from Spruce Street to discharge point north of Hemlock Street. Sizing is based on a capacity of 13.3 cfs at the terminus. Project is low priority. Extensive new development in basin could be a basis for construction.

Table 7.23: Project #21 Opinion of Probable Cost
Highway 101 drainage improvements - Basin Z3

Item	Quantity	Unit	Unit Cost	Extension
18" Storm Drain Piping	575	LF	$65	$37,375
Catch Basin	3	EA	$1,100	$3,300
Outfall Rip Rap	1	LS	$300	$300
Misc. Resurfacing and Ditching	1	LS	$7,000	$7,000
Construction Subtotal				**$47,975**
Contingencies				$4,798
Engineering				$9,595
Legal and Administration				$2,399
Permitting and Easements (allowance)				$2,000
Project Total				**$66,766**

7.2 HEMLOCK STREET IMPROVEMENTS

7.2.1 Background

Hemlock Street between 3rd Street and 5th Street is currently in extremely poor repair and unusable. The north half of the street has subsided up to 1.5 feet in places and in some places the edges and portions of the roadway have fallen down the roadbank to Zimmerman Creek. Utilities run parallel in the street and reportedly include: sanitary sewer, municipal water, electrical, and cable. There are three culvert crossings, plus the 24" culvert and intake associated with Zimmerman Creek, across Hemlock Street in this vicinity. The City is concerned with stabilizing the street and possibly restoring it.

7.2.2 Context

The area roughly circumscribed by Hemlock Street, 3rd Street, Spruce Street, and 5th Street was filled in to facilitate development. Zimmerman Creek was relocated to the southeast approximately midway between 4th Street and 5th Street on Hemlock Street; originally, the creek ran northwest and crossed Hemlock Street closer toward 3rd Street. Hemlock Street itself is constructed on fill. The streambank side of the road is very steep. Zimmerman Creek runs parallel to Hemlock Street and appears to be at least 20-30 feet lower than the street. The creek itself does not appear to have migrated toward the roadway, although the sidehill (of Hemlock Street) has subsided and eroded in places such that it may appear to have been undermined by the creek. (Neighbors interviewed also believe the creek has not moved.)

7.2.3 Groundwater

The area has many springs that are active during the wet season. One large mound of soil was observed at a residence. The owner stated that water literally jets upward from the spot during wet periods. Mounding of soil is evidence of piping and material transport. Water can gradually erode a larger hole (referred to as piping) which can then transport more water. The mounding is an indicator of groundwater activity.

Ground movement/settlement is also reported to occur in the area as evidenced by cracking sheet rock and foundation movement. General groundwater movement probably follows the original area topography. This would result in groundwater movement both parallel and perpendicular to Hemlock Street. It is also possible

that the fill under Hemlock Street acts like a dike. If this is the case, groundwater could "build up" creating more head (pressure) on the south side of Hemlock Street, and eventually seeping or piping through to the other side above Zimmerman Creek.

7.2.4 Zimmerman Creek and Roadway Damage

Local residents report that Zimmerman Creek backed up at the culvert crossing Hemlock Street approximately four years ago. The stream was thereby effectively diverted downslope along the south side of Hemlock Street and also over the top of the street and down the north bank to Zimmerman Creek. A large ditch was eroded along the south side of the street. Approximately two years ago, a new 24" culvert and concrete intake with steel grating (trash rack) was constructed. The rack is reported to have plugged often; the immediate neighbor reports often clearing it with a pitch fork. The City attributed the plugging problem to leaf buildup and raised the end of the trash rack sufficiently to allow passage of leaves and small debris. Plugging and consequent diversion of the stream down Hemlock Street is reported to have occurred several times since the first incident. Seepage from the ditch on the south side could have caused piping and undermining the ground below Hemlock Street and runoff, in large quantities, across the top of Hemlock Street would have contributed to erosion on the north bank.

7.2.5 Storm Water Management and Hemlock Street Stabilization

A complete evaluation of Hemlock Street will require a detailed geotechnical evaluation of the fill, roadway construction, and current condition; and of the possible role of groundwater in destabilizing Hemlock Street, The geotechnical evaluation should also address rebuilding the street, north bank, and in stabilizing the roadway and adjacent bank. A geotechnical evaluation is likely to cost, on the order of, $30,000; however, if the City decides to proceed with the geotechnical study, it should contract a qualified geotechnical consultant to prepare a detailed scope of work and to more accurately determine the associated cost.

Damage to Hemlock Street is attributable, at least in part, to the backing up and diversion of Zimmerman Creek along and across Hemlock Street. Further obstruction of the Zimmerman Creek culvert is possible in the future. The intake grating is needed both to prevent potential plugging of the culvert, as occurred previously, and to prevent entry of small children. The issue, from a surface water standpoint, is how to control or manage future diversions of the creek that may

occur. Project #23 (see Figure 7.2) includes a new 24" storm drain across Hemlock Street on the northwest side of 4th Street and an 18" storm drain on the south side of Hemlock Street. Connecting the proposed 18" line via ditch to the Zimmerman Creek intake would allow diverted flows to proceed to Zimmerman Creek by an alternate, controlled path. The ditch could include bentonite (worked into the surface to reduce seepage) and rip rap to stabilize the ditch banks. Project #24 will also need to be constructed since pipe P24 is badly damaged and needs to be replaced. The north side of the roadway will also need fill and bank stabilization. These proposed improvements will help stabilize the area but may not, by themselves, be sufficient to fully stabilize Hemlock Street. Also, the proposed improvements do not include general roadway surface, and subsurface restoration.

Table 7.24 presents an order-of-magnitude opinion of probable cost for the proposal storm water management component

Table 7.24: Hemlock Street Opinion of Probable Cost

Item	Quantity	Unit	Unit Cost	Extension
24" Storm Drain Piping	100	LF	$90	$9,000
18" Storm Drain Piping	50	LF	$55	$2,750
Catch Basin	2	EA	$1,100	$2,200
Bentonite and Rip Rap Ditch Lining	1	LS	$1,500	$1,500
Road Bank Fill (allowance)	1000	CY	$10	$10,000
Outfall Rip Rap	1	LS	$1,400	$1,400
Bank Stabilization (plantings allowance)	1	LS	$10,000	$10,000
Misc. Resurfacing and Ditching	1	LS	$3,000	$3,000
Construction Subtotal				**$39,850**
Contingencies				$3,985
Engineering				$7,970
Legal and Adminitration				$1,993
Project Total				**$53,798**

Table 7.24 does not include: costs for the geotechnical study, allowances for

geotechnical recommendations (including bank stabilization measures beyond placement of fill, outfall rip rap, and plantings of willows or other native trees), or repair and restoration of the Hemlock Street roadway. Table 7.24 does include costs for all of project #24 ($8,370) and part of the costs for project #23 ($15,000). The balance of approximately $30,400 is attributable to stabilization measures along Hemlock Street between the Zimmerman Creek crossing and 3rd Street.

7.3 WATER QUALITY

Potential sources of pollutants associated with storm water impacts on stream water quality and are discussed in Section 4.4. Specific pollutant sources meriting constructed improvements were not found. Many pollutants bind with sediment and other solids; hence, effective erosion control and sediment management can significantly improve water quality associated with municipal runoff. Also important is a program or efforts to educate the public about potential pollutant sources and how to eliminate or reduce their impact. Erosion and sediment control are discussed in Section 7.4.

7.4 EROSION AND SEDIMENT CONTROL

Erosion is a natural process that exists everywhere to some extent. Erosion from, or stemming from, human activities, if unmanaged, can impact downstream properties; generate sediments that bind and transport pollutants; increase receiving stream turbidities and impact fish; and prematurely fill ditches, pipelines, and catch basins with transported sediment and materials. Erosion can also compromise constructed infrastructure such as streets.

Sediment control refers to practices that trap sediment and particulates resulting from erosion. In general, it is best to focus most management efforts on reducing erosion where it is likely to occur.

DEQ recently developed an erosion and sediment control manual[1]. The 138 page manual provides considerable detail on both erosion control and sediment control practices and could be an excellent resource for Wheeler's public works department. The manual is located on the internet at:

www.deq.state.or.us/wq/wqpermit/ESCManual/ESCManual.pdf

[1] *Erosion and Sediment Control Manual*, GeoSyntec Consultants, San Diego, CA, April 2005.

Basic principles of erosion and sediment control, reprinted from the manual, are listed below:

- Fit the project to the existing topography, soils, and vegetation;
- Minimize disturbance and retain natural vegetation;
- Schedule construction to minimize soil exposure during rainy season;
- Vegetate and mulch denuded areas;
- Minimize concentrated flows and divert runoff away from slopes or critical areas;
- Minimize slope steepness and slope length by using benches, terraces, contour furrows, or diversion ditches;
- Utilize channel linings or temporary structures in drainage channels to slow runoff velocities
- Keep sediment on site by using sediment basins, traps, or sediment barriers; and
- Monitor and inspect sites frequently and correct problems promptly.

One preventative measure to reduce the cost of maintenance due to sedimentation of the drainage infrastructure is for the City of Wheeler to adopt and enforce an Erosion and Sediment Control (ESC) ordinance. An ordinance would require developers and contractors to obtain a permit prior to any activity that removes vegetation or disturbs soil. An ESC permit, an integral part of the planning and building permit process, would require that a simple plan be provided that shows how erosion and sediment control will be provided during construction activities and until the construction site is stabilized (or re-vegetated).

It is recommended that the City of Wheeler considered promulgation of an ESC ordinance. Example ESC ordinances may be obtained from other municipalities with an existing ordinance or it can be provided by a professional consulting firm. Many Oregon cities have such ordinances currently in place. The League of Oregon Cities may be able to provide Wheeler a contact list.

DEQ requires a Stormwater Permit (General Permit #1200-C) for development (or disturbance of soil) of more than one acre, in which an erosion control plan must be provided to the agency for review and approval.

All projects discussed in Section 7.1 and 7.2 should incorporate erosion and sediment control considerations as part of the engineering design process.

7.5 MAINTENANCE

Maintenance of the drainage system on an annual basis is necessary to maintain constructed flow capacity for stormwater runoff. To maximize the use of the drainageways during runoff periods, and thereby reduce the potential for storm water related damage, a good maintenance program is an absolute necessity.

Based on field observations, it can be concluded that sediment deposition in drainageways is a problem for the City of Wheeler. Drainage infrastructure that becomes filled with sediment has reduced hydraulic capacity and often results in diverted flows and associated erosion.

The primary goal of a recommended drainage maintenance program could be stated as:

> "With available funds, the City of Wheeler will provide preventative maintenance and rehabilitate drainageway facilities in a manner that will ensure reasonably adequate drainage function of hydraulic structures and conveyances during periods of stormwater runoff."

Many problem areas are well known to public works staff. In addition, Section 4.3 provides information on infrastructure that would benefit from regular maintenance

Maintenance of ditches and areas upstream or downstream of culverts could be more effectively accomplished if the City obtained a backhoe for The Public Works Department. Potential uses for a backhoe in a city like Wheeler extend well beyond drainage system maintenance. A good used backhoe will cost approximately $30,000.

As a general rule, monies have not been historically allocated for maintenance of a city's storm drainage system. Public works staff do their best with the budgets they are provided. A potential source of additional funds for maintenance purposes is the establishment of a storm water utility (see Section 8.3.3).

7.6 DESIGN AND DEVELOPMENT STANDARDS

7.6.1 Design Criteria

The range of design possibilities for storm water infrastructure are extensive and an engineer will be able to select and utilize appropriate approaches for each specific project including approaches that may be innovative or uniquely applicable to the demands of the project. Nevertheless, many communities adopt design standards to ensure compliance with minimum standards and to provide a general guide for public works activities that may include construction of storm water infrastructure according to the budget and capabilities of City staff. Adoption of design standards by city ordinance may be considered for the future. If the City chooses to adopt design standards by ordinance, it is recommended that a professional engineer prepare the document. The standards defined below are to aid City staff in the design review of project, and the construction of projects by public works.

Road-ditches - maximum grades: road ditches with a 2% grade or greater should be constructed with small check dams with rip rap on the fall side.

Construction of storm sewer pipe - minimum size: All storm sewer pipe shall be 12-inch in diameter or greater, and terminate at an approved point of disposal.

Construction of storm sewer pipe - anchors: Storm sewer pipe constructed on slopes greater than 20% shall be secured by concrete anchors.

Construction of storm sewer pipe - minimum grades: All storm sewer pipe shall be constructed on a slope which will produce a mean velocity of at least three (3) feet per second based on Manning's equation. Minimum acceptable grades for various pipe sizes are listed below:

Pipe Diameter (in inches)	Corrugated Pipe Slope (ft/ft)	Smooth Pipe Slope (ft/ft)	Capacity at 3 fps (cfs)
12	0.0103	0.0044	2.36
15	0.0076	0.0032	3.68
18	0.0060	0.0025	5.30

21	0.0049	0.0021	7.22
24	0.0041	0.0017	9.43
27	0.0035	0.0015	11.93
30 and larger	0.0030	0.0013	14.73

Construction of storm sewer pipe - spacing of drainage appurtenances: Storm sewer pipe shall be constructed with access for cleaning no further than 400 feet apart with junctions made at manholes, cleanouts, or catch basins.

7.6.2 Future Development

Effective storm water management must take into account the impacts of future development and provide some guidance for rational expansion of the City's stormwater infrastructure. For redevelopment, infill, or small (single house) construction on lots adjacent to developed City roadways, there will typically be an existing drainage pathway, either natural or constructed. For larger developments, in particular those requiring the extension or development of a City street, several drainage options may be present. Where practicable, drainage in these areas should be directed toward the nearest creek rather than toward downstream, existing infrastructure unless there is clear benefit in doing so and hydraulic capacity available. For example, Basin G1 includes a large undeveloped area with numerous undeveloped City right-of-ways (ROWs). Several possibilities exist for routing flows along City ROWs to Gervais Creek and no single possibility is "best" without knowing the location, nature, and extent of any proposed development. As a general rule all development requiring the extension, development, or use of an undeveloped City ROW should be required to:

- Construct appropriate storm water infrastructure along the roadway that will accommodate a 25-year storm event from all upstream area that may reasonably be expected to drain to it.

- Construct or otherwise improve a drainage path from the newly developed roadway to the nearest creek, including the provision of appropriate erosion and sediment control measures.

By following such an approach, the City will provide some relief for existing, undersized infrastructure that, due to cost impacts and consideration, the City has not yet replaced.

To ensure that future development incorporates rational storm water planning and design, the City should consider development and adoption of storm drainage ordinances. Ordinances can be prepared by an engineering or planning consultant with final review and editing by an attorney. Elements that may be considered for inclusion in the ordinances include:

- Designation of review body (for example: The Planning Commission and/or City Engineer).
- Application/submittal/review process and requirements for developments that affect, directly or indirectly, storm water runoff and associated water quality.
- Establishment of fees for review. (This is particularly important if the City Engineer is involved and/or if multiple reviews are needed.)
- Definitions of terms and descriptions of the types of developments covered.
- Compliance with civil law doctrine of drainage (see Section 5.1) with regard to accommodation of drainage from upstream areas and protection of downstream areas from post-development flows.
- Requirement and responsibility of developer to ensure all regulatory requirements, including appropriate permits and approvals, are secured prior to construction.
- Minimum design standards or criteria should be included, referenced, or otherwise referred to.
- Process for waivers or consideration of alternative storm water strategies.