SECTION 4 STORM AND SURFACE WATER

DESIGN AND CONSTRUCTION STANDARDS
AND
SPECIFICATIONS

SECTION 4

STORM AND SURFACE WATER

4-1 GENERAL

This section of the Standards provides criteria for the design of storm and surface water drainage systems, including storm pipes, culverts, and catch basins. Each of the sections in this chapter contains the design criteria and references standard details for the various systems or facilities.

Drainage control and storm water treatment shall be provided for all property improvements within the City of Snohomish per these Standards and current version of the Department of Ecology (DOE) Storm Water Management Manual and the City's Land Use Code.

Projects which will disturb one acre or more of land, or create 5,000 square feet or more of impervious surface, paved or otherwise, must refer to the said DOE Storm Water Management Manual for drainage plan and runoff control requirements.

The use of Low-Impact Development concepts are strongly encouraged where they do not conflict with the requirements of these Standards. Low-Impact Development concepts include such practices as preserving native vegetation for stormwater dispersal, soil amendments to promote stormwater infiltration, pervious pavements, and vegetated swales.

4-2 STORM DRAINAGE CONVEYANCE SYSTEM DESIGN CRITERIA

4-2.1 OVERVIEW

For the purposes of this section, the conveyance system includes all portions of the surface water system that transport storm and surface water runoff, either natural or man-made, except those features protected as environmentally sensitive areas under the City's land use code. Environmentally sensitive areas may only be modified as allowed under the City of Snohomish Land use Code. Storm water must generally be treated and detained prior to discharge to an environmentally sensitive area, including those features created for mitigation.

This section covers the following components of the conveyance system:

Pipe systems
Culverts
Outfalls
Open channels

4-2.2 DESIGN FLOW AND ROUTE REQUIREMENTS

Design Flow

All existing and proposed conveyance systems shall be designed to convey runoff from the 25-year storm. The method used to determine the design flow will depend on the characteristics of the drainage area and the type of conveyance. Tight-lined conveyance systems receiving runoff from relatively small and/or highly impervious drainage areas shall be sized using flows determined using the rational method. Flows for culverts or channels receiving runoff from large and/or relatively pervious drainage areas shall be sized using flows determined using hydrograph methods.

A backwater analysis may be required for a proposed or existing pipe system if the ability of the pipe system to convey the peak rate of runoff from the 25-year design storm event may be effected by tail water conditions (outlet control) anywhere in the pipe system.

Structures such as catch basins and manholes for proposed pipe systems, such as catch basins and manholes, must provide a minimum of 0.5 feet of freeboard between the headwater surface (hydraulic grade line) and the top of the structure for flow from a 25-year storm. However, structures may overtop for flow resulting from a 100-year storm. When overtopping occurs for the 100-year storm, the additional flow over the ground surface is analyzed using the methods described in **Section 1-6 and is added to the flow capacity of the pipe system.

Easements and Building Setback Lines

All public and privately maintained conveyance systems shall be located in drainage easements in accordance with **Section 4-1.3 and **Section 4-2.1.3.8. The exceptions are roof downspout and minor yard and footing drains, unless they serve other adjacent properties.

4-2.3 PIPE SYSTEMS

Pipe systems are networks of storm drain pipes, catch basins, manholes, inlets, and outfalls designed and constructed to convey storm and surface water. The hydraulic analysis of flow in storm drain pipes is typically limited to "gravity flow". The following subsections give design criteria for different components and aspects of pipe systems.

4-2.3(1) PIPE MATERIALS

1. Pipe material, joints, and protective treatment shall conform to the requirements set forth in Section 9-05 of the WSDOT/APWA Standard Specifications.

   The following pipe materials are allowed for use in pipe systems in the City of Snohomish; other pipe materials may be approved on a case-by-case basis:

   (a) Plain concrete pipe (12 inches in diameter, used only for driveway culvert)
   (b) Reinforced concrete pipe
   (c) Ductile iron pipe

(d) PVC pipe (SDR35, ASTM D3034 with 3 feet of cover, minimum)
(e) Corrugated high density polyethylene pipe, with smooth interior
(f) Profile wall PVC, culvert pipe, profile wall PVC storm sewer pipe (AASHTO M304, or ASTM F794 Series 46).

2. Coupling bands shall be of the same material as the pipe.

3. Materials for concrete, rubber gaskets, metal castings, reinforcing steel, and masonry units shall meet the requirements of the appropriate sections of the WSDOT/APWA Standard Specifications.

4-2.3(2) PIPE SIZES, SLOPES, AND VELOCITIES

1. No storm drain pipe between catch basins or manholes in the public right-of-way shall be less than 12 inches in diameter; with the exception that 8-inch pipe may be used between inlets and catch basins in runs of 50 feet or less.

2. The minimum velocity in any pipe or culvert carrying the design storm flow shall be two feet per second.

3. The maximum allowable velocity in concrete pipe shall be 30 feet per second.

4. Changes of pipe size are allowed only at junctions, and structures must be located at all junctions.

5. Downstream decrease in pipe size is not a recommended practice and will only be allowed under special conditions.

4-2.3(3) STRUCTURES

1. Manholes, catch basins, and inlets shall be constructed of pre-cast units in accordance with the following Standard Plans:

Item	Section
Manholes	605A-C
Manhole ring and cover	405
Catch Basins	402 through 404
Inlets	401
Steps and Ladder	606, 606A
Frames and Grates	405A through 409

2. Catch basin (or manhole) diameter shall be determined by pipe size and orientation at the junction structure. A plan view of the junction structure, drawn to scale, will be required when more than four pipes enter the structure on the same plane, or if angles of approach and clearance between pipes is of concern. The plan view (and sections if necessary) must insure a minimum solid concrete wall distance between pipe openings of 8 inches for 48-inch and 54-inch catch basins and 12 inches for 72-inch and 96-inch catch basins.

3. Catch basin evaluation of structural integrity for H-20 loading may be required for multiple junction catch basins and other structures.

4. Catch basins shall be provided within 50 feet of the entrance to a pipe system to provide for silt and debris removal.

5. HDPE pipe systems longer than 100 feet must be secured at the upstream end and the downstream end must be placed in a four foot section of the next larger pipe size. This sliding sleeve connection accounts for the high thermal expansion/contraction coefficient of this pipe material.

6. The maximum slope of the ground surface for a radius of five feet around a catch basin grate shall be 3:1.

7. A Type II catch basin or a manhole shall be required when the depth to the flow-line exceeds 5.5 feet, regardless of the pipe size.

8. All Type II catch basins and all manholes shall be equipped with ladders per Standard Plan No. 606 or 606A.

9. A Type II catch basin shall be installed as the last collector in the public right-of-way prior to discharge to the combined sanitary sewer.

10. Concrete inlets shall not be used where the discharge goes directly into the main storm drain system.

4-2.3(4) PIPE ALIGNMENT/CONNECTIONS/COVER

1. Pipes must be laid true to line and grade with no curves, bends, or deflections in any direction, except for HDPE and ductile iron with flanged restrained mechanical joint bends (not greater than 30 degrees) on steep slopes.

2. A catch basin or manhole will be required at all changes in storm drain diameter and changes in grade or alignment.

3. Connections to a pipe system shall be made only at catch basins or manholes. No wyes or tees are allowed except on roof, footing, or yard drain systems on pipes eight inches in diameter or less, with clean-outs upstream of each wye or tee.

4. Six inches minimum vertical and three feet minimum horizontal clearance (between outside surfaces) shall be provided between storm drain pipes and other utility pipes and conduits.

5. Any closed storm drainage system collecting runoff from paved areas in the public right-of-way or private property shall provide for floatable material separation (see Standard Plan No. 410) prior to discharge to the main storm drainage system in the public right-of-way, unless otherwise approved by the City Engineer.

6. All PVC connections to catch basins or manholes shall be made by grouting in an approved manhole adapter into which the PVC pipe is inserted.

7. Activities such as trench excavation, tunneling or boring, pipe embedment, backfilling, compaction, safety and pavement patching, whether for public or private utilities, shall conform to the requirements set forth in other sections of these Standards. For all the above, except pavement patching, see Section 3-9 Underground Utilities and Standard Plan Nos. 610, 611, and 615. For pavement patching see Section 3-14 and Standard Plan No. 316.

4-2.3(5) FRAMES/LIDS/GRATES/COVERS

1. In general, frames and grates shall be furnished and installed per Standard Plan Nos. 405 through 409.

2. The cover or grating of a manhole or catch basin shall not be grouted to final grade until the final elevation of the pavement, gutter, ditch, or sidewalk in which it is to be placed has been established, and until permission thereafter is given by the City Inspector to grout the cover or grating in place.

3. Lids, grates, and covers shall be seated properly to prevent rocking.

4. All catch basins and manholes in unpaved areas shall be equipped with locking frames and lids or grates per Standard Plan Nos. 405 or 607.

5. All Type II catch basins and all manholes with catches shall be supplied with locking lids or grates per standard plan No. 405.

6. Type II catch basins and manholes functioning exclusively as access structures shall be equipped with round 24-inch covers and frames per Standard Plan No. 607.

7. Round lids on all storm drain structures shall have “Drain” cast into the lid.

8. In conditions when the effectiveness of a normal grate installation would be limited, an open curb face frame and grate shall be furnished and installed per Standard Plan Nos. 408 and 409. These conditions include high likelihood of clogging from leaf fall, especially in sag vertical curves; when the inlet is a surface drainage end point, such as a cul-de-sac; and when normal inlet grates may be passed over due to the road grade. The use of open curb face frame and grates must be approved by the City Engineer.

4-2.3(6) RESTRICTOR DEVICES

1. The minimum orifice size diameter allowed for use in the City of Snohomish is one inch.

2. Restrictor devices shall be constructed and installed in accordance with Standard Plan numbers 412A through 412C.

4-2.3(7) DEBRIS BARRIERS

Debris barriers (trash racks) are required on all pipes entering or leaving a closed pipe system, including pipes entering or leaving a control/restrictor manhole or catch basin from a surface-type BMP (detention pond, infiltration basin, wet pond, biofiltration swale, etc.).

4-2.3(8) DRAINAGE EASEMENTS

1. Public drainage easements a minimum of 15 feet wide are required for maintenance and access of pipes located outside of the public right-of-way which convey runoff from public streets or other facilities.

2. Where possible, pipes shall be located within the center of the drainage easement, but in no case shall a pipe be closer than five feet to a property line.

3. Where possible, drainage easements shall be contained on one lot, and not bisected by a lot line.

4. Shared private pipes must be located within private drainage easements.

5. Easements for downspout roof drains, yard drains, and footing drains are not required unless these systems are shared by more than one property owner.

4-2.4 CULVERT DESIGN CRITERIA

4-2.4(1) Headwater

1. For new culverts 18 inches in diameter or less, the maximum allowable 25-year design storm headwater elevation (measured from the inlet invert) shall not exceed two times the pipe diameter/arch culvert height used and shall be one foot or more below the road or parking lot sub-grade.

2. For new culverts larger than 18 inches in diameter, the maximum 25-year design storm headwater elevation for the new culvert shall be one foot or more below the road or parking lot sub-grade.

4-2.4(2) INLET

1. For culverts 18 inches in diameter and larger, the embankment around the culvert inlet shall be protected from erosion by rock lining or riprap as specified in **Table 4-2.1, except the length shall be a minimum of five feet (upstream of the culvert), and the height shall be at the design headwater elevation.

2. Trash racks/debris barriers are required on culverts that are over 60 feet in length and that are 12 inches to 36 inches in diameter. Exceptions are culverts on fish-bearing streams.

3. In order to maintain the stability of roadway embankments, concrete headwalls, wing walls, or tapered inlets and outlets may be required if right-of-way and/or easement constraints prohibit the culvert from extending to the toe of the embankment slope. Normally concrete inlet structures/headwalls installed in or near roadway embankments must be flush with and conform to the slope of the embankment.

4-2.4(3) OUTLETS

The receiving channel at the outlet shall be protected from erosion by rock lining, as specified in **Table 4-2.1, except the height shall be one foot above the maximum tail water elevation or one foot above the crown of the pipe, whichever is higher.

4-2.4(4) FISH PASSAGE

Guidance for designing culverts for fish passage must be obtained from the Washington State Department of Fish and Wildlife.

4-2.5 OUTFALL DESIGN CRITERIA

4-2.5(1) GENERAL

1. All outfalls (at a minimum) shall be provided with rock protection per **Table 4-2.1. For outfalls with a velocity at the design flow greater than 10 fps, a gabion dissipater or engineered energy dissipater shall be required.

2. Mechanisms which reduce velocity prior to discharge from an outfall are encouraged.

3. Engineered energy dissipaters, including stilling basins, drop pools, hydraulic jump basins, baffled aprons, and bucket aprons, are required for outfalls with velocity at design flow greater than 20 fps.

4. Inlet control will usually dictate outfall pipe system capacity. The inlet conditions should be carefully examined, as well as the consequences should the inlet to the pipe system become plugged or capacity exceeded.

4-2.5(2) OUTFALL SYSTEMS TRAVERSING STEEP SLOPES

1. Outfall systems constructed of pipe segments which are banded and/or gasketed are not acceptable for traversing steep slopes. Failure of the system will result from leaks which develop at the joints.

2. Continuously fused, welded or flange bolted mechanical joint pipe systems (such as high density polyethylene pipe (HDPEP) or ductile iron pipe with flange-bolted mechanical joints) with proper anchoring shall be used for outfall systems traversing steep slopes.

3. In general, outfall pipes systems shall be installed in trenches with standard bedding on slopes up to 20 percent. On slopes greater than 20 percent, outfall pipe systems shall be placed on the ground surface with proper pipe anchorage.

4. HDPEP outfall systems must be designed to address the material limitations as specified by the manufacturer, in particular thermal expansion/contraction and pressure design. Sliding sleeve connections to address thermal expansion and contraction shall be used. These sleeve connections consist of a section of the appropriate length of the next larger size diameter of pipe into which the outfall pipe is fitted. These sleeve connections must be located as close to the discharge end of the outfall system as is practical.

5. Flows of very high energy will require a specifically engineered energy dissipation structure as described above.

4-2.6 OPEN CHANNEL DESIGN CRITERIA

Open channels, either natural or artificial, may be used to convey storm water on and from a site. In general, however, natural channels are protected as environmentally sensitive areas under the City's Land Use Code and may not be used to convey untreated, undetained storm water. Alteration of these channels, including bank stabilization projects, requires special permits. Artificial channels are those constructed from upland areas specifically to convey storm and surface water. In general, the criteria in this section do not apply to biofiltration swales, which are primarily designed to treat storm water runoff.

When constructing artificial channels, vegetation-lined channels are preferred when properly designed and constructed. Rock-lining may be necessary along the length of channels or at specific locations (such as bends and outfalls) when a vegetative lining will not provide adequate protection from erosive velocities.

4-2.6 (1) ARTIFICIAL CHANNELS

1. Channel section geometry shall be trapezoidal. Side slopes shall not be steeper than 3H:1V for vegetation-lined channels and 2H:1V for rock-lined channels, unless the channel is engineered specifically for steeper slopes.

2. A minimum 0.5 ft freeboard above design flows must be provided.

3. Vegetation-lined channels shall have bottom slope gradients of five percent or less and a maximum average velocity at the design flow of five fps.

4. Rock-lined channels shall be used when design flow velocities exceed five fps. Rock lining shall be in accordance with **Table 4-2.2.

5. A maintenance access easement 15 feet wide (minimum) is required along all publicly maintained constructed channels located on private property. However, required easement widths and building setback lines may vary with channel top width. A minimum 15 feet setback must be provided between any structures and the top of the bank of the channel.

4-2.6 (2) ROCK-LINING

In rock-lined channels, stone (riprap) is placed on the channel sides and bottom to protect the underlying material from erosion. Proper riprap design requires the determination of the median size of stone, the thickness of the riprap layer, the gradation of stone sizes, and the selection of angular stone which will interlock when placed.

Research by the U.S. Army Corps of Engineers has provided criteria for selecting the median stone size, W_{50} (Figure 4-2.1). If the riprap is to be used in a highly turbulent zone, such as a culvert outfall, downstream of a stilling basin, at sharp changes in channel geometry, etc., the median stone (W_{50}) should be increased from 200 percent to 600 percent depending on the severity of the locally high turbulence. The thickness of the riprap layer should generally be twice the median stone diameter (D_{50}) or at least that of

the maximum stone. The riprap should have a reasonably well-graded assortment of stone sizes within the following gradation:

$1.25^3 (D_{max}/D_{50})^3$ 1.50, $(D_{15}/D_{50}) = 0.50$, $(D_{min}/D_{50}) = 0.25$

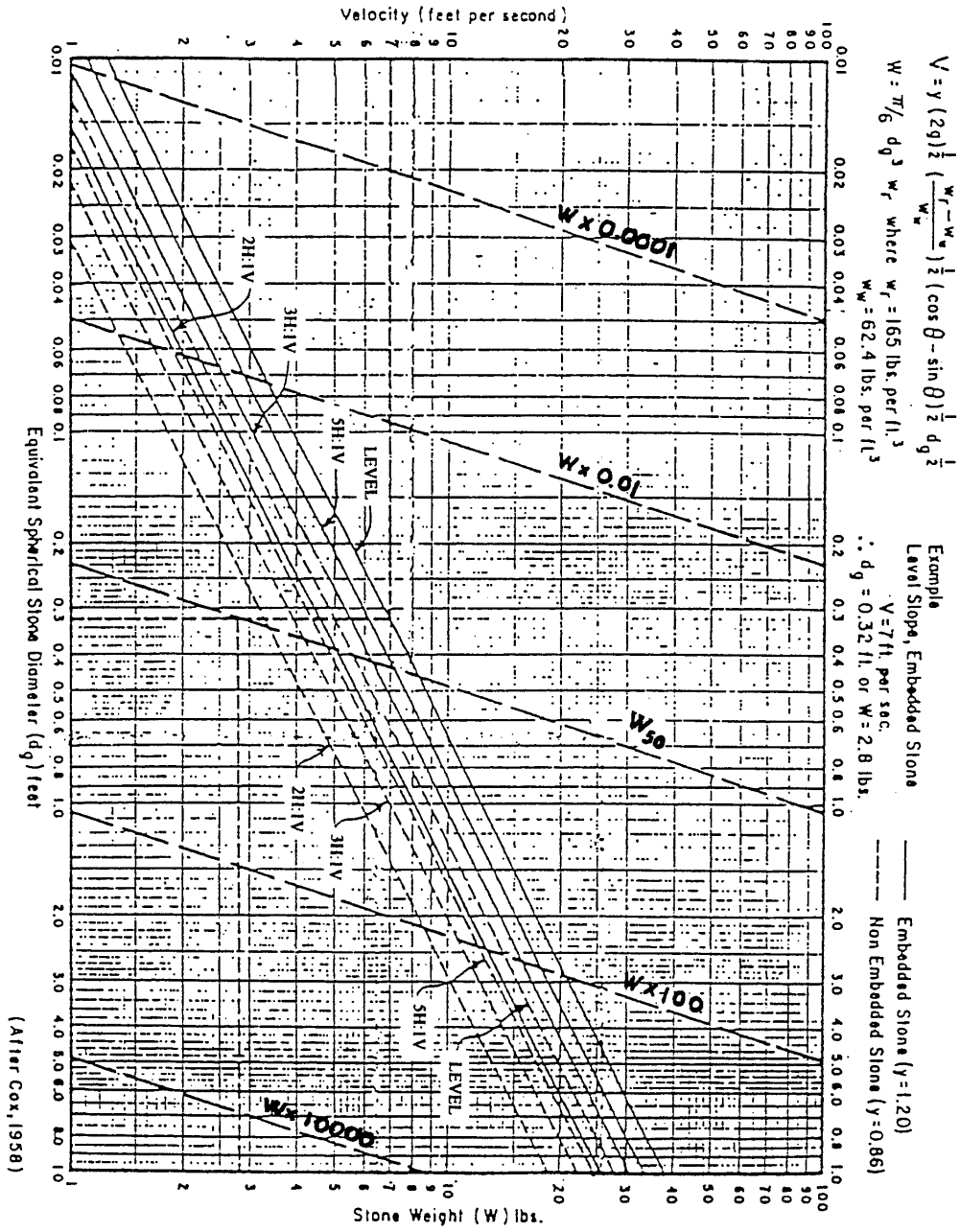
4-2.6 (3) RIPRAP FILTERS

Riprap should be underlain by a sand and gravel filter (or filter fabric) to keep the fine materials in the natural or artificial channel from being washed through the voids in the riprap. Likewise, the filter material must be selected so that it is not washed through the voids in the riprap. Adequate filters can usually be provided by a reasonably well-graded sand and gravel material with $D_{15} < 5d_{85}$, where d refers to the sieve opening through which 85 percent of the material being protected will pass and D_{15} has the same interpretation for the filter material. A filter with a D_{50} of 0.5 mm will protect any finer material including clay. Where very large riprap is used, it is sometimes necessary to use two filter layers between the material being protected and the riprap.

For additional information and procedures for specifying filters for riprap and general guidance, refer to the Army Corps of Engineers Manual EM 1110-2-1601 (1970) "Hydraulic Design of Flood Control Channels", paragraph 14, Riprap Protection.

Figure 4-2. 1 Median Stone Size Selection for Riprap Design

Figure 4-2. 1 Median Stone Size Selection for Riprap Design



Rev. 4/02

Table 4-2.1 Outlet Protection

Design Flow Discharge Velocity (fps)	REQUIRED PROTECTION (Minimum Dimensions)				
	Type	Thickness	Width	Length	Height
0 - 5	Riprap*	1 ft	Diameter + 6 ft	8 ft or 4x diameter, whichever is greater	Crown + 1 ft
>5 - 10	Riprap**	1 ft	Diameter + 6 ft or 3x diameter, whichever is greater	12 ft of 3X diameter, whichever is greater	Crown + 1 ft
>10 - 20	Gabion	1 ft	As required	As required	Crown + 1 ft

Note: The stone for riprap shall be hard, sound, and durable and free of rock fines, soil, or other extraneous material. It shall also be free of segregation, seams, cracks, and other defects which would tend to destroy its resistance to weather.

* Riprap for these velocities shall be reasonably well-graded with rock gradation as follows:

100 % passing an 8 inch square sieve (maximum stone size = 8 inches)
40 - 60% passing a 6 inch square sieve (median stone size = 6 inches)
0 - 10% passing a 2 inch square sieve (minimum stone size = 2 inches)

** Riprap for these velocities shall be reasonably well-graded with rock gradation as follows:

100% passing a 24 inch square sieve (maximum stone size = 24 inches)
40 - 60% passing a 16 inch square sieve (median stone size = 16 inches)
0 - 10% passing a 4 inch square sieve (minimum stone size = 4 inches)

Note: The above riprap sizing assumes 3H:1V side slopes on the outlet channel.

Table 4-2. 2 Channel Protection

Table 4-2.2 Channel Protection

Velocity at Design Flow	Required Protection	Thickness	Min. Height Above Design Water Surface
0 - 5 fps	Grass Lining/Bioengineering	Not applicable	0.5 feet
>5 - 8 fps	Riprap*/Bioengineering	1 ft	1 ft
>8 - 12 fps	Riprap**	2 ft	2 ft
>12 - 20 fps	Slope Mattress	varies	2 ft
>20 fps	Gabion, etc.	varies	varies

Note: The stone for riprap shall be hard, sound, and durable and free of rock fines, soil, or other extraneous material. It shall also be free of segregation, seams, cracks, and other defects which would tend to destroy its resistance to weather.

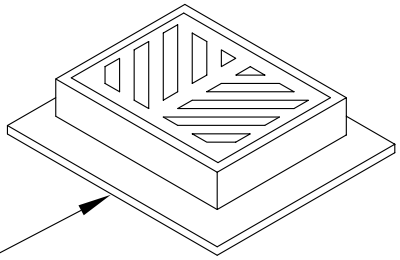
* Riprap for these velocities shall be reasonably well-graded with rock gradation as follows:

100 % passing an 8 inch square sieve (maximum stone size = 8 inches)
40 - 60% passing a 6 inch square sieve (median stone size = 6 inches)
0 - 10% passing a 2 inch square sieve (minimum stone size = 2 inches)

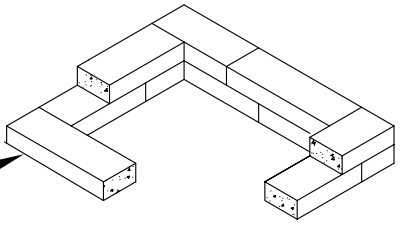
** Riprap for these velocities shall be reasonably well-graded with rock gradation as follows:

100% passing a 24 inch square sieve (maximum stone size = 24 inches)
40 - 60% passing a 16 inch square sieve (median stone size = 16 inches)
0 - 10% passing a 4 inch square sieve (minimum stone size = 4 inches)

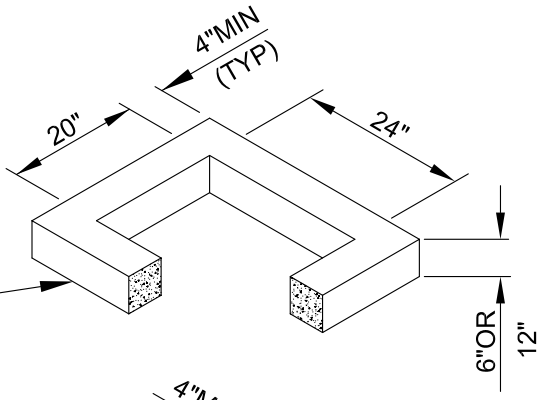
DRAWING INDEX



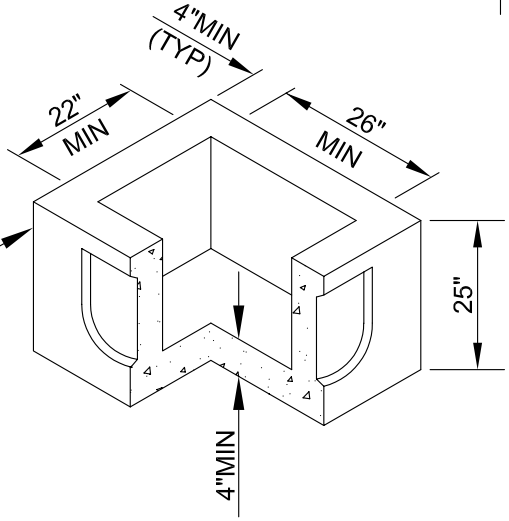
FRAME AND OPEN GRATE PER STD 405
VANED GRATE PER STD 406A



2"x4"x8" SOLID BRICK
USED FOR FINAL ADJUSTMENT
TO GRADE. 6" HIGH MAX



6" OR 12" CONCRETE
RISER SECTION
CLASS 4000 CONC



PRECAST CONC BASE SECTION
W/MAX OF ONE 17"Ø KNOCKOUT
PER SIDE. ENTRANCE ANGLE
TO BE LIMITED BY KNOCKOUTS
CLASS 4000 CONC
PIPE OUTER DIA PLUS
INLET WALL THICKNESS
SHALL NOT EXCEED 17".

INLET TO CONFORM TO WSDOT STANDARD PLAN B-26

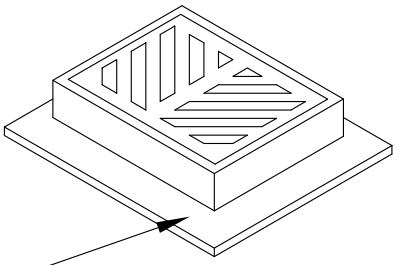
SNOHOMISH
WASHINGTON

PRECAST CONCRETE INLET

Approved By:
City Engineer
Date: May 30, 2004

401
Number

City of Snohomish Public Works Department



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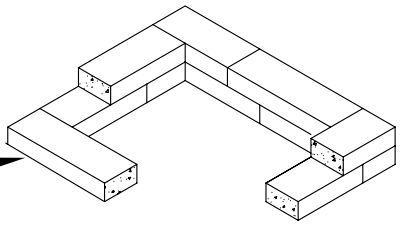
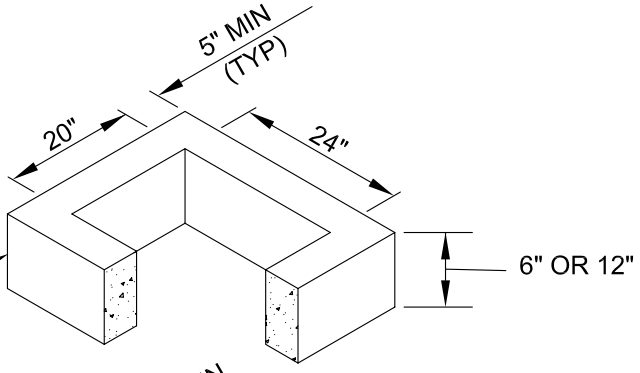
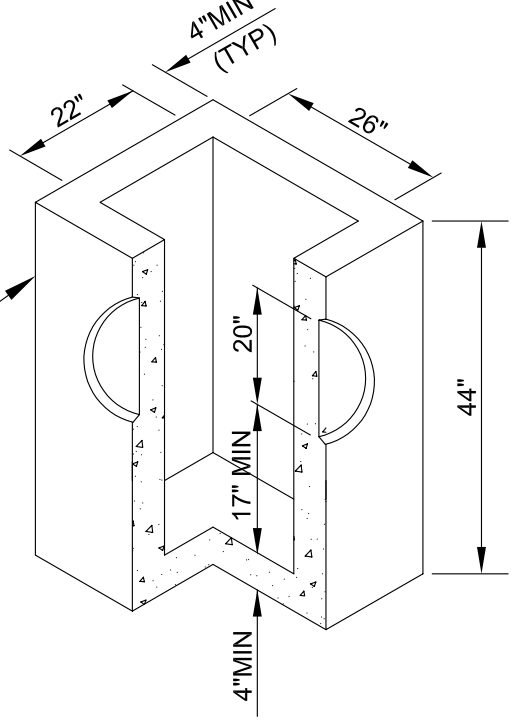
VANED GRATE PER STD 406A
SOLID COVER PER STD 406



2"x4"x8" SOLID BRICK
USED FOR FINAL ADJUSTMENT
TO GRADE. 6" HIGH MAX



6" OR 12" CONCRETE
RISER SECTION
CLASS 4000 CONC



PRECAST CONC BASE SECTION
W/MAX OF ONE 20"Ø KNOCKOUT
PER SIDE, ENTRANCE ANGLE
TO BE LIMITED BY KNOCKOUTS
CLASS 4000 CONC
PIPE OUTER DIA PLUS CB
WALL THICKNESS SHALL
NOT EXCEED 20".

CATCH BASIN TO CONFORM TO WSDOT STANDARD PLAN B-1

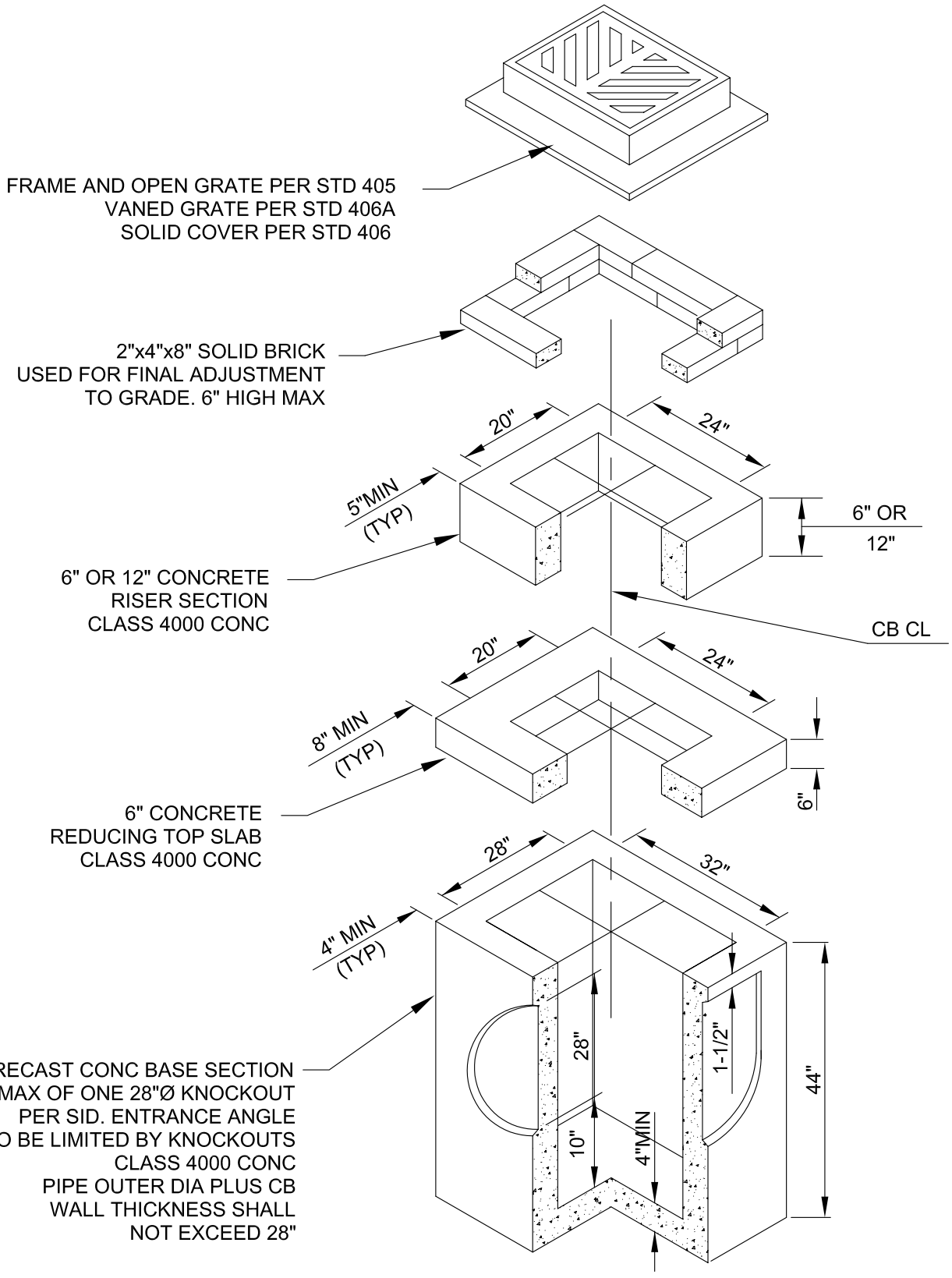
SNOHOMISH
WASHINGTON

CATCH BASIN TYPE A

Approved By:
City Engineer
Date: May 30, 2004

402
Number

City of Snohomish Public Works Department



CATCH BASIN TO CONFORM TO WSDOT STANDARD PLAN B-1A

SNOHOMISH
WASHINGTON

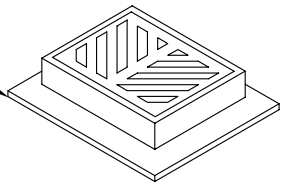
CATCH BASIN TYPE B

Approved By:
City Engineer
Date: May 30, 2004

403
Number

City of Snohomish Public Works Department

FRAME AND OPEN GRATE PER STD 405
VANED GRATE PER STD 406A
SOLID COVER PER STD 406



2"x4"x8" SOLID BRICK
USED FOR FINAL ADJUSTMENT
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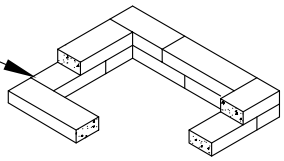
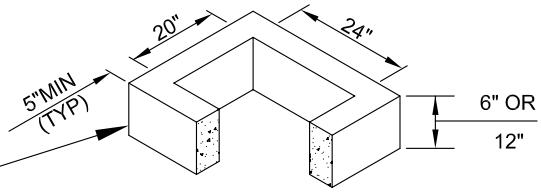
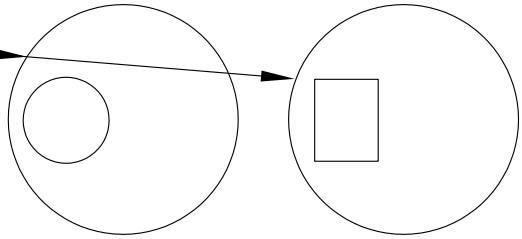




6" OR 12" CONCRETE
RISER SECTION
CLASS 4000 CONC

TOP SLAP WITH
24" ROUND ACCESS OR
20"x24" RECTANGULAR ACCESS



NOTES:

1 ALL TYPE 2 CB'S EQUIPPED WITH OPEN GRATES SHALL BE LOCKING TYPE.

2 ALL TYPE 2 CB'S NOT IN PAVED AREAS SHALL BE EQUIPPED WITH LOCKING LIDS,

3 CB'S SHALL BE SET SO THAT STEPS ARE DIRECTLY UNDER OPENING.

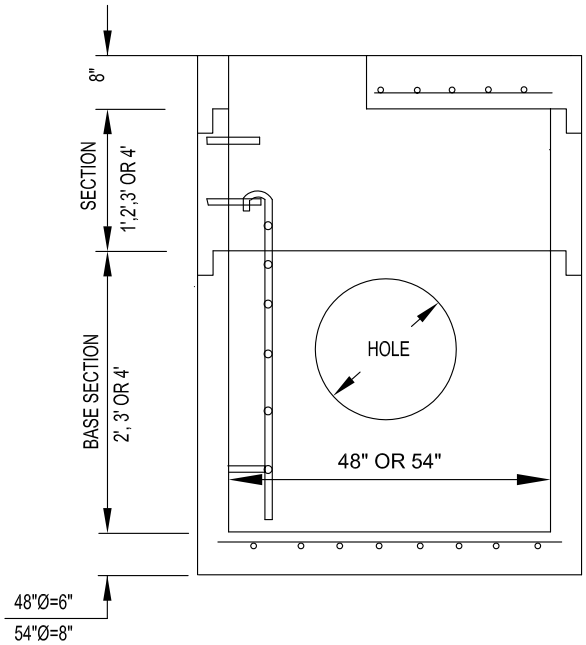
4 ALL TYPE 2 CB'S SHALL BE EQUIPPED WITH STEPS AND LADDER PER STD 606.

5 CONCRETE SHALL BE CLASS 4000.

6 MIN DISTANCE FROM INVERT TO CB BOTTOM SHALL BE 2.0'.

7 CB SECTIONS AND LID WILL BE HS20 TRAFFIC LOAD CERTIFIED BY MFG.

8 HOLE SIZE = PIPE OD + 5". MAX
MAX HOLE SIZE = 36" (48"° CB)
MAX HOLE SIZE = 42" (54"° CB)



CATCH BASIN TO CONFORM TO WSDOT STANDARD PLAN B-1E

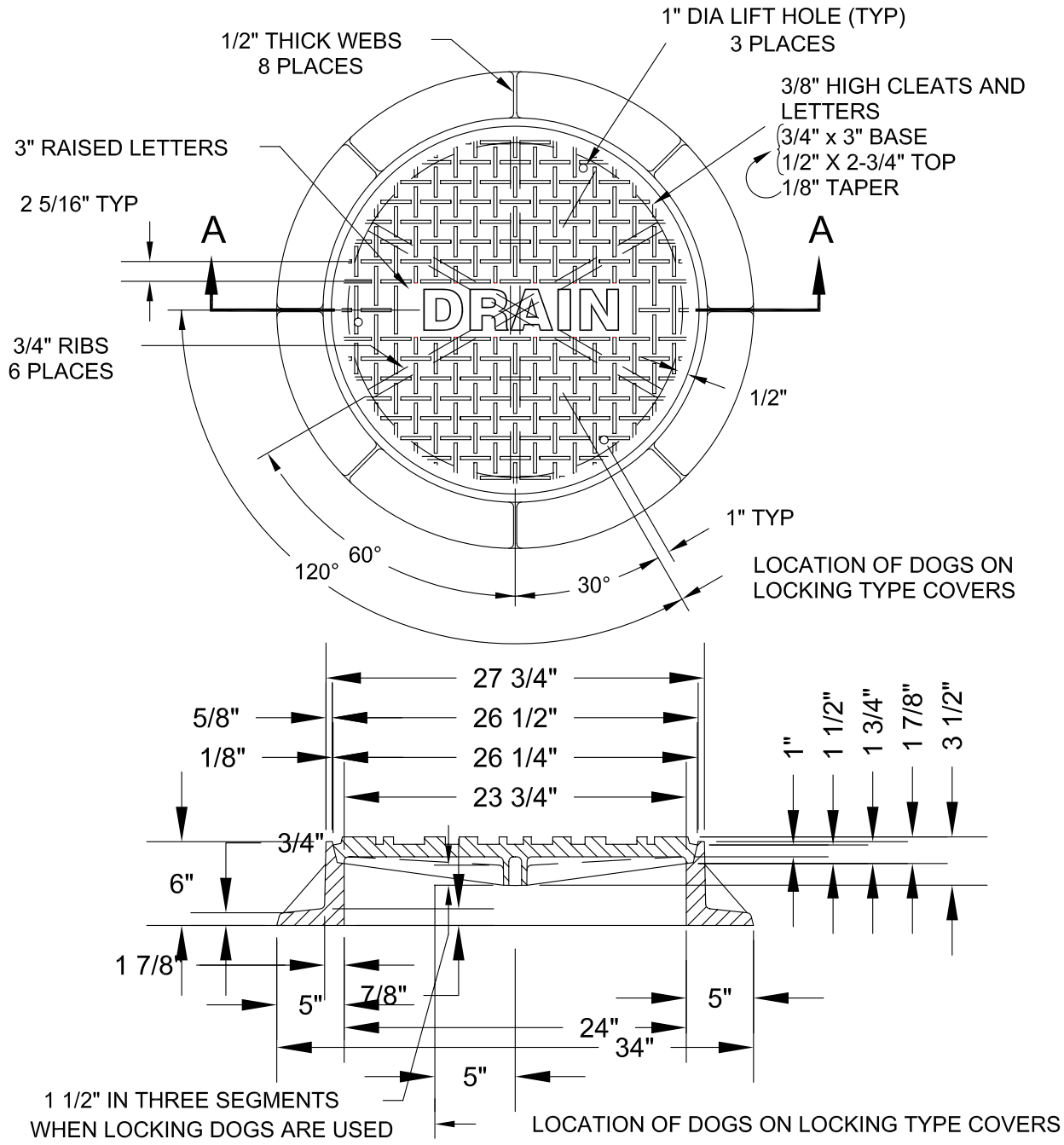
SNOHOMISH
WASHINGTON

CATCH BASIN TYPE 2 (48" OR 54")

Approved By:
City Engineer
Date: May 30, 2004

404
Number

City of Snohomish Public Works Department



SECTION A-A

NOTES:

1. MANHOLE RINGS SHALL BE GRAY IRON CONFORMING TO THE REQUIREMENTS OF AASHTO M 105, GRADE 30B.
2. MANHOLE COVER TO BE DUCTILE IRON CONFORMING TO ASTM A536, GR 80-55-06
3. LOCKING COVER TO BE USED AT OFF-STREET LOCATIONS AND OTHER LOCATIONS AS DIRECTED. THE LID SHALL BE LOCKED DOWN WITH 3-5/8" S.S SOCKET HEAD CAP SCREWS.
4. RING AND COVER SHALL BE TESTED FOR ACCURACY OF FIT AND SHALL BE MARKED IN SETS FOR DELIVERY.
5. ALL CASTINGS TO HAVE A BITUMINOUS COATING.

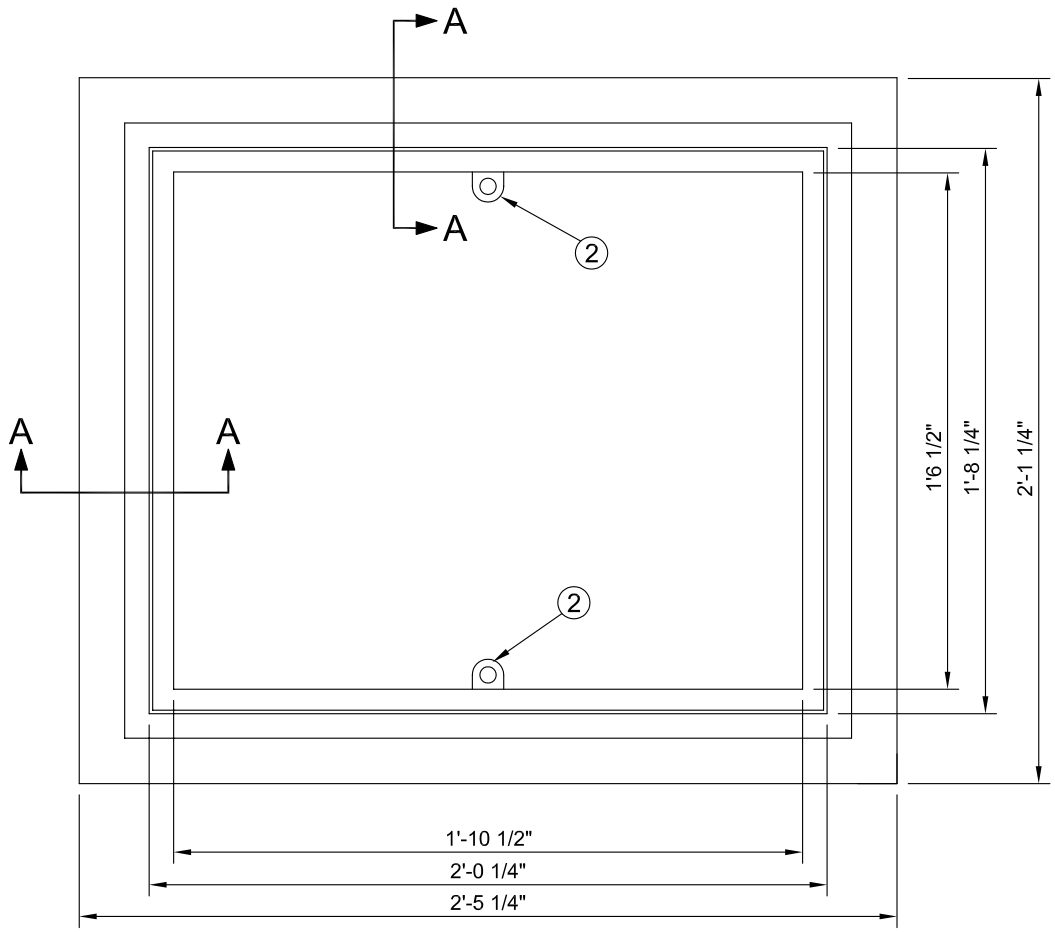
SNOHOMISH
WASHINGTON

STORM DRAIN MANHOLE RING AND COVER

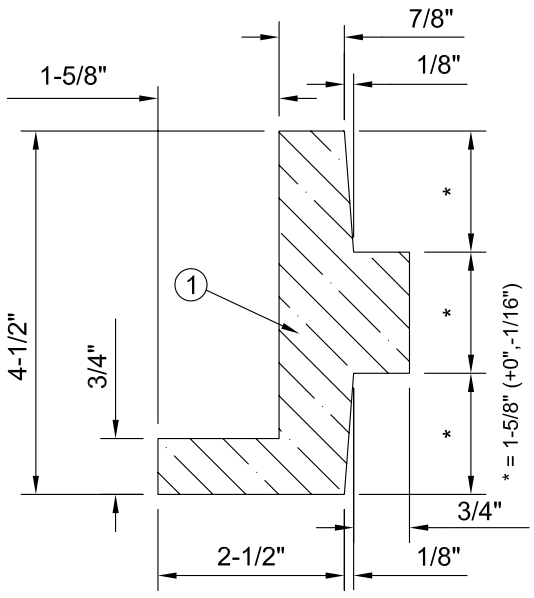
Approved By:
City Engineer
Date: May 30, 2004

405
Number

City of Snohomish Public Works Department



TOP VIEW



SECTION A-A

NOTES:

1. MATERIAL USED SHALL BE CAST IRON PER ASTM-A48, CLASS 30. FRAME SHALL HAVE A BITUMINOUS COATING APPLIED.
2. WHEN A LOCKING GRATE OR COVER IS REQUIRED THE FRAME SHALL BE FABRICATED SO AS TO ACCEPT TWO (2) 5/8" STAINLESS STEEL SOCKET HEAD CAP SCREWS OF GRATE OR COVER.
3. FOR APPROVED GRATES AND SOLID MANHOLE COVER SEE STD DWG'S 405A, 406A, 406B & 406C

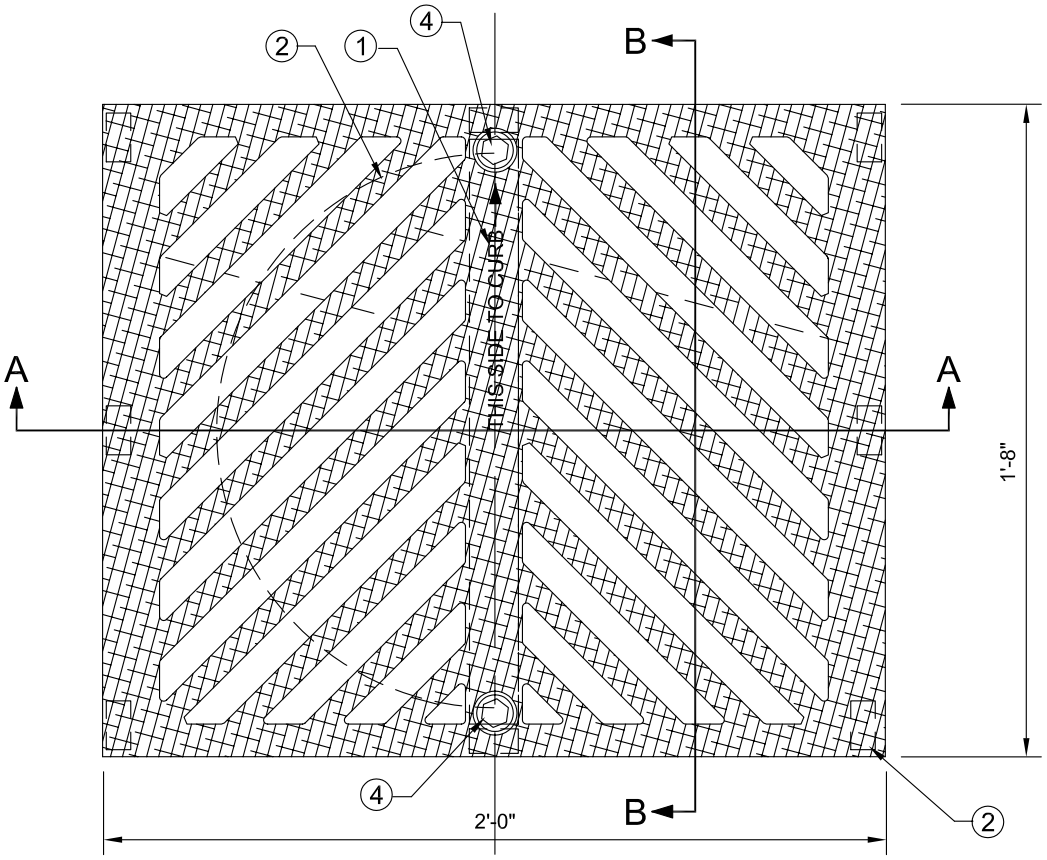
SNOHOMISH WASHINGTON

FRAME FOR GRATE OR SOLID COVER

Approved By:
City Engineer
Date: May 30, 2004

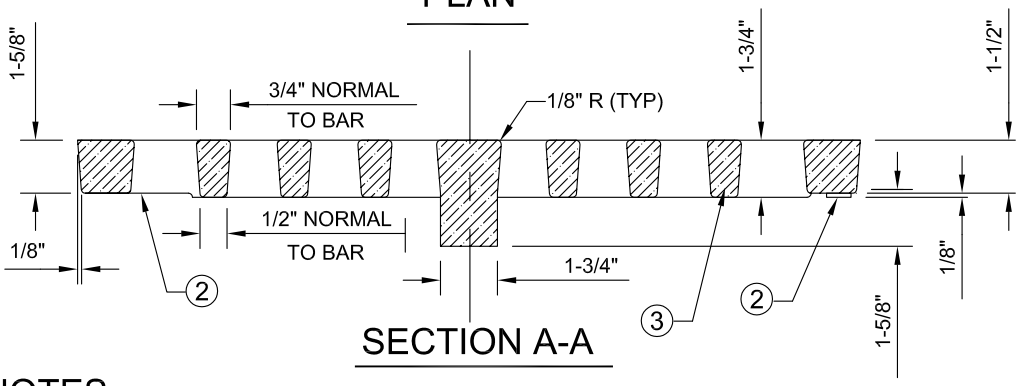
405a
Number

City of Snohomish Public Works Department



PLAN

SECTION B-B



SECTION A-A

NOTES:

1. FOUNDRY NAME, THIS SIDE TO CURB W/ARROW AND (DI) FOR DUCTILE IRON SHALL BE EMBOSSED ON TOP OF GRATE WITH 1/16" RECESSED LETTERS.
2. SEATING OF GRATE SHALL BE ACCOMPLISHED BY ONE OF THE FOLLOWING:
   A.8 INTEGRALLY CAST PADS (1-1/2"x3/4"x1/8").
   B. MACHINE BOTTOM SURFACE OUTSIDE A 17" DIA
3. MATERIAL USED SHALL BE DUCTILE IRON PER ASTM-A536, GRADE 80-55-06. ALL CASTINGS SHALL HAVE A BITUMINOUS COATING.
4. WHEN LOCKING GRATE REQUIRED HOLES WILL BE PROVIDED IN CASTING TO ALLOW FOR TWO 5/8" DIA STAINLESS STEEL SOCKET HEAD CAP SCREWS SO THAT NO PART OF HEAD PROTRUDES ABOVE TOP OF CASTING.
5. GRATE TO BE USED WITH FRAME SHOWN IN STANDARD DWG 405.

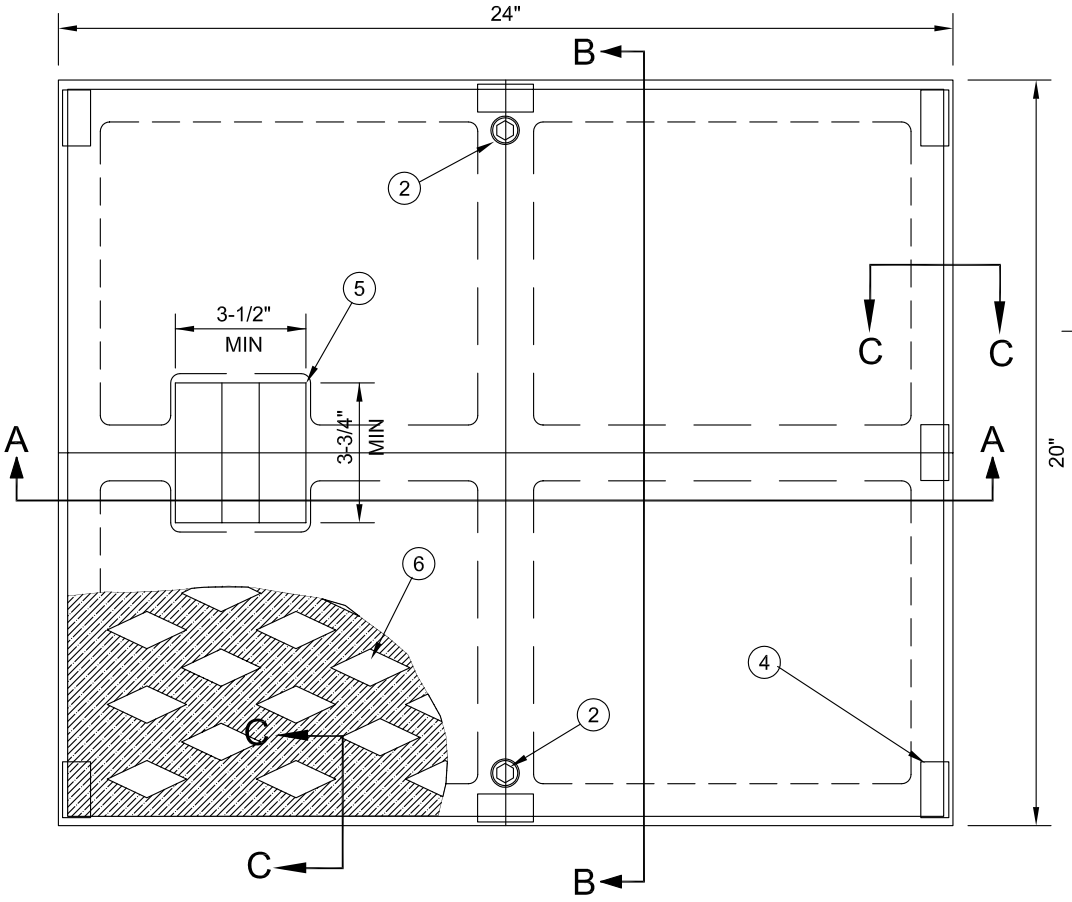
SNOHOMISH
WASHINGTON

GRATE FOR CATCH BASIN OR INLET

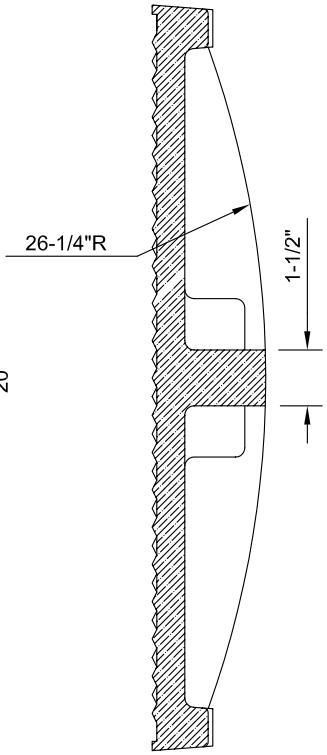
Approved By:
City Engineer
Date: May 30, 2004

406a
Number

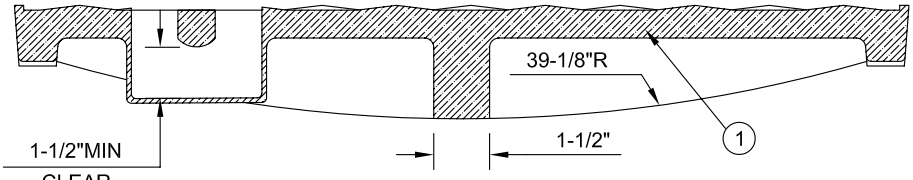
City of Snohomish Public Works Department



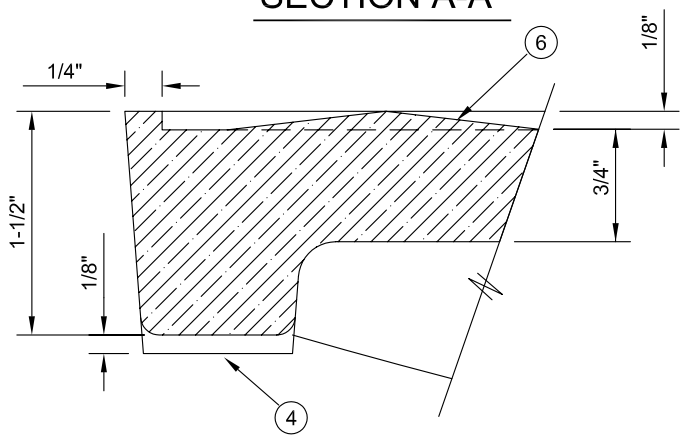
TOP VIEW



SECTION B-B



SECTION A-A



SECTION C-C

NOTE:

1. MATERIAL USED SHALL BE DUCTILE IRON PER ASTM-A536, GRADE 80-55-06, WITH BITUMINOUS COATING.
2. WHEN LOCKING GRATE REQUIRED HOLES WILL BE PROVIDED IN CASTING TO ALLOW FOR TWO 5/8" DIA STAINLESS STEEL, SOCKET HEAD CAP SCREWS. NO PART OF SCREW WILL PROTRUDE ABOVE GRATE.
3. GRATE TO BE USED WITH FRAME SHOWN IN STD DWG 405.
4. GRATE SEATING: 8 INTEGRALLY CAST PADS.
5. CAST POCKET LIFT HANDLE.
6. NON-SKID DIAMOND PATTERN APPROX 2-1/2"x1"x1/8"HIGH

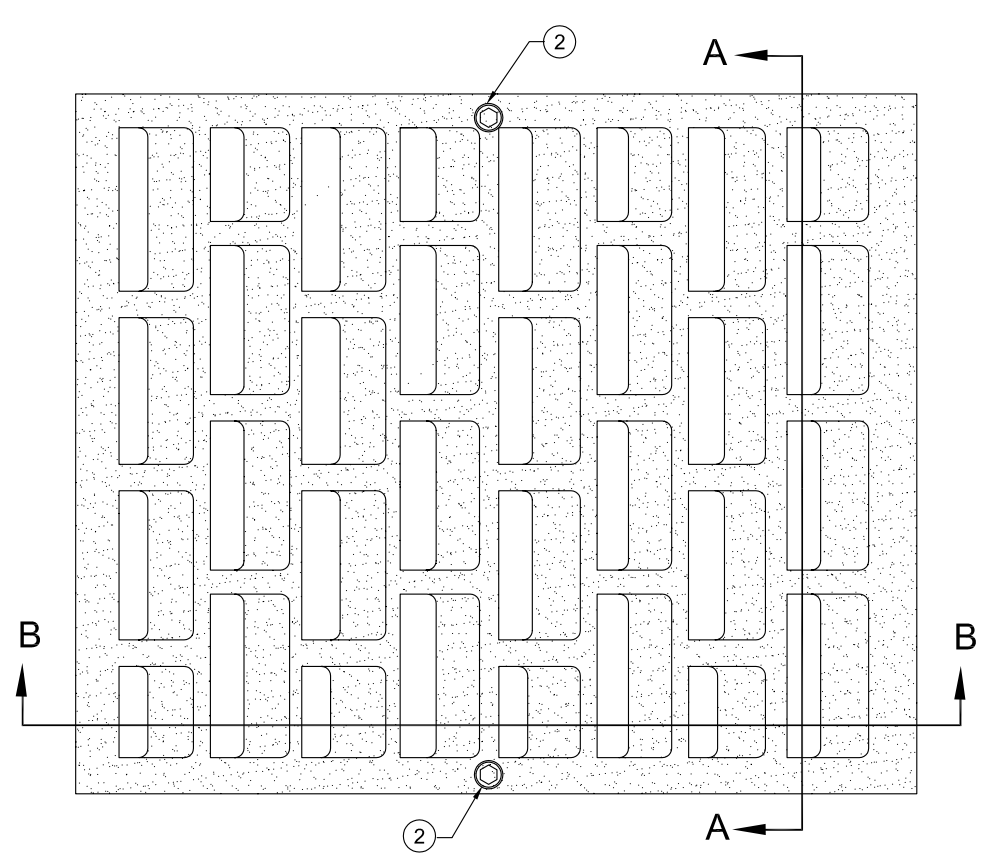
SNOHOMISH
WASHINGTON

SOLID LID COVER FOR CATCH BASIN OR INLET

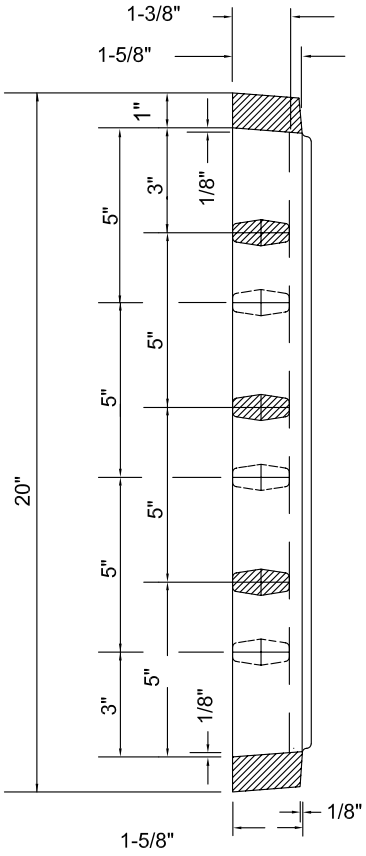
Approved By:
City Engineer
Date: May 30, 2004

406b
Number

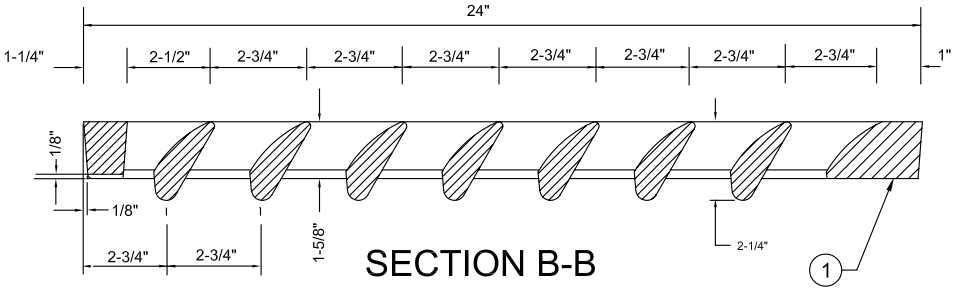
City of Snohomish Public Works Department



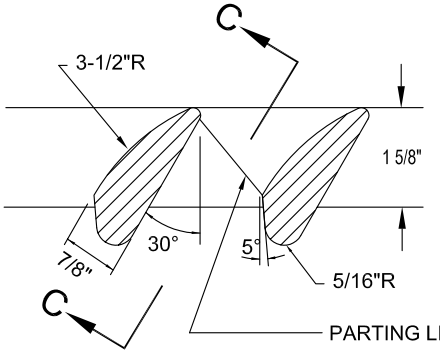
TOP VIEW



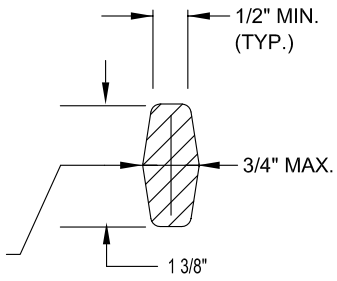
SECTION A-A



SECTION B-B



VANE DETAIL



SECTION C-C

NOTE:

1. MATERIAL USED SHALL BE DUCTILE IRON PER ASTM-A536, GRADE 80-55-06, WITH BITUMINOUS COATING.
2. WHEN LOCKING GRATE REQUIRED HOLES WILL BE PROVIDED IN CASTING TO ALLOW FOR TWO 5/8" DIA STAINLESS STEEL, SOCKET HEAD CAP SCREWS. NO PART OF SCREW WILL PROTRUDE ABOVE GRATE.
3. GRATE TO BE USED WITH FRAME SHOWN IN STD DWG 405.

W.S.D.O.T. STD PLAN B-2B

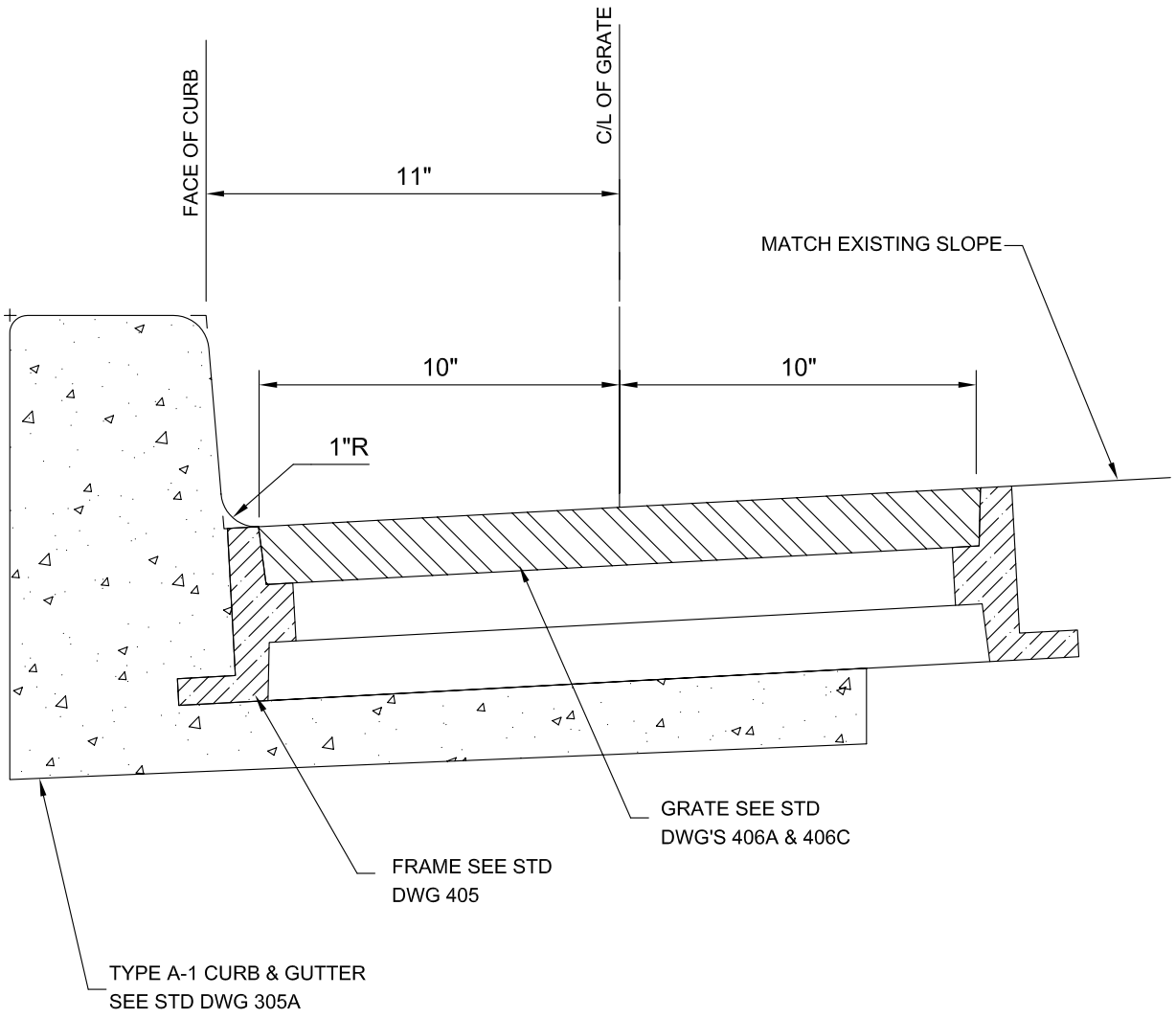
SNOHOMISH
WASHINGTON

VANED GRATE FOR CATCH BASIN OR INLET

Approved By:
City Engineer
Date: May 30, 2004

406c
Number

City of Snohomish Public Works Department



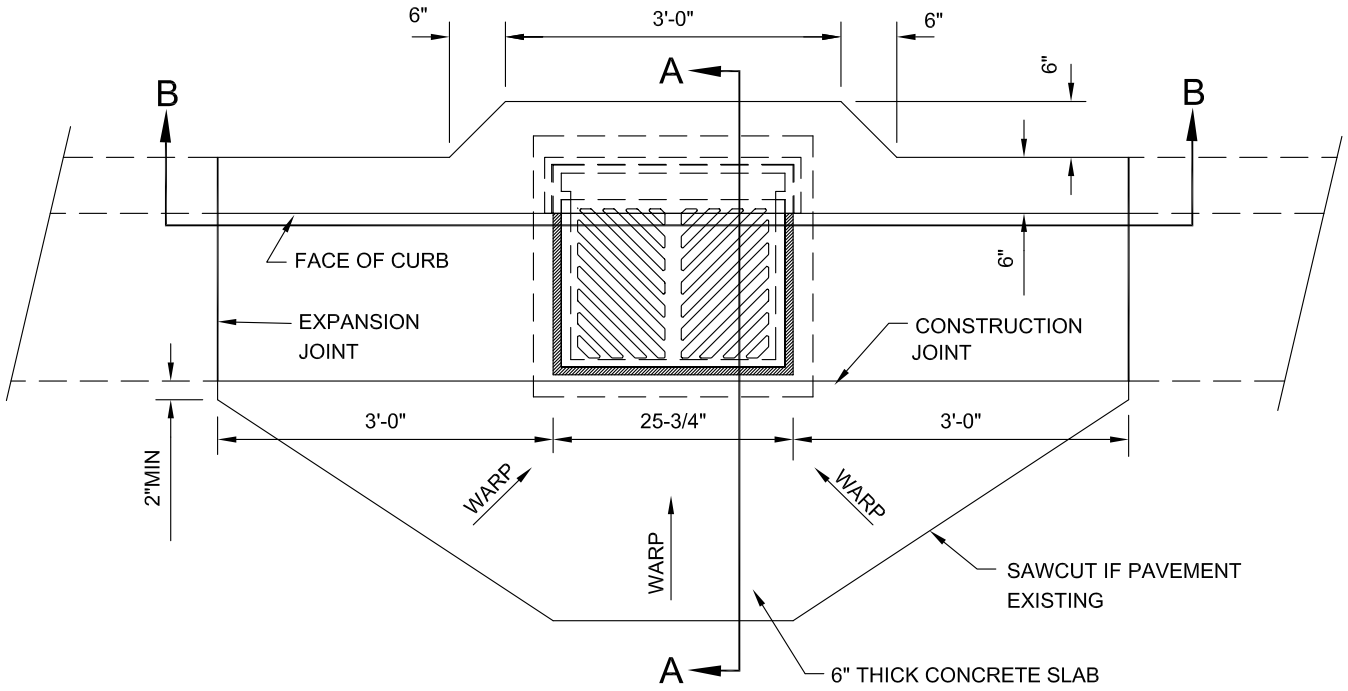
SNOHOMISH
WASHINGTON

TYPICAL FRAME AND GRATE INSTALLATION

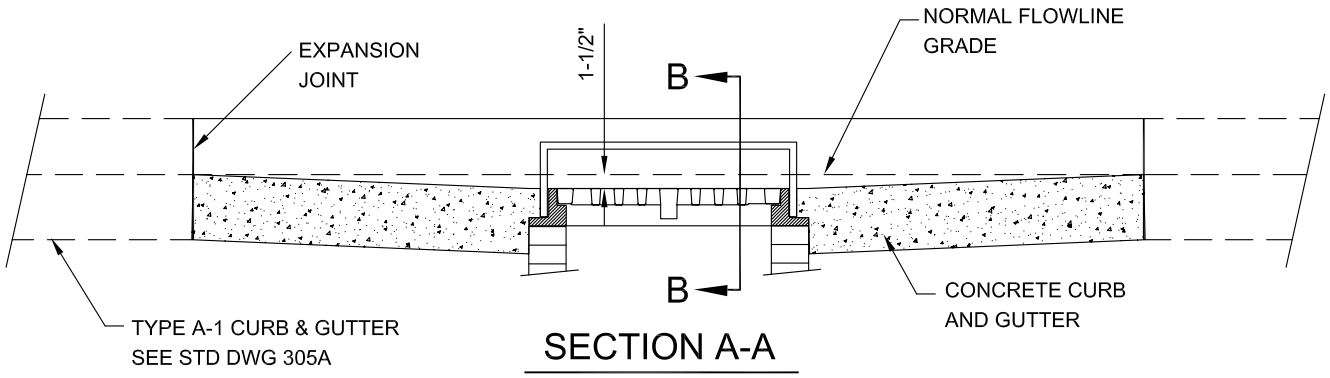
Approved By:
City Engineer
Date: May 30, 2004

407
Number

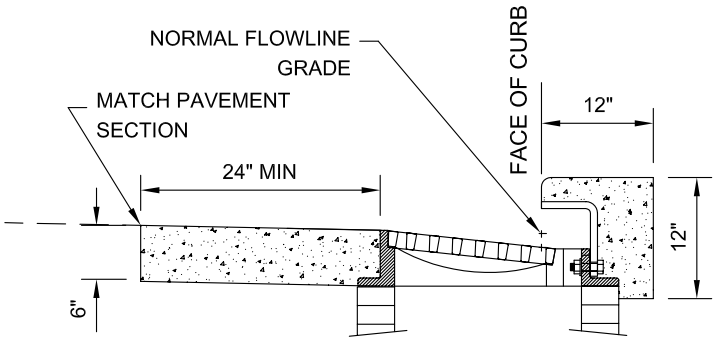
City of Snohomish Public Works Department



TOP VIEW



SECTION A-A



SECTION B-B

NOTES:

1. INSTALLATION OF OPEN CURB FACE FRAME AND GRATE MUST BE APPROVED BY CITY ENGINEER ON A CASE BY CASE BASIS.

   PROBLEMS OF FLOATABLE MATERIAL ENTERING STORM DRAINAGE SYSTEM BY USE OF THIS INSTALLATION MUST BE ADDRESSED.

2. SEE STD DWG 409 FOR FRAME AND GRATE DETAILS.

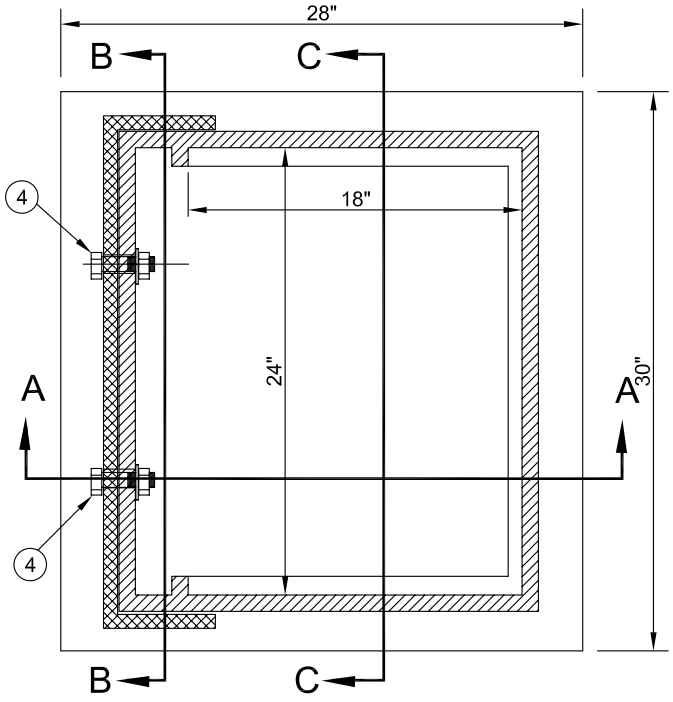
SNOHOMISH
WASHINGTON

OPEN CURB FACE FRAME AND GRATE INSTALLATION

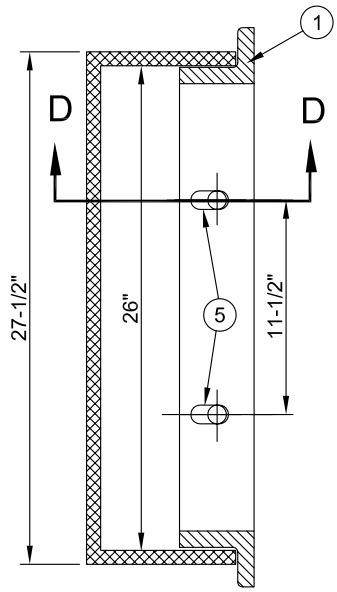
Approved By:
City Engineer
Date: May 30, 2004

408
Number

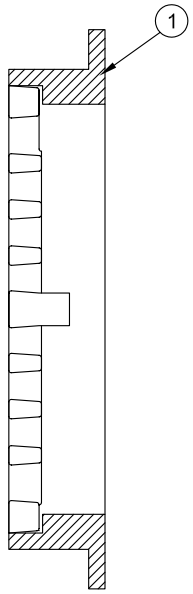
City of Snohomish Public Works Department



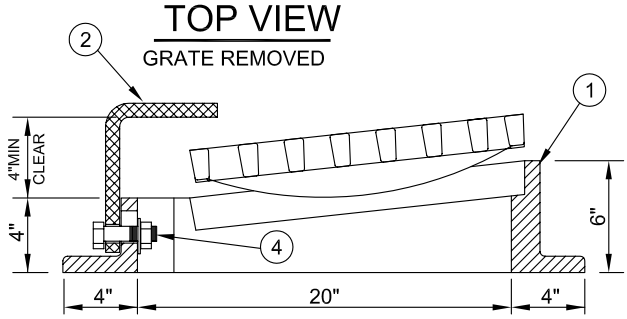
TOP VIEW



SECTION B-B

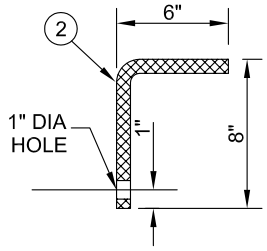


SECTION C-C

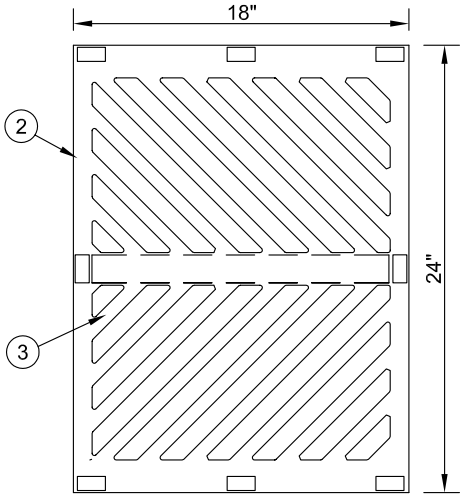


SECTION A-A

GRATE RAISED



SECTION D-D



GRATE TOP VIEW

NOTES:

1. FRAME MATERIAL SHALL BE CAST IRON ASTM A48, CLASS 30, WITH A BITUMINOUS COATING.
2. GRATE AND COVER MATERIAL SHALL BE DUCTILE IRON ASTM A536, GRADE 80-55-06 WITH BITUMINOUS COATING.
3. GRATE TO BE FABRICATED PER STANDARD DWG 406A WITH OVER ALL DIMENSIONS OF 24"x18".
4. PROVIDE 3/4" BOLT, NUT AND WASHERS
5. ADJUSTMENT SLOT IN FRAME CASTING APPROXIMATELY 1"x2". VERTICAL PLACEMENT TO PROVIDE MIN CLEARANCE BETWEEN GRATE AND COVER PLATE.
6. SEE STANDARD DWG 408 FOR INSTALLATION DETAILS.

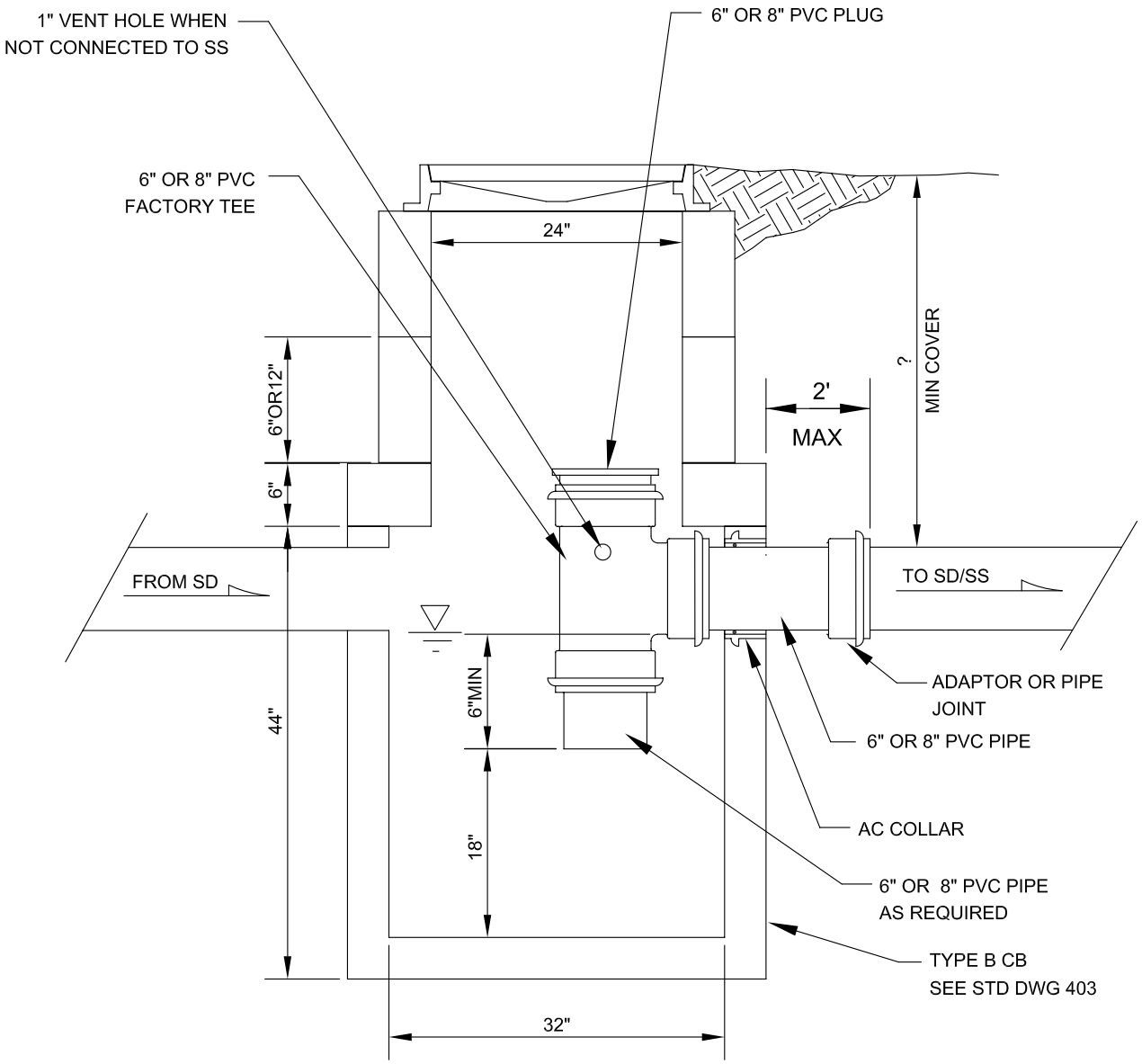
SNOHOMISH WASHINGTON

OPEN CURB FACE FRAME AND GRATE INSTALLATION

Approved By:
City Engineer
Date: May 30, 2004

409
Number

City of Snohomish Public Works Department



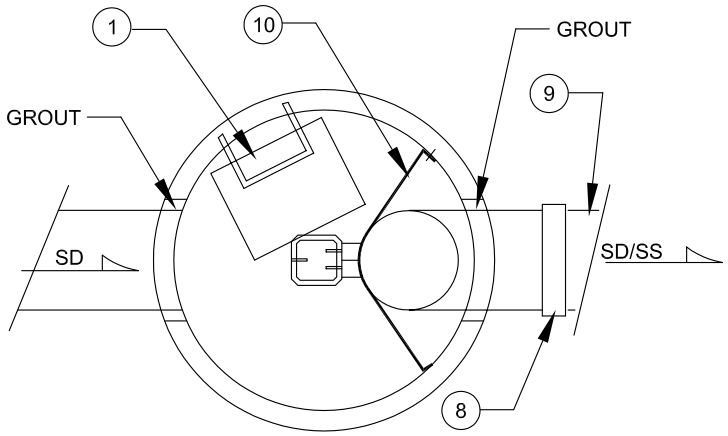
SNOHOMISH
WASHINGTON

FLOATABLE MATERIAL SEPARATOR AND/OR GAS TRAP (6" OR 8")

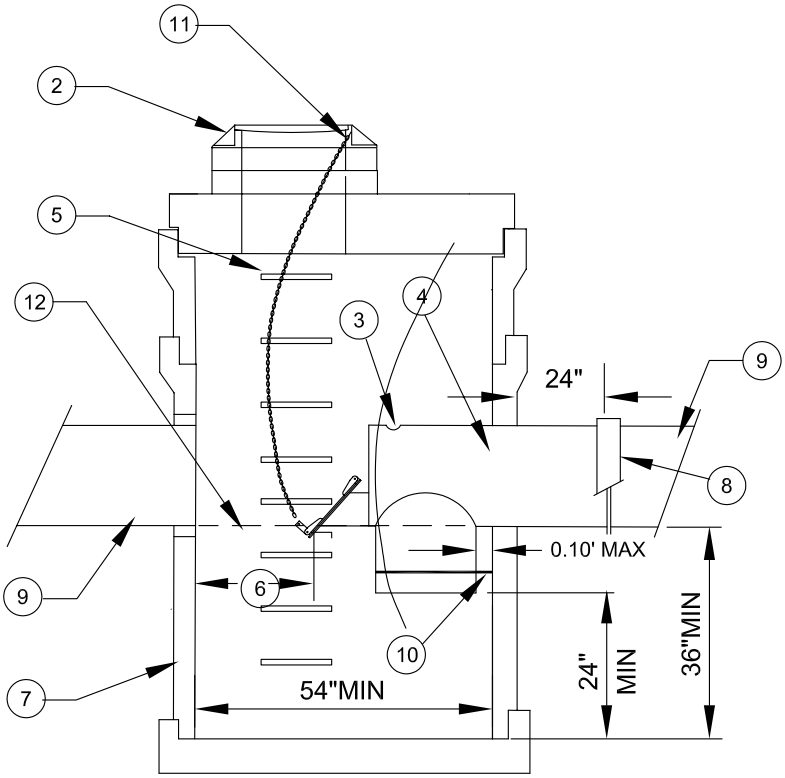
Approved By:
City Engineer
Date: May 30, 2004

410
Number

City of Snohomish Public Works Department



PLAN



ELEVATION

NOTES:

1. INSTALL CB TOP, FRAME, GRATE AND SECTIONS SO THAT LIFT GATE IS VISIBLE THROUGH OPENING AND STEPS CLEAR INLET AND RESTRICTOR UNIT.
2. INSTALL LOCKING FRAME & GRATE OR LID PER STD DWG 405 . FRAME AND LID PER STD DWG 405 IS REQUIRED IF INSTALLATION IN NOT IN PAVED AREA OR IS NOT TO FUNCTION AS A CB.
3. 1" VENT HOLE WHEN NOT CONNECTED TO TO COMBINED SANITARY SEWER SYSTEM.
4. SEPARATOR ASSEMBLY SEE STD DWG 412B & 412C AS APPLICABLE.
5. STEPS PER STD DWG 606.
6. MIN CLEARANCE: 36"FOR OUTLETS OF 24" AND LARGER 18" FOR OUTLETS OF 18" AND SMALLER
7. 54" TYPE 2 CB OR LARGER.
8. BAND STRAP WITH GASKET
9. SEE PLAN AND SPECIFICATIONS FOR SIZE AND TYPE OF PIPE ENTERING AND EXITING CB.
10. SECURE SEPARATOR TO CB WITH 8 GA ALUMINUM STRAP. BOLT TO CB WALL WITH STAINLESS STEEL ANCHOR BOLTS AND TACK WELD TO SEPARATOR UNIT.
11. BOLT OR WELD CHAIN TO FRAME.
12. INVERT ELEVATION: SEE PLANS AND SPECIFICATIONS.

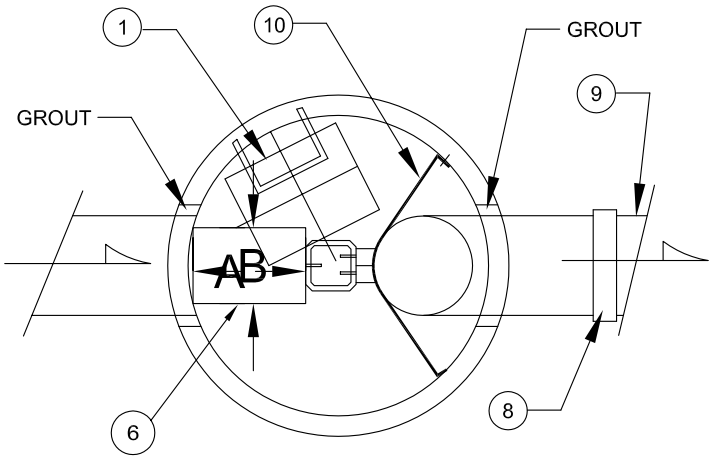
SNOHOMISH WASHINGTON

FLOATABLE MATERIAL SEPARATOR AND/OR GAS TRAP (12" AND LARGER)

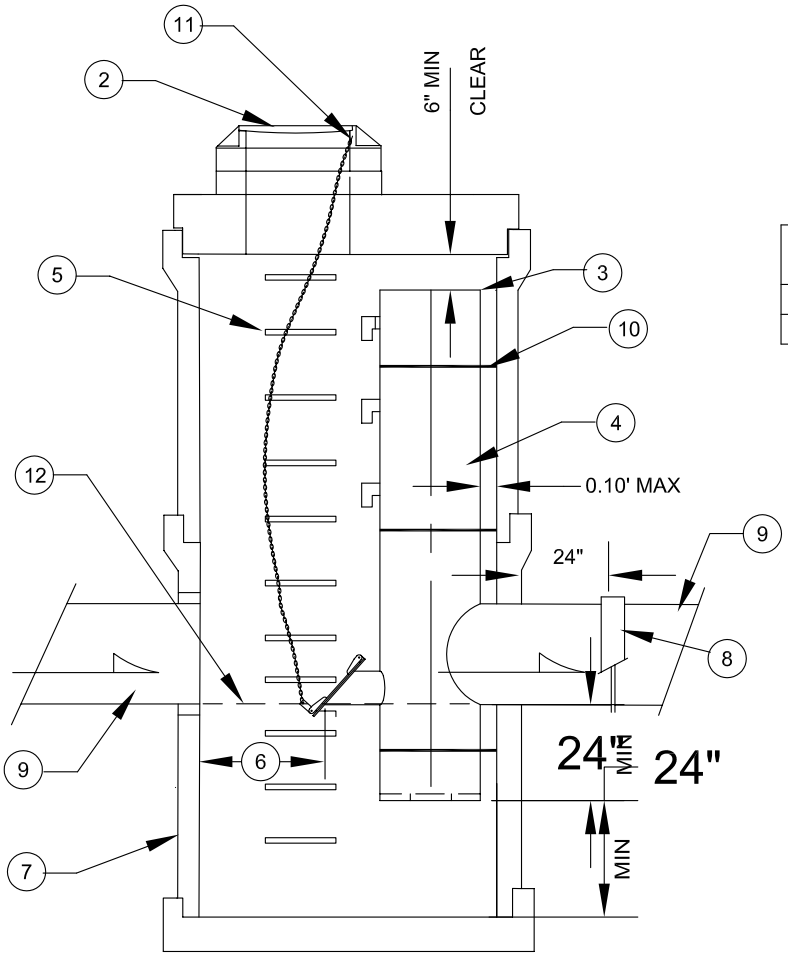
Approved By:
City Engineer
Date: May 30, 2004

411
Number

City of Snohomish Public Works Department



PLAN



ELEVATION

NOTES:

1. INSTALL CB TOP, FRAME, GRATE AND SECTIONS SO THAT LIFT GATE IS VISIBLE THROUGH OPENING AND STEPS CLEAR INLET AND RESTRICTOR UNIT.
2. INSTALL LOCKING FRAME & GRATE OR LID PER STD DWG 405. FRAME AND LID PER STD DWG 405 IS REQUIRED IF INSTALLATION IS NOT IN PAVED AREA OR IS NOT TO FUNCTION AS A CB.
3. OVERFLOW ELEVATION.
4. RESTRICTOR ASSEMBLY SEE STD DWG 412B & 412C.
5. STEPS PER STD DWG 606.
6. MIN CLEARANCE:
   36"FOR OUTLETS OF 24" AND LARGER
   18" FOR OUTLETS OF 18" AND SMALLER
6. MAINTENANCE CLEAR ZONE:
   THIS AREA IS REQUIRED FOR CLEANING AND WILL BE FREE OF OBSTRUCTIONS FROM GATE TO TOP OF STRUCTURE.

DIM	OUTLET SIZE	
	18" AND SMALLER	24" AND LARGER
A	18"	36"
B	18"	24"

7. 54" TYPE 2 CB OR LARGER.
8. BAND STRAP WITH GASKET
9. SEE PLAN AND SPECIFICATIONS FOR SIZE AND TYPE OF PIPE ENTERING AND EXITING CB.
10. SECURE RESTRICTOR TO CB WITH 8 GA ALUMINUM STRAPS BOLT TO CB WALL WITH STAINLESS STEEL ANCHOR BOLTS AND TACK WELD TO RESTRICTOR UNIT. ONE STRAP ABOVE AND BELOW OUTLET REQUIRED, INTERMEDIATE STRAPS REQUIRED FOR RESTRICTOR RISERS GREATER THAN 12' ABOVE OUTLET.
11. BOLT OR WELD CHAIN TO FRAME.
12. INVERT ELEVATION: SEE PLANS AND SPECIFICATIONS.

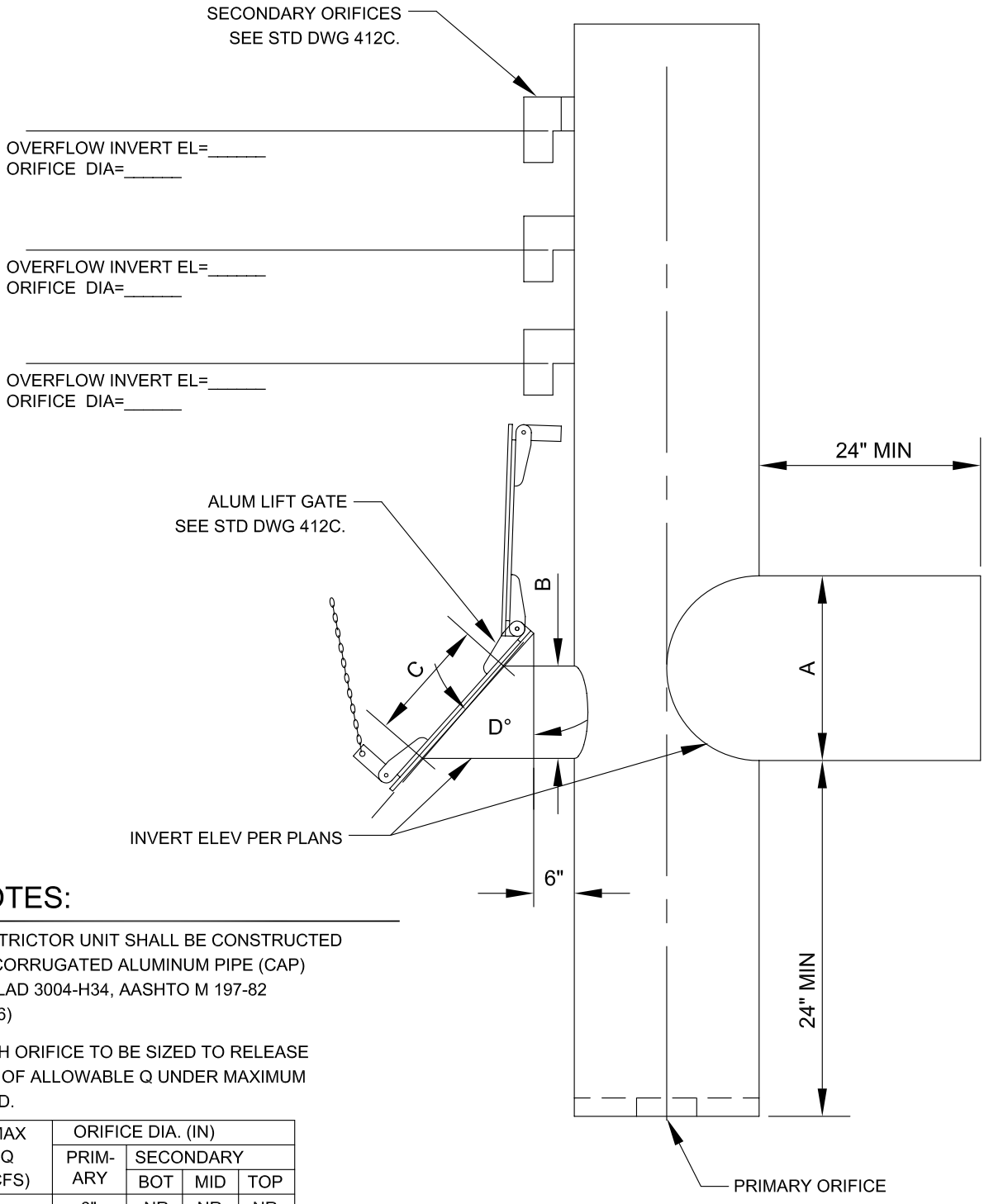
SNOHOMISH WASHINGTON

TYPICAL RESTRICTOR INSTALLATION

Approved By:
City Engineer
Date: May 30, 2004

412a
Number

City of Snohomish Public Works Department



NOTES:

1 RESTRICTOR UNIT SHALL BE CONSTRUCTED OF CORRUGATED ALUMINUM PIPE (CAP) ALCLAD 3004-H34, AASHTO M 197-82 (1986)

2 EACH ORIFICE TO BE SIZED TO RELEASE 25% OF ALLOWABLE Q UNDER MAXIMUM HEAD.

MAX Q (CFS)	ORIFICE DIA. (IN)			
	PRIM-ARY	SECONDARY		
		BOT	MID	TOP
0-5	3"	NR	NR	NR
6-10	6"	NR	NR	NR
11-25	3"	3"	NR	NR
	8"	4"	3"	NR
	9"	3"	3"	3"

ITEM	DESCRIPTION	SIZE	
A	OUTLET	18" AND SMALLER	24" AND LARGER
B	CLEANING	6" ID	10" ID
C	GATE SIZE	8" OPENING	12" OPENING
D	ANGLE	42°±	34°±

SNOHOMISH WASHINGTON

TYPICAL RESTRICTOR INSTALLATION

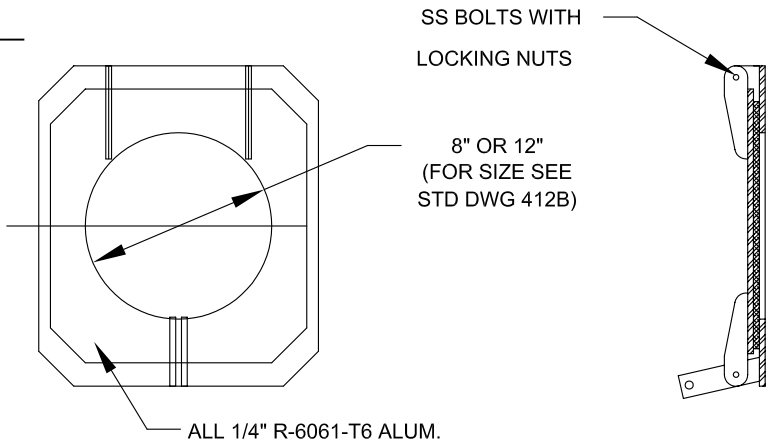
Approved By:
City Engineer
Date: May 30, 2004

412b
Number

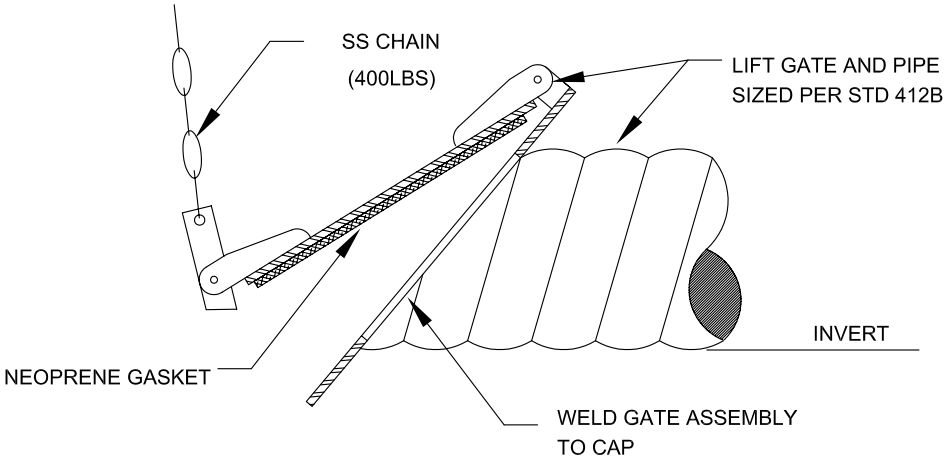
City of Snohomish Public Works Department

NOTES:

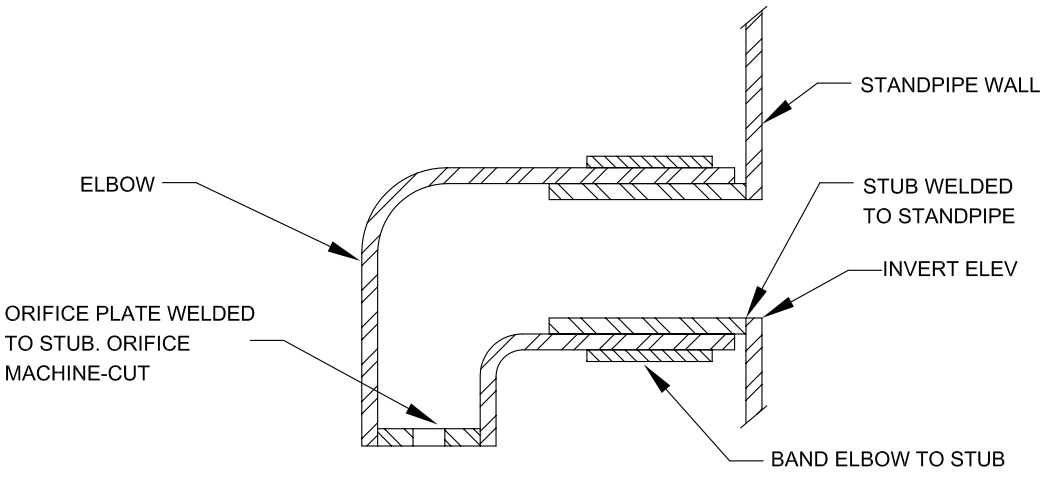
LIFT GATE SHALL BE CONSTRUCTED OF: 1/4" R-6061-T6 ALUM. W/CLOSED CELL NEOPRENE PER ASTM 1056-67 CHEMICAL RESISTANT (OIL & GREASE), OZONE RESISTANT, 67° TO +250° F SERVICE TEMP.



LIFT GATE DETAIL



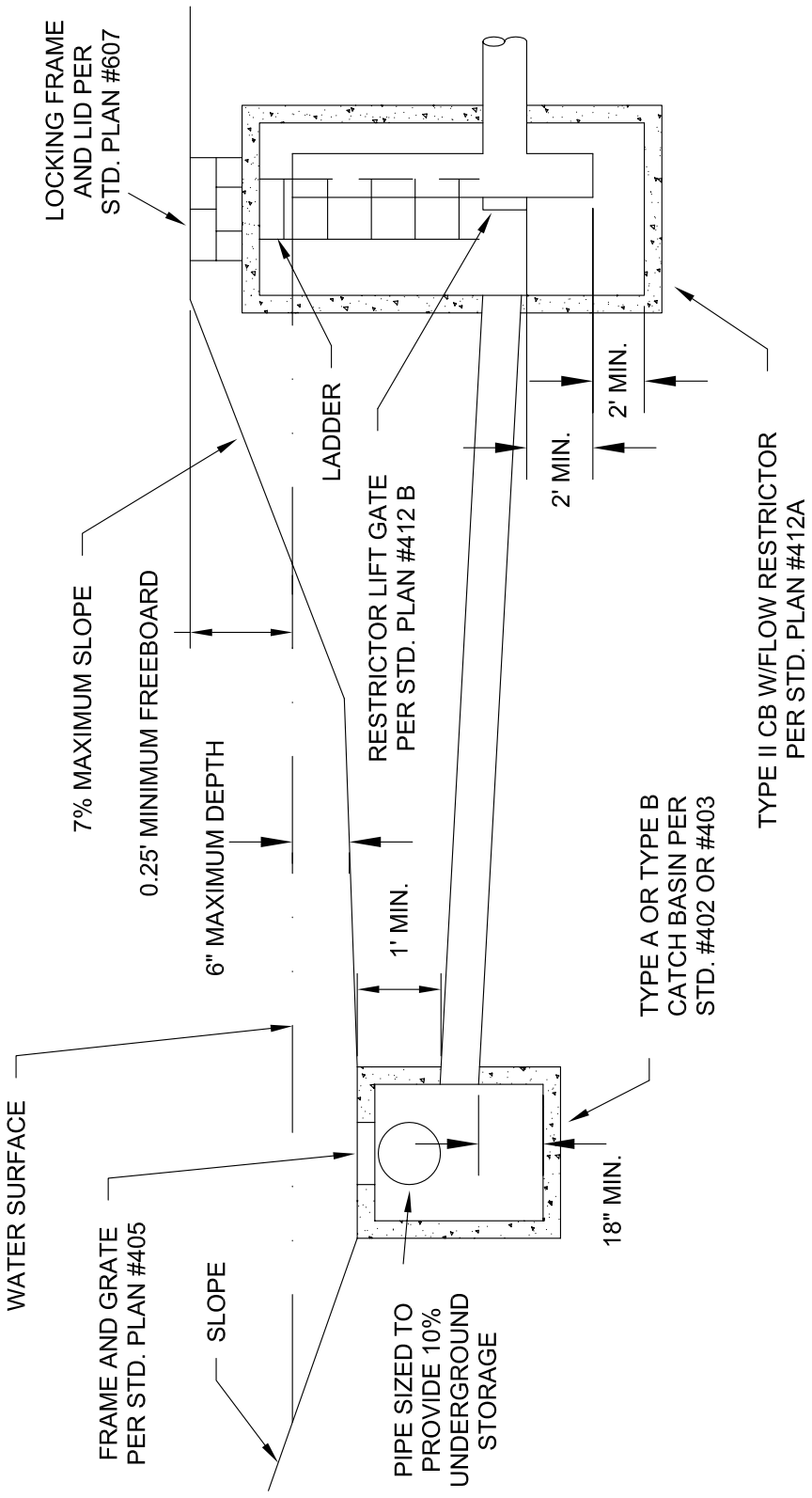
LIFT GATE ASSEMBLY



ALL PARTS TO BE R-6061-T6 ALUM

SECONDARY ORIFICE DETAIL

SNOHOMISH WASHINGTON	**LIFT GATE ASSEMBLY AND SECONDARY ORIFICE DETAIL**	Approved By: City Engineer Date: May 30, 2004	412c Number
	City of Snohomish Public Works Department		



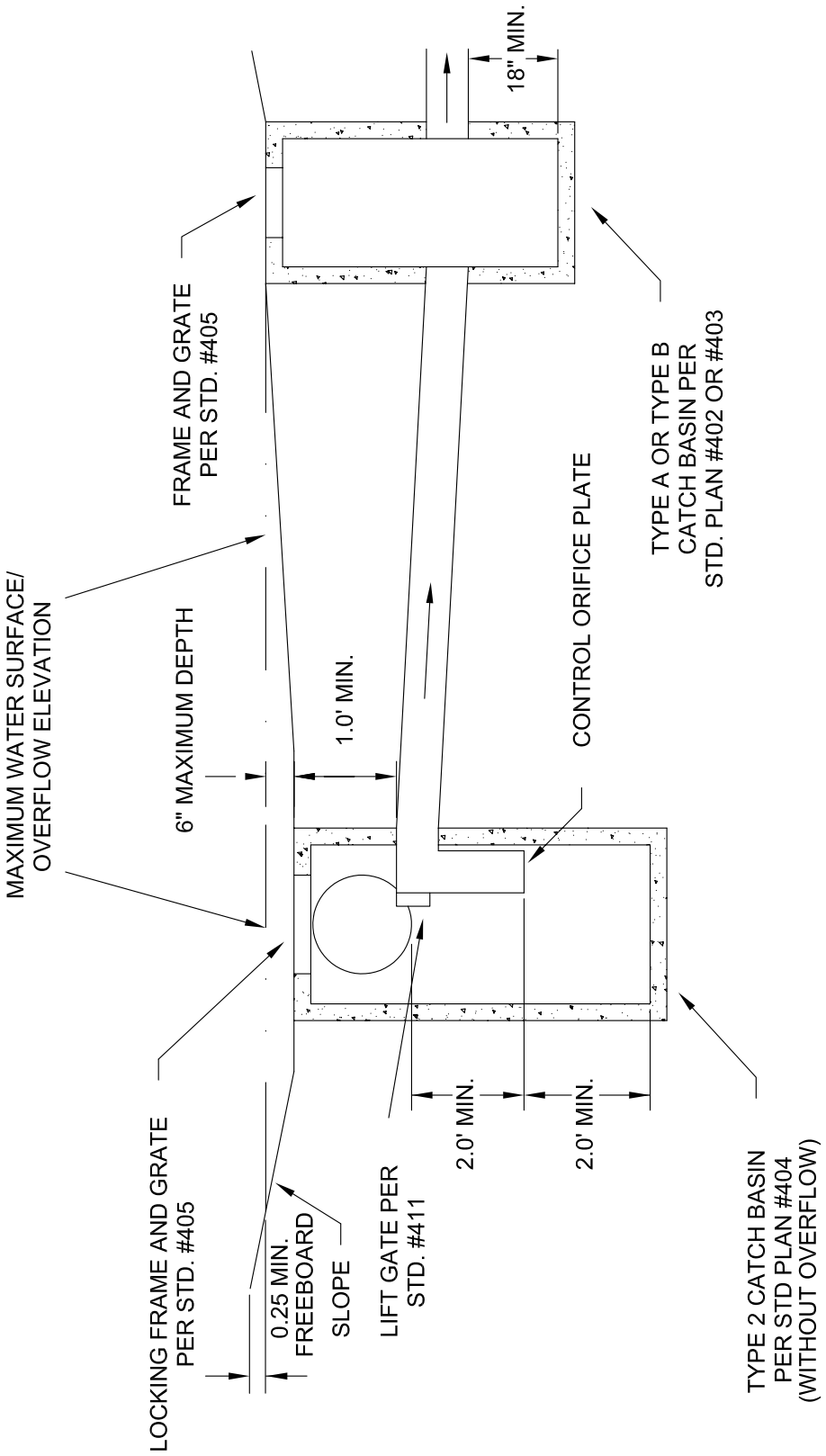
SNOHOMISH WASHINGTON

TYPICAL PARKING LOT DETENTION

Approved By:
City Engineer
Date: May 30, 2004

414
Number

City of Snohomish Public Works Department



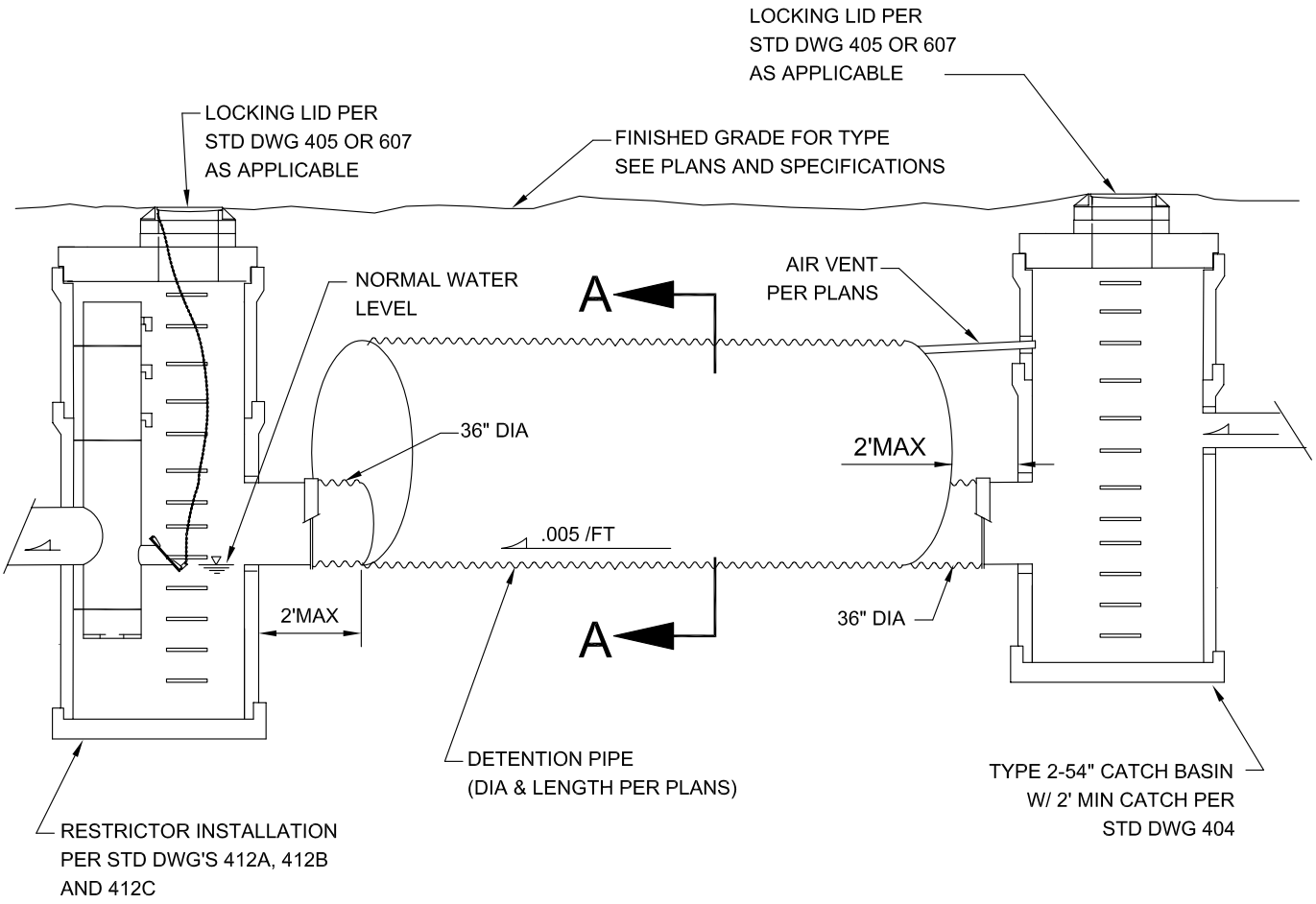
SNOHOMISH
WASHINGTON

TYPICAL PARKING LOT DETENTION

Approved By:
City Engineer
Date: May 30, 2004

415
Number

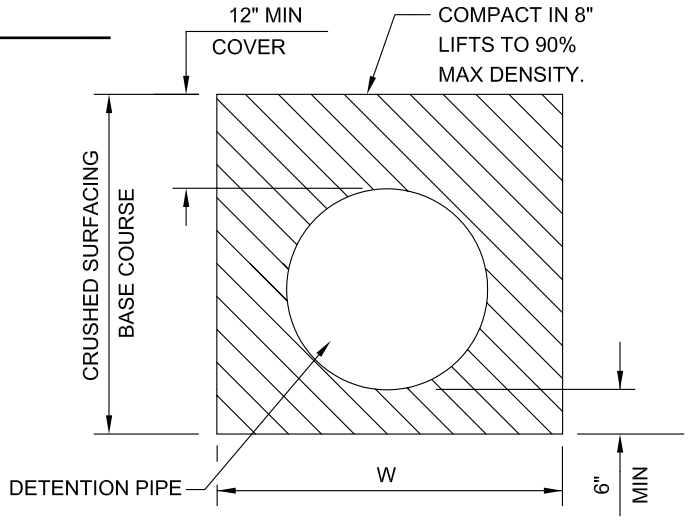
City of Snohomish Public Works Department



ELEVATION

NOTES:

1. DETENTION PIPE SHALL BE FABRICATED FROM ONE OF THE FOLLOWING:
   A. CORRUGATED STEEL PIPE
      14 GAGE MIN, WITH TREATMENT #1.
   B. CORRUGATED ALUMINIUM PIPE 12 GAGE MIN.
   C. HIGH DENSITY POLYETHYLENE PIPE.
2. ANNUAL INSPECTIONS AND CLEANING REQUIRED BY OWNER TO INSURE PROPER OPERATION OF DETENTION SYSTEM.
3. W = MAXIMUM WIDTH OF TRENCH FOR PIPES 15" OR LESS IN DIAMETER W = 40". FOR PIPES 18" OR GREATER W = 1 1/2" x I.D. + 18".
4. COMPACT IN 8" LIFTS TO 90% MAX DENSITY.



SECTION A-A

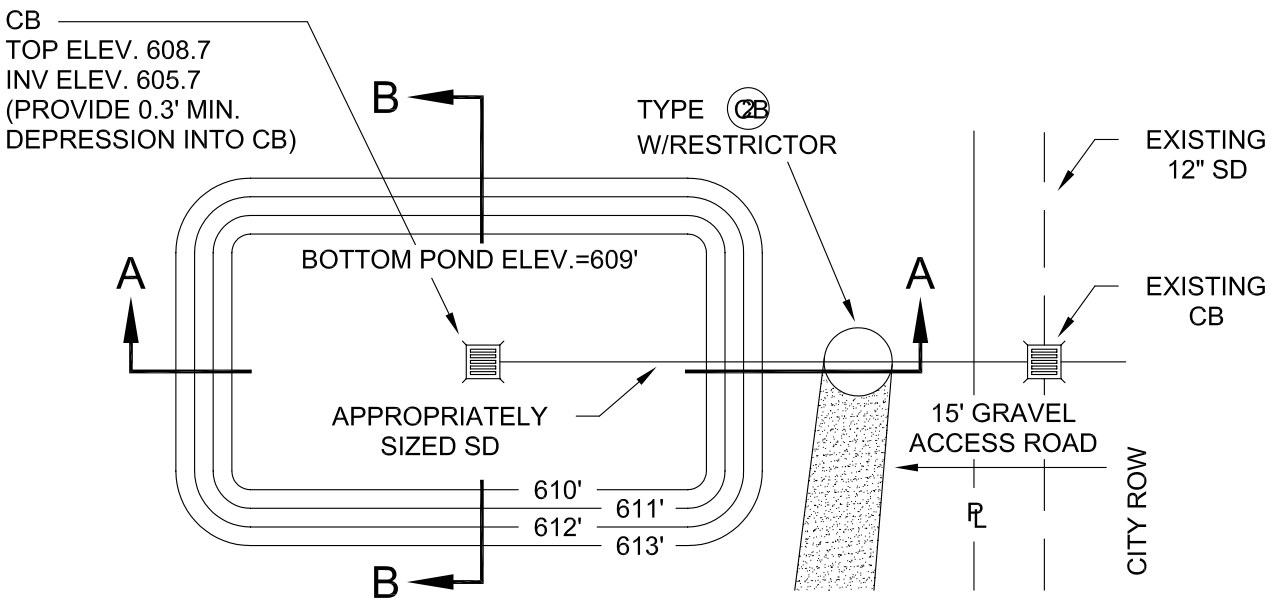
SNOHOMISH WASHINGTON

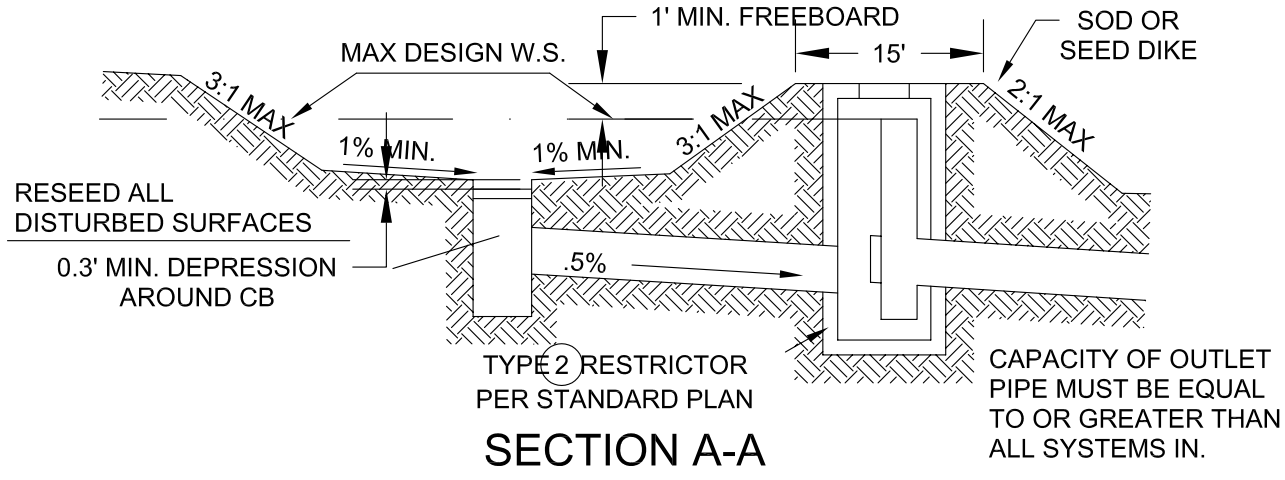
TYPICAL CLOSED UNDERGROUND DETENTION SYSTEM

Approved By:
City Engineer
Date: May 30, 2004

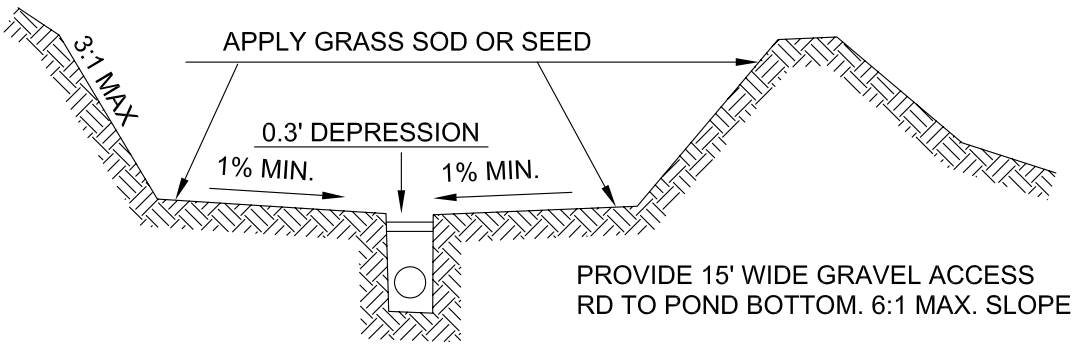
416
Number

City of Snohomish Public Works Department





SECTION A-A



SECTION B-B

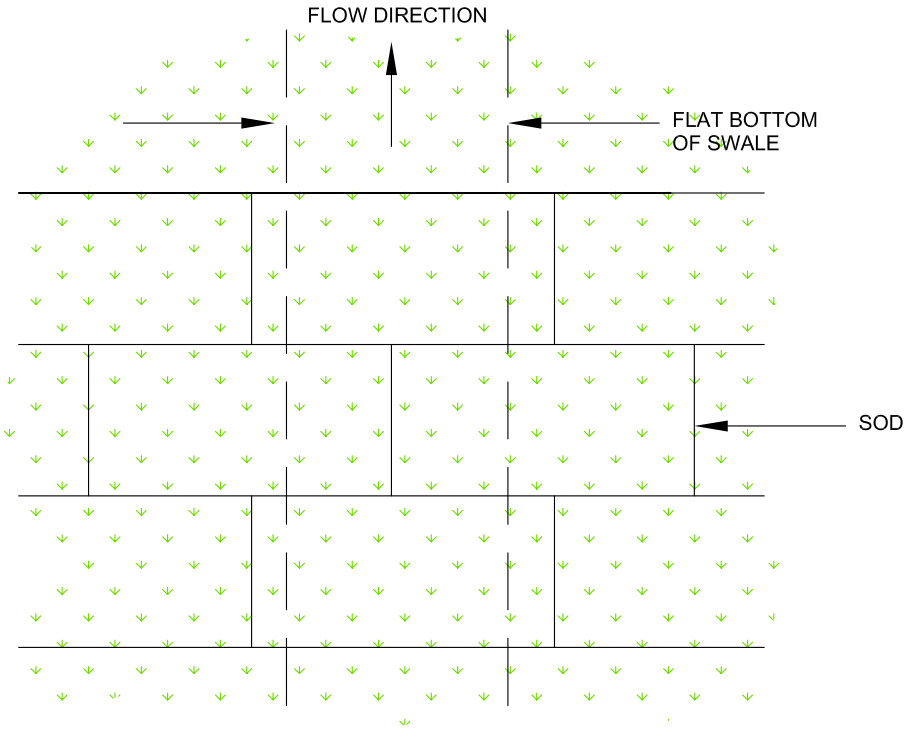
SNOHOMISH
WASHINGTON

TYPICAL DRY TYPE DETENTION POND

Approved By:
City Engineer
Date: May 30, 2004

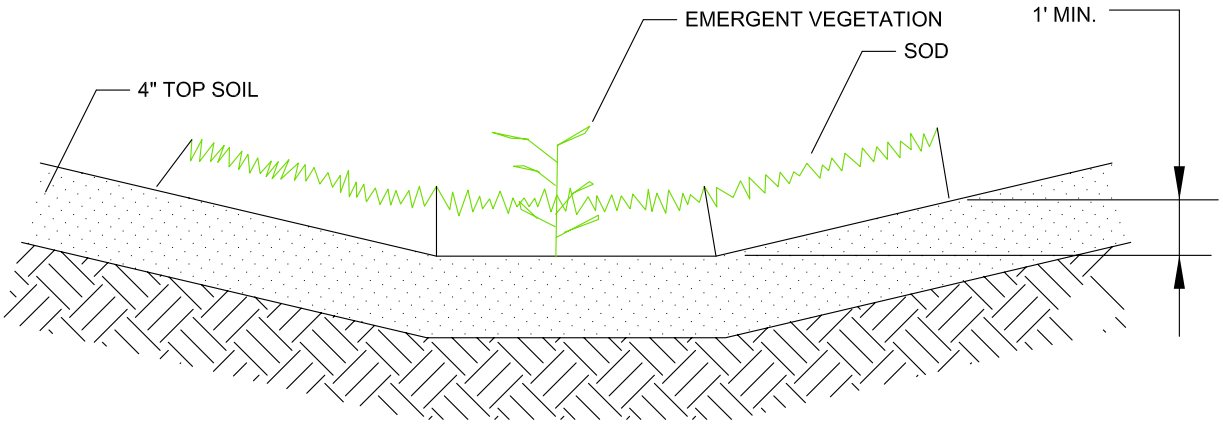
417
Number

City of Snohomish Public Works Department



BIOFILTRATION SWALE PLAN VIEW

NTS



BIOFILTRATION SWALE CROSS SECTION

NTS

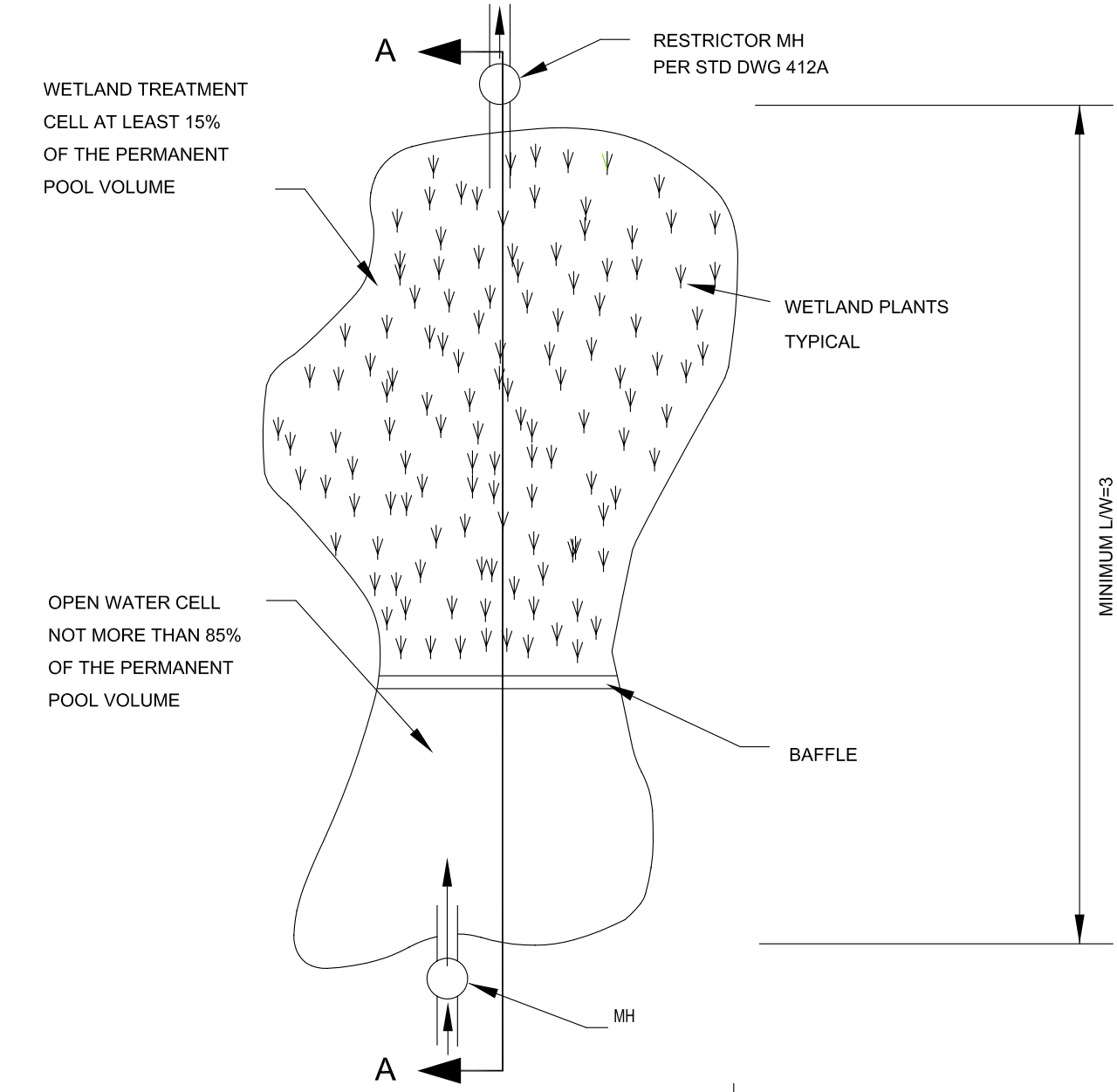
SNOHOMISH
WASHINGTON

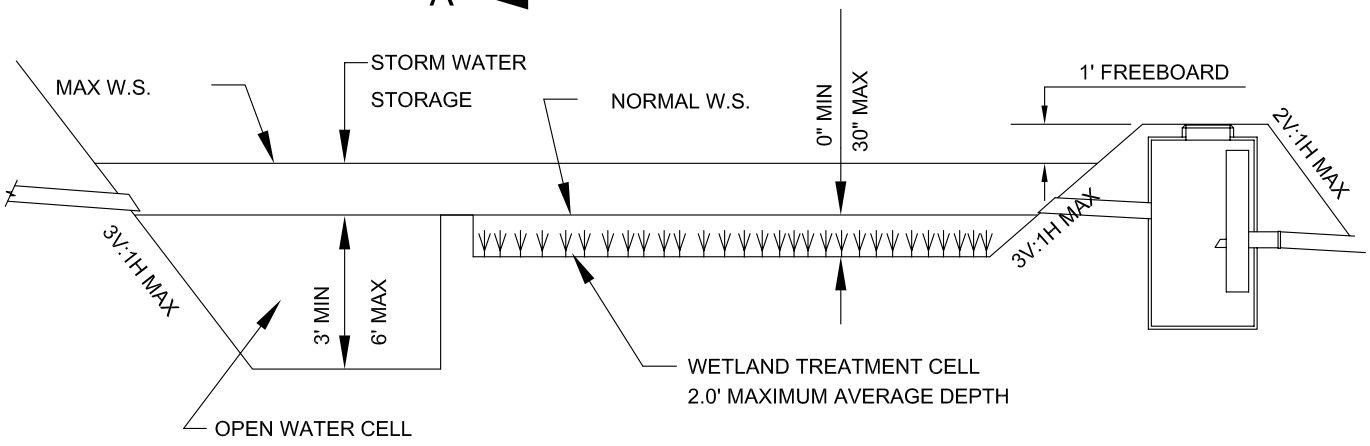
BIOFILTRATION SWALE

Approved By:
City Engineer
Date: May 30, 2004

419
Number

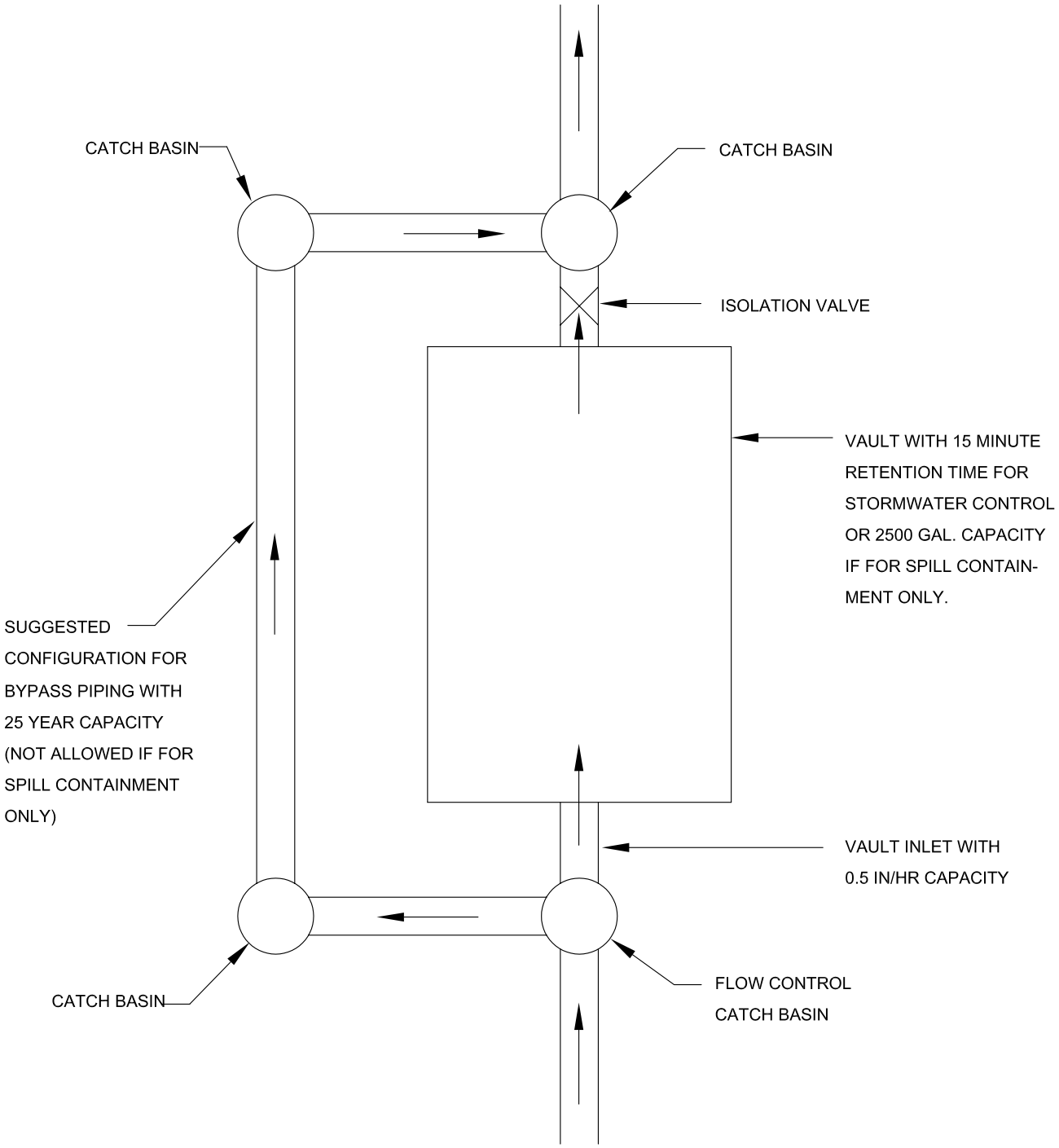
City of Snohomish Public Works Department





SECTION A-A

SNOHOMISH WASHINGTON	**TYPICAL WET POND LAYOUT**	Approved By: City Engineer Date: May 30, 2004	420 Number
	City of Snohomish Public Works Department		



PLAN VIEW

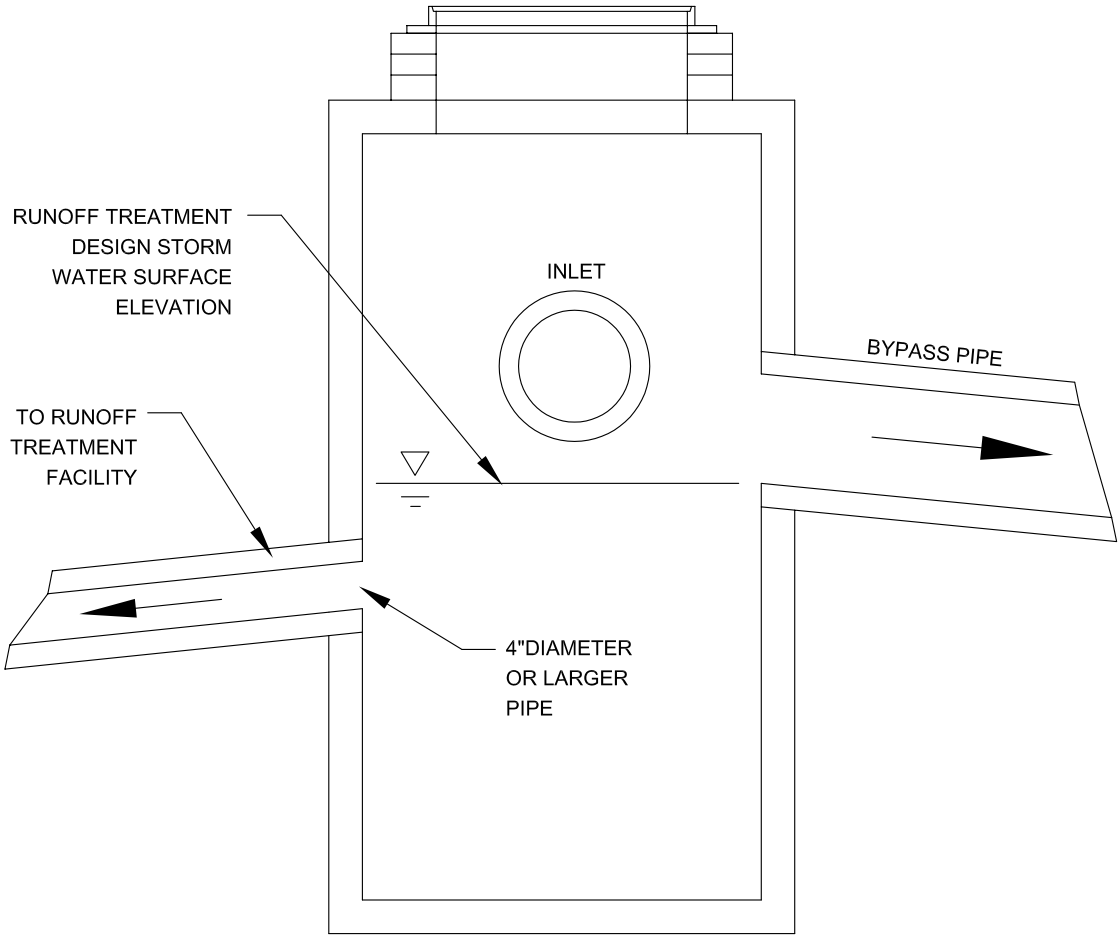
SNOHOMISH WASHINGTON

OIL/WATER SEPARATOR AND GRIT REMOVAL VAULT

Approved By: _____ City Engineer
Date: May 30, 2004

421 Number

City of Snohomish Public Works Department



SECTION

NTS

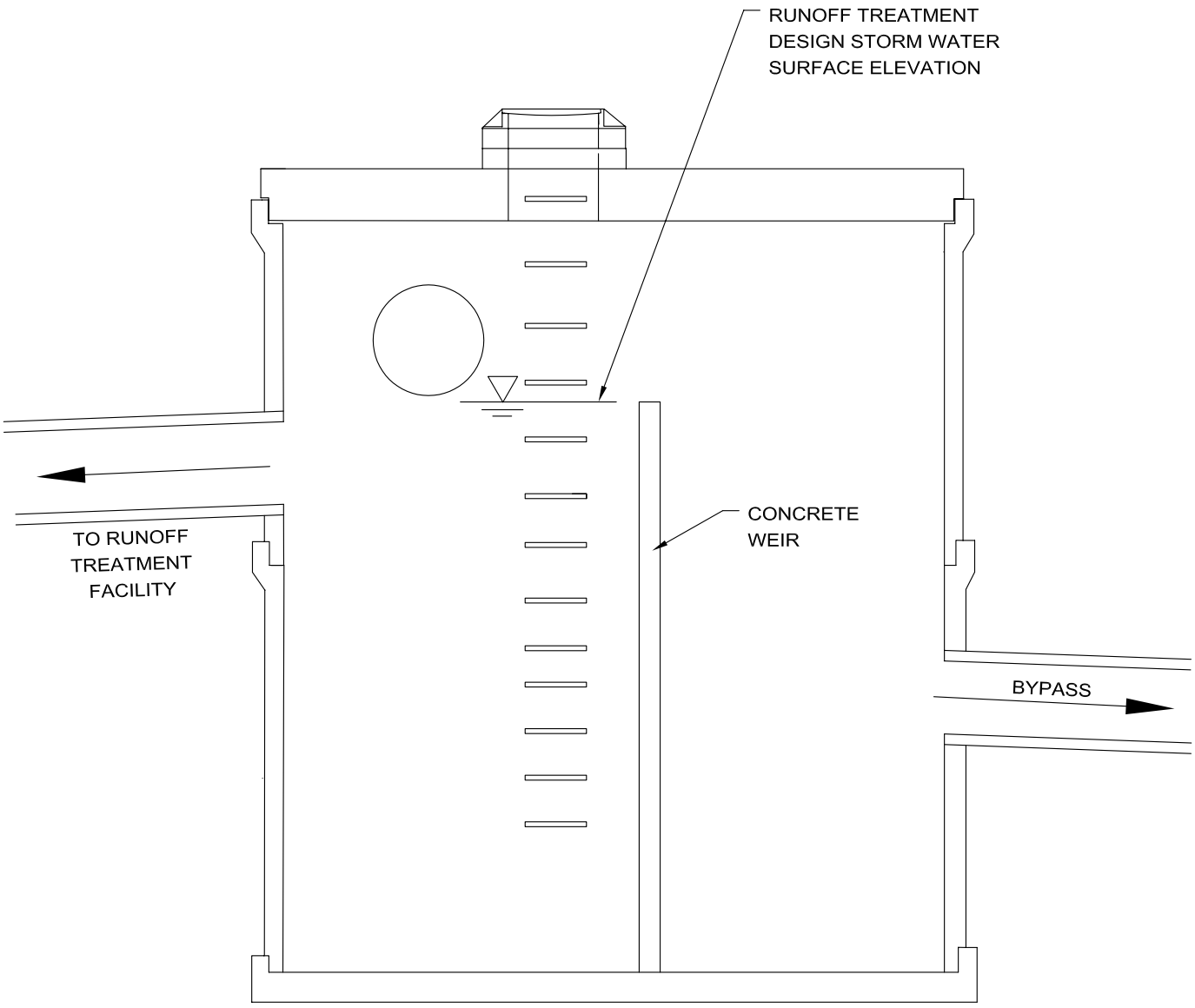
SNOHOMISH
WASHINGTON

BYPASS STRUCTURE TYPE 1

Approved By:
City Engineer
Date: May 30, 2004

422a
Number

City of Snohomish Public Works Department



CONCRETE VAULT OR TYPE 2 CATCH BASIN
(SIZE DETERMINED BY CLEARANCE REQUIREMENTS)

ELEVATION

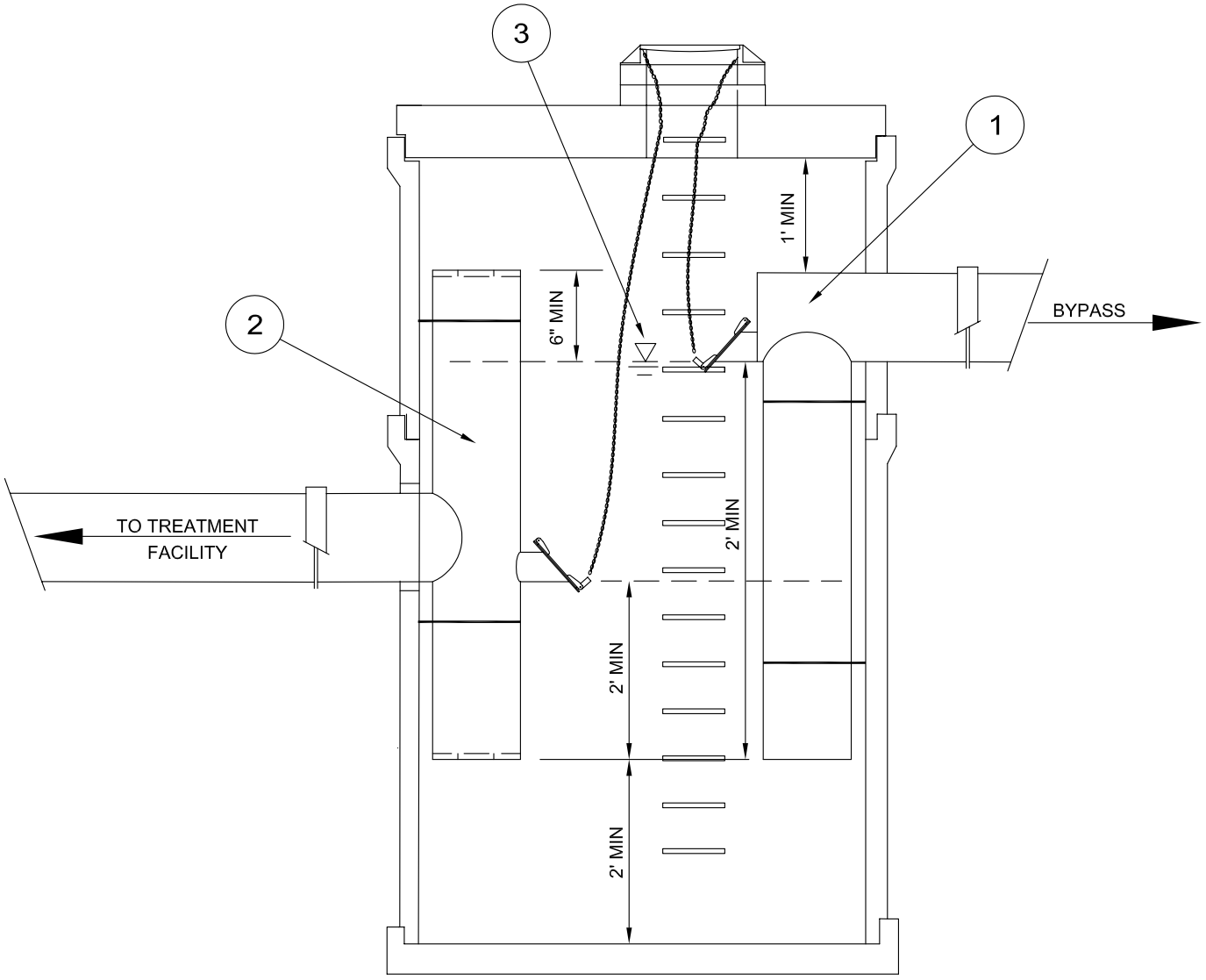
SNOHOMISH
WASHINGTON

BYPASS STRUCTURE TYPE 2

Approved By:
City Engineer
Date: May 30, 2004

422b
Number

City of Snohomish Public Works Department



ELEVATION

N.T.S.

NOTES:

1. FLOATABLE MATERIAL SEPARATOR PER CITY STD DWG 411, WITHOUT VENT HOLE.
2. RESTRICTOR STANDPIPE WITHOUT SECONDARY OVERFLOW ORIFICES AND WITH PRIMARY ORIFICE AND A CAP OR PLATE WITH 1" DIAMETER (MAX) VENT HOLE. INSTALL PER STD DWG 412A.
3. RUNOFF TREATMENT DESIGN STORM WATER SURFACE ELEVATION.

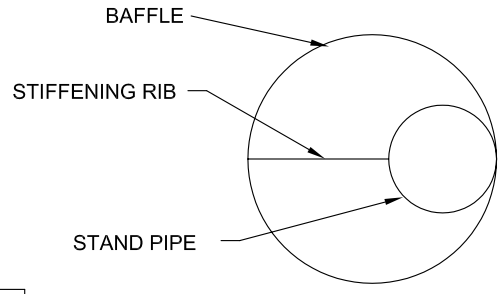
SNOHOMISH
WASHINGTON

BYPASS STRUCTURE TYPE 3

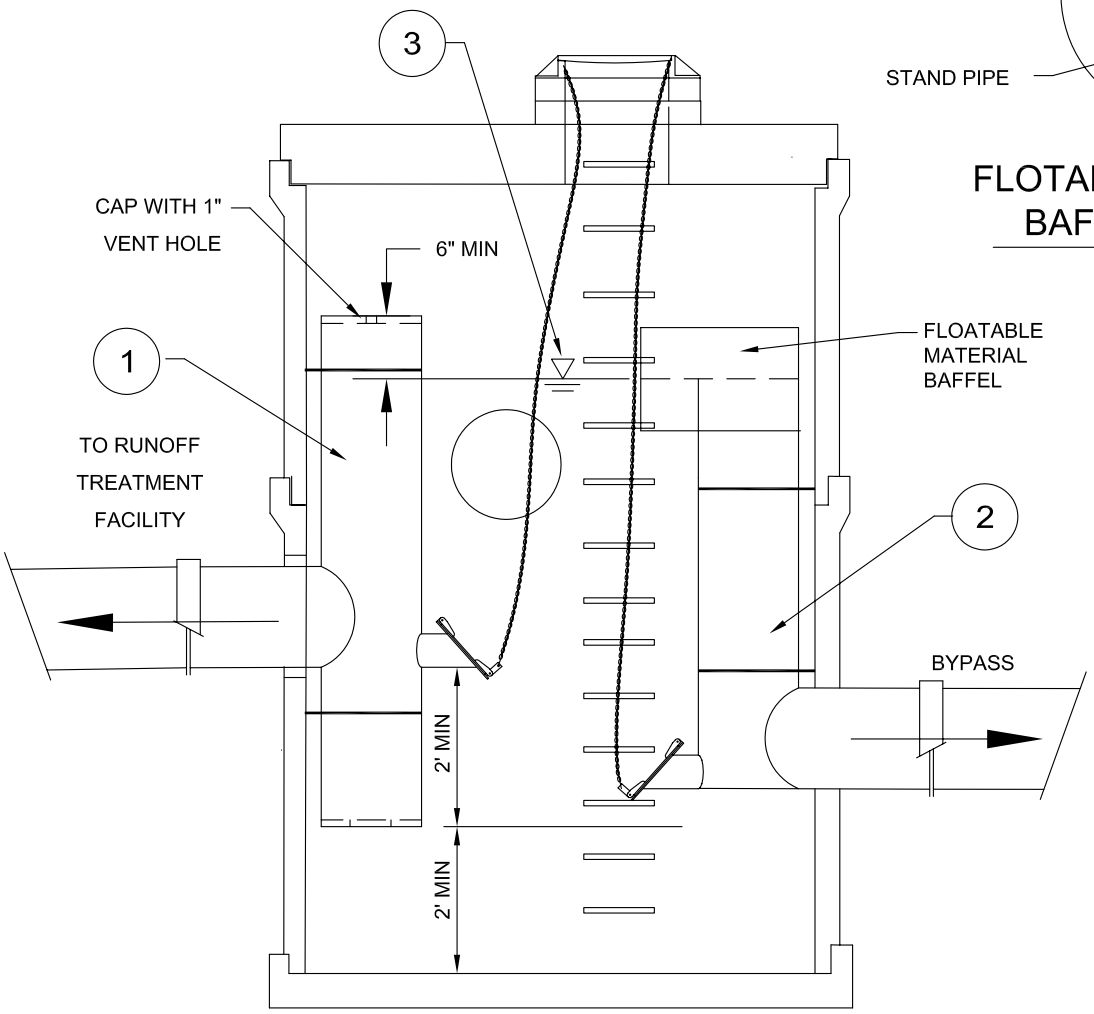
Approved By:
City Engineer
Date: May 30, 2004

422c
Number

City of Snohomish Public Works Department



FLOTABLE MATERIAL
BAFFLE DETAIL



ELEVATION

NOTES:

1. RESTRICTOR STANDPIPE WITHOUT SECONDARY OVERFLOW ORIFICE AND WITH PRIMARY ORIFICE AND CAP OR PLATE WITH 1"DIAMETER (MAX) VENT HOLE. INSTALL PER STD DWG 412A.
2. RESTRICTOR STANDPIPE WITHOUT ANY PRIMARY OR SECONDARY ORIFICES AND WITH FLOATABLE MATERIAL BAFFLE. INSTALL PER CITY STANDARD DWG 412A.
3. RUNOFF TREATMENT DESIGN STORM WATER SURFACE ELEVATION.

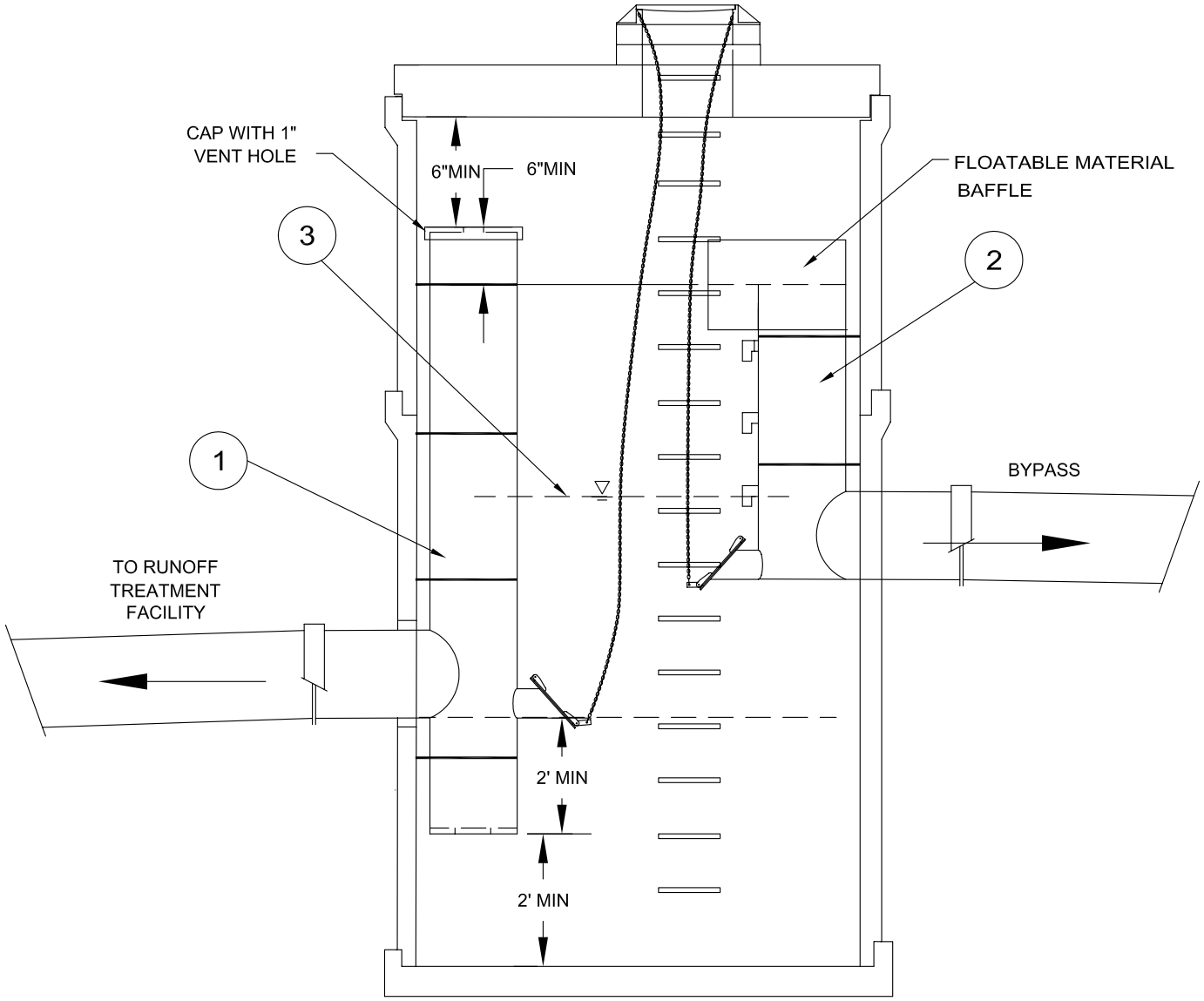
SNOHOMISH
WASHINGTON

BYPASS STRUCTURE TYPE 4

Approved By:
City Engineer
Date: May 30, 2004

422d
Number

City of Snohomish Public Works Department



ELEVATION

N.T.S.

NOTES:

1. RESTRICTOR STANDPIPE WITHOUT SECONDARY ORIFICES AND WITH PRIMARY ORIFICE AND A CAP OR PLATE WITH 1" DIAMETER (MAX) VENT HOLE. INSTALL PER STD DWG 412A.
2. RESTRICTOR STANDPIPE WITH SECONDARY ORIFICES AND A FLOATABLE MATERIAL BAFFLE (PER STD DWG 422D). INSTALL PER STD DWG 412A.
3. RUNOFF TREATMENT DESIGN STORM WATER SURFACE ELEVATION.

SNOHOMISH
WASHINGTON

MULTIPLE RESTRICTOR STRUCTURE

Approved By:
City Engineer
Date: May 30, 2004

422e
Number

City of Snohomish Public Works Department