Disposal of Municipal Wastewater Treatment Plant Effluent by Indirect Discharge to Surface Water via Groundwater or Hyporheic Water

DEQ
State of Oregon
Department of Environmental Quality

Internal Management Directive
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Introduction

Why is this Internal Management Directive (IMD) needed?

Local governments and special districts with surface water discharge permits (National Pollutant Discharge Elimination System [NPDES] permits) are finding it difficult to meet increasingly stringent in-stream water quality standards. As a result, they search for alternatives to the direct discharge of treated municipal wastewater effluent[1] to surface water. One alternative is indirect discharge to surface water via groundwater or hyporheic water[2] ("indirect discharge")[3].

Purpose

This IMD will:

- Guide Department staff on the regulations, policies, and issues related to indirect discharges;
- Clarify that the appropriate permit to use for this type of system is an NDPES permit because the indirect discharge by design will reach surface water;
- Clarify how to apply the Groundwater Quality Protection rules (OAR 340-040) and the Underground Injection Control (UIC) rules (OAR 340-044) when developing new permits (or modifying existing permits) that allow indirect discharges; and
- Provide clear protocols and steps to obtain an NPDES permit that allows indirect discharges.

When should staff use this IMD?

Department permitting staff, groundwater staff, and management may use this IMD when permitting facilities that dispose of municipal wastewater treatment plant effluent by indirect discharge to surface water via groundwater or hyporheic water. This may include new applications, renewals, or modifications of NPDES permits for existing facilities.

When should this IMD not be used?

This IMD focuses on the conversion of a municipal wastewater system from a direct, in-stream disposal method to an indirect, land or subsurface applied disposal method specifically designed to discharge treated effluent to surface water via groundwater or hyporheic water. It is not the intent or focus of this IMD to be applied to other

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[1] *Treated municipal wastewater effluent* means treated liquid sanitary wastes collected and treated by public and/or private sanitary districts, including city and county sanitary systems and wastewater treatment facilities that meet permit specific concentrations for the effluent.

[2] *Hyporheic water* is the water in saturated sediments under or beside a stream channel or floodplain that contributes water to a stream. Hyporheic flow is the subsurface flow that transitions between groundwater and surface water and can extend landward of the surface water body. The source of hyporheic flow can be from the channel itself or the water percolating to the stream from surrounding land areas. Under this IMD, hyporheic water is categorized as groundwater instead of surface water.

[3] This document will use the term *indirect discharge* to mean *disposal of municipal wastewater treatment plant effluent by indirect discharge to surface water via groundwater or hyporheic water*. Note that this document is **not** using the term as defined under the Clean Water Act to mean "the introduction of pollutants into a POTW from any non-domestic source regulated under 307(b), (c) or (d) of the Clean Water Act."

wastewater discharges. However, the Department recognizes there may be special circumstances where it would be appropriate to apply the concepts outlined in this IMD to other treated wastewater discharges, especially if a greater net environmental benefit can be realized. This IMD does not apply to non-permitted or non-treated wastewater discharges. This IMD also should not be applied to:

- Domestic wastewater facilities covered under OAR 340-071; and
- Other municipal wastewater facilities that are not designed to indirectly discharge to surface water via groundwater or hyporheic water.

Who else can use this IMD?

This document also may be consulted by permittees and permit applicants for planning purposes and to help guide the collection and preparation of information for submittal to the Department, but it does not create rights or obligations on the part of the public or regulated entities.

Directives

Under appropriate circumstances, Department staff administering the water quality program may determine that:

- The indirect discharge as outlined in this IMD meets the intent of Oregon’s groundwater quality protection rules;
- The indirect discharge can be allowed under an NPDES permit if as described in this IMD, all the discharge will be designed to reach surface water via groundwater or hyporheic water;
- The disposal of municipal wastewater treatment plant effluent by indirect discharge to surface water via groundwater or hyporheic water within a waste management area is often a more desirable method of disposal than direct discharge to surface water because natural physical, chemical, and biological processes may enhance effluent quality prior to discharge to surface water;
- The Department has discretion in establishing the boundaries of a waste management area in which treated effluent mixes with groundwater [OAR 340-040-0030(2)(e)];
- Concentrations of wastewater constituents in groundwater and hyporheic water within the waste management boundary may exceed background groundwater quality and still satisfy the requirements of OAR 340-040;
- The groundwater compliance monitoring requirement immediately downgradient of the waste management area [OAR 340-040-0030(2)(a)] is inappropriate for the systems described in this IMD because the waste management area transitions directly to surface water;
- The surface water quality standards contained in OAR 340-041 will apply to the indirectly discharged treated wastewater once it reaches surface water. Effluent limits and other conditions set forth in the NPDES permit issued for the system must ensure that water quality standards in the receiving stream are met; and
- Disposal of municipal wastewater treatment plant effluent by indirect discharge to surface water via groundwater or hyporheic water within the waste management boundary can be allowed only when the groundwater and hyporheic water are not used as underground sources of drinking water, and therefore, OAR 340-044-0015(2)(f), which prohibits the direct injection of municipal wastewater into an underground source of drinking water, does not apply.

Treated Municipal Wastewater Discharge Systems

Overview

The Department classifies municipal wastewater treatment systems into two categories: 1) those that discharge directly to surface water, and 2) those that discharge to land. Each category has its own permitting process and requirements that must be met. However, in areas near streams or rivers, it can be unclear which process to apply.

Surface water discharge historically has been preferred because it provides rapid mixing of effluent with surface water, and is often the least expensive discharge option. However, December 2003 modifications to the in-stream temperature standard for Oregon surface waters [OAR 340-041-0028] makes it difficult and costly to meet the standard when treated municipal wastewater effluent is directly discharged to surface water.

Why remove a direct discharge from surface water?

Disposal of municipal wastewater treatment plant effluent by indirect discharge to surface water via groundwater or hyporheic water may be environmentally beneficial if planned, installed, and operated correctly, and if located under the right geographic, hydrogeologic, and environmental conditions. The type of indirect discharge system should be matched to the specific conditions of the site.

The following are potential benefits of using indirect discharge:

- Wastewater temperature may be reduced in the groundwater or hyporheic water to meet in-stream temperature standards and therefore stream flow volumes may be maintained;
- Some “polishing” of the wastewater, such as reducing total metals or removing residual chlorine through natural geochemical processes, may occur within the soils and aquifer containing groundwater or hyporheic water; and
- If a land application component is used in the design, nutrients in wastewater may be beneficially reused by plants and therefore reducing the nutrient load for a mandated Total Maximum Daily Load (TMDL).

Methods for indirect discharge systems

There are many methods for land discharge of treated municipal wastewater that could be used for indirect discharge to surface water. These include:

- Rapid and moderate rate infiltration systems;
- Constructed wetlands designed for evaporation/transpiration and minimal seepage;
- Constructed wetlands designed for infiltration;
- Surface spray irrigation applied at greater than agronomic rates;
- Subsurface drip irrigation applied at greater than agronomic rates;
- Exfiltration galleries, drainfields, mounds, and bottomless sand filters;
- Evaporation ponds with infiltration components; and
- Injection wells discharging above or below the water table.

Features an indirect discharge should have

An indirect discharge system should have the following characteristics:

- The intent of the system design is to route wastewater through shallow unsaturated soils and/or groundwater for additional polishing and diffusion before it discharges to surface water. This would include situations where wastewater is discharged to hyporheic water;
- Site conditions (geology or hydrology[4]) and system design are such that (effectively) all the wastewater and affected groundwater will discharge to surface water after leaving the waste management area;
- As required by the Groundwater Quality Protection rules in OAR 340-040, groundwater outside the waste management area will not be adversely affected by the system;
- Conditions in the waste management area and the quality of discharge are such that long term contamination would be unlikely following termination of the discharge;
- A local government or special district owns or otherwise controls the property containing the waste management area; and
- It is virtually impossible that water supply wells do not exist and cannot be placed within the waste management area.

Rules Governing Treated Municipal Wastewater Discharges

Rules Department staff need to consider when permitting indirect discharges

The rules that govern these types of system include:

- *Groundwater Quality Protection* (OAR 340-040);
- *Water Quality Standards: Beneficial Uses, Policies, and Criteria For Oregon* (OAR 340-041);
- *Construction and Use of Waste Disposal Wells or Other Underground Injection Activities (Underground Injection Control)* (OAR 340-044); and
- *Regulations Pertaining to National Pollutant Discharge Elimination System (NPDES) and Water Pollution Control Facilities (WPCF) Permits* (OAR 340-045).

[4] In addition to physical geologic or geomorphic features of a site, there are many types of hydraulic boundaries including but not limited to groundwater divides, constant head boundaries, and hydraulic no-flow boundaries (i.e., a groundwater flowline perpendicular to equipotential lines) that can allow Department staff to conclude that effectively all the indirect discharge will reach surface water.

Groundwater Quality Protection (OAR 340-040)

Key aspects of statutes and rules

Groundwater quality in Oregon is protected from pollution, and the discharge of wastes without a permit, under Oregon Revised Statutes (ORS) 468B.025 and ORS 468B.050, respectively. The goals and policies to protect groundwater quality in Oregon are found in ORS 468B.155 and 160, and codified in the Oregon Groundwater Quality Protection rules, OAR 340-040.

Important aspects of the groundwater protection statutes and rules include:

- Most discharges of wastewater to waters of the state without first obtaining a permit are prohibited;
- Identification of groundwater as a critical natural resource in the state that provides domestic, industrial, and agricultural water supply, as well as providing base flow to rivers, lakes, streams, and wetlands [OAR 340-040-0020(1)];
- Recognition that groundwater, once polluted, is difficult and sometimes impossible to clean up and establishment of an *anti-degradation* policy to control discharges to groundwater so that the highest possible water quality is maintained [OAR 340-040-0020(2)];
- Authority for the Department to use permits to achieve groundwater protection requirements;
- A policy that all groundwater quality be protected throughout the state, **but** with the recognition that the Department needs to concentrate its groundwater quality protection implementation efforts in areas where pollution would have the greatest impact on beneficial uses [OAR 340-040-0020(8)]; and
- The allowance for a case-by-case determination concerning the highest and best practicable methods of treatment and disposal necessary to protect human health and the environment while taking into account the method's cost effectiveness, the site's physical characteristics, and the effluent's toxicity and persistence [OAR 340-040-0020(11)].

How the rules are implemented

OAR 340-040-0030, Permitted Operations, is relevant to permitting indirect discharges. If the permittee has the potential to cause a *likely adverse groundwater quality impact*, then they must have a *groundwater quality protection program*. This includes the following key elements:

- Monitoring background and downgradient groundwater quality;
- Designating compliance points[5] at the *waste management boundary*;
- Setting c*oncentration limits* (or a variance to the limits) and specifying them in the facility's permit;
- Reporting monitoring data, unexpected changes in groundwater quality, and exceedances of concentration limits; and

[5] *Compliance point* means the point or points where groundwater quality parameters must be at or below a permit-specific concentration limits or a concentration limit variance. *Downgradient detection monitoring point* means the point or points at which groundwater quality is monitored to immediately determine whether a pollutant has been discharged to groundwater. The detection monitoring point is not necessarily the same as the compliance point.

- Taking specific actions if there is an unexpected change in groundwater quality or if a concentration limit is exceeded.

The rule states the groundwater quality protection program as described above is necessary **only** if the Department finds there will be a likely adverse groundwater quality impact **outside** of a waste management area.

How a "waste management area boundary" is defined

The rule defines a *waste management area* as "any area where waste, or material that could become waste if released to the environment, is located, or has been located." The "boundary" is the edge of the waste management area. Factors to consider when establishing the boundary include:

- The type of land discharge/treatment;
- The size of the land discharge/treatment area;
- The boundaries of the property controlled by the permittee; and
- The ultimate fate of the discharged wastewater.

What a "likely adverse groundwater quality impact" is

The Groundwater Quality Protection rules do not specifically define the term "likely adverse groundwater quality impact." However, the rule (OAR 340-040-0030) does state that unless a concentration limit variance is granted, concentration limits for contaminants listed in Tables 1, 2, and 3 must be set at background groundwater concentrations for new facilities and between background and concentrations listed in the tables for existing facilities[6]. For unlisted parameters where a likely adverse impact is determined, the limit is background for new or existing facilities.

An indirect discharge system established in accordance with this IMD by design will not have a "likely adverse impact to groundwater quality" outside the waste management area. While still satisfying the requirements of OAR 340-040, groundwater and hyporheic water within the waste management boundary <u>may exceed background groundwater quality</u> for a system established in accordance with this IMD.

Concentration limits

A *concentration limit* is the maximum concentration of a contaminant allowed at the compliance point located at the waste management boundary. Therefore, contaminant concentrations immediately below the effluent distribution system (e.g., in the subsurface under a drainfield or infiltration basin) may be above background if the limits are met at the compliance point.

The Department has flexibility in determining:

- Which contaminants are of concern (i.e., how many concentration limits are set);
- How concentration limits will be calculated;
- When concentration limits are established; and
- Where the compliance point should be located relative to the waste management activities.

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[6] A *new facility* is a facility or new activity authorized to operate under a DEQ permit for the first time after October 1989. An existing facility is one that was permitted prior to October 1989.

If the Department finds that there will not be a likely adverse groundwater quality impact outside of the waste management area, formally establishing compliance points (and establishing concentrations limits at those points) is not required by OAR 340-040-0030.

Concentration limit variances

Both new and existing facilities may request a *concentration limit variance* (CLV) provided no substantial present or potential hazard to human health or the environment is posed at that level. The Department Director can grant a CLV without Environmental Quality Commission approval up to and including the concentration levels listed in OAR 340-040-0020 Tables 1, 2 and 3.

If the Department finds that there will not be a likely adverse groundwater quality impact outside of the waste management area, formally establishing compliance points (and establishing concentration limit variances at those points) is not required by OAR 340-040-0030.

Highest and best practicable treatment method

The groundwater quality protection policy in OAR 340-040-0020(11) requires a point source to employ the highest and best practicable methods to prevent the movement of pollutants to groundwater. The rules also require a point source to consider a number of other factors when choosing the highest and best practicable treatment method, including the following:

- The technologies available for treatment and waste reduction;
- Cost effectiveness;
- Site characteristics; and
- Pollutant toxicity and persistence.

For systems addressed in this IMD, the Department usually will be able to conclude that indirect discharge systems meet this policy due to the level of treatment of municipal wastewater, the potential environmental gain from removing a direct discharge from surface water, and the waste management area controls (such as land ownership) that will ensure that groundwater degradation is minimized.

Water Quality Standards (OAR 340-041)

Highest and best practicable treatment method

These rules set forth Oregon's plans for management of the quality of public waters within Oregon. As with the Groundwater Quality Protection rules, the highest and best practicable treatment and/or control of wastes, activities, and flows must in every case be provided so as to maintain dissolved oxygen and overall water quality at the highest possible levels and water temperatures, coliform bacteria concentrations, dissolved chemical substances, toxic materials, radioactivity, turbidities, color, odor, and other deleterious factors at the lowest possible levels.

For systems addressed in this IMD, these requirements should be evaluated at the interface of the waste management area and the receiving stream.

Underground Injection Control (OAR 340-044)

What constitutes "injection"?

An *injection system* or *underground injection system* means "a well, improved sinkhole, sewage drain hole, subsurface fluid distribution system or other system or groundwater point source used for the subsurface emplacement or discharge of fluids."

When subsurface injection of domestic wastewater is allowed

Although the UIC rules were developed to limit and control injection of wastes to the subsurface to protect groundwater quality for current or potential beneficial uses, the rules allow disposal of municipal wastewater effluent to the subsurface on a case-by-case basis via "injection systems" [OAR 340-044-0018(4)], provided:

- The disposal is authorized under a Department-issued permit [OAR 340-044-0012(1)(c) and 340-044-0035(1)];
- Is formally registered with the Department as a UIC system [OAR 340-044-0020(1)]; and
- Complies with the requirements of OAR 340-040 [OAR 340-044-0014(1)] as described elsewhere in this IMD.

"Direct" and "indirect" injection

The UIC rules state "no person shall cause or allow…injection systems injecting…municipal wastewater directly into an underground source of drinking water"[7] [340-044-0015(2)(f)].

The Department historically has interpreted "injecting directly into" as meaning injecting *below* the water table. Furthermore, since the UIC rules allow various forms of sewage disposal via onsite septic systems or other types of subsurface fluid distribution systems, the Department historically has considered any injection *above* the water table to be *not* "injecting directly into" an underground source of drinking water, and therefore allowable if a permit is issued and if registered as a UIC.

No technical distinction between "direct" and "indirect" injection

However, this distinction is largely artificial in shallow aquifer systems. The earth's crust can be divided into two regions: the saturated zone or phreatic zone (e.g., aquifers, aquitards, etc.), where all available spaces are filled with water, and the unsaturated zone (also called the vadose zone), where there are still pockets of air that can be replaced by water. A "water table" is simply the boundary between the two zones.

In unconfined aquifers[8] (like the ones that would be used under this IMD), saturation increases with depth, and the degree of saturation changes with time (i.e., the water table moves up and down) largely in response to precipitation. Also, depths to the water table can change in response to artificial forms of recharge such as irrigation or wastewater disposal.

Because the purpose of the systems described in this IMD is to dispose municipal wastewater treatment plant effluent by indirect discharge to surface water via groundwater or hyporheic water, wastewater clearly will reach groundwater. For these reasons, the Department cannot rely on its traditional interpretation of injection "above" the water table as differing from injection "below" the water table.

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[7] 340-044-0005(46) defines *underground source of drinking water* as an aquifer or groundwater source that supplies or potentially could supply drinking water for human consumption.

[8] An *aquifer* is an underground layer of water-bearing permeable rock or unconsolidated materials (gravel, sand, silt, or clay) from which groundwater can be usefully extracted using a water well. *Unconfined aquifers* are sometimes also called *water table* or *phreatic* aquifers, because their upper boundary is the water table or phreatic surface. Typically (but not always) the shallowest aquifer at a given location is unconfined, meaning it does not have a confining layer (an aquitard or aquiclude) between it and the surface. Unconfined aquifers usually receive recharge water directly from the surface, from precipitation or from a body of surface water (e.g., a river, stream, or lake) which is in hydraulic connection with it.

Injection to groundwater can be allowed

The UIC rules state "injection of wastes to the subsurface shall be limited and controlled in a manner that protects existing groundwater quality for current or potential beneficial uses including use as an underground source of drinking water" [340-044-0010(1)]. Also, the UIC rules allow the Department to issue permits for the subsurface injection of domestic wastewater on a case-by-case basis [340-044-0018(4)]. These two rules allowing injection of wastes to the subsurface appear to conflict with the UIC rule that prohibits municipal wastewater to be injected directly into an underground source of drinking water [340-044-0015(2)(f)].

In the face of these apparent conflicts within the UIC rules, the Department is interpreting that the types of indirect discharge systems described in this IMD can be permitted provided:

- The system is designed so that it will not impact existing groundwater beneficial uses such as water supply wells (i.e., exceed drinking-water standards in a domestic water supply well);
- The system design and the permit conditions make it virtually impossible for new water supply wells to be placed in the waste management area and for effluent to leave the management area, except via surface water;
- The system placement and the wastewater treatment level is such that the Department can find that there will be no lasting effects on groundwater or hyporheic water quality, and that groundwater could potentially be used as a water supply if the disposal system were to be decommissioned.

For permits containing these provisions, the Department can find that the permitted system will not be injecting municipal wastewater directly into an underground source of drinking water.

NPDES and WPCF Permits (OAR 340-045)

Types of permits

Facilities treating municipal wastewater in Oregon must obtain a water quality permit from the Department. The type of permit a local government or special district needs to dispose its wastewater depends on what is discharged and where the discharge goes. The Department administers two types of water quality permits:

National Pollutant Discharge Elimination System (NPDES)
The NPDES permit is a requirement of the Federal Water Pollution Control Act (Clean Water Act) and Oregon law. NPDES permits are required for discharges of pollutants to surface waters.

Water Pollution Control Facilities (WPCF)
The WPCF permit is a state requirement for the discharge of wastewater to the ground; discharge to surface water is not allowed. WPCF permits are issued for land irrigation of wastewater, wastewater lagoons, onsite sewage disposal systems, and underground injection control systems (i.e., dry wells, sumps, etc.). The primary purpose of a WPCF permit is to prevent discharges to surface waters and to protect

groundwater from contamination. This permit is also used to prevent nuisance conditions such as odors and mosquitoes.

Which permit should be used?

Legally defining what types of discharges are required to have a federal NPDES permit under the Clean Water Act is unclear. Normally, an NPDES permit is required before a point source can add pollutants to waters of the United States. However, the extent to which a water body is a water of the U.S. is in a state of flux following recent (i.e., circa 2007) U.S. Supreme Court decisions. This means that whether NPDES permit requirements could apply to discharges of wastes to groundwater with a direct or otherwise significant hydrological connection to surface water also is unclear.

Based on site conditions and the design of indirect discharge systems as defined in this IMD are such that “all” the wastewater and affected groundwater will discharge to surface water after leaving the waste management area, the Department interprets its rules to require an NPDES permit rather than a WPCF permit for these systems.

Relationships Between Division 40 and Division 45 Rules

Overview

Under division 40, the waste management boundary is often established at the downgradient and sidegradient edges of the effluent plume within the groundwater waste management area. This is analogous to the compliance point established under division 45 for a surface water discharge as the downstream edge of an approved mixing zone.

Divisions 40 and 45 do not address the scenario where surface water is the downgradient edge of a groundwater waste management area as illustrated in Figure 1.

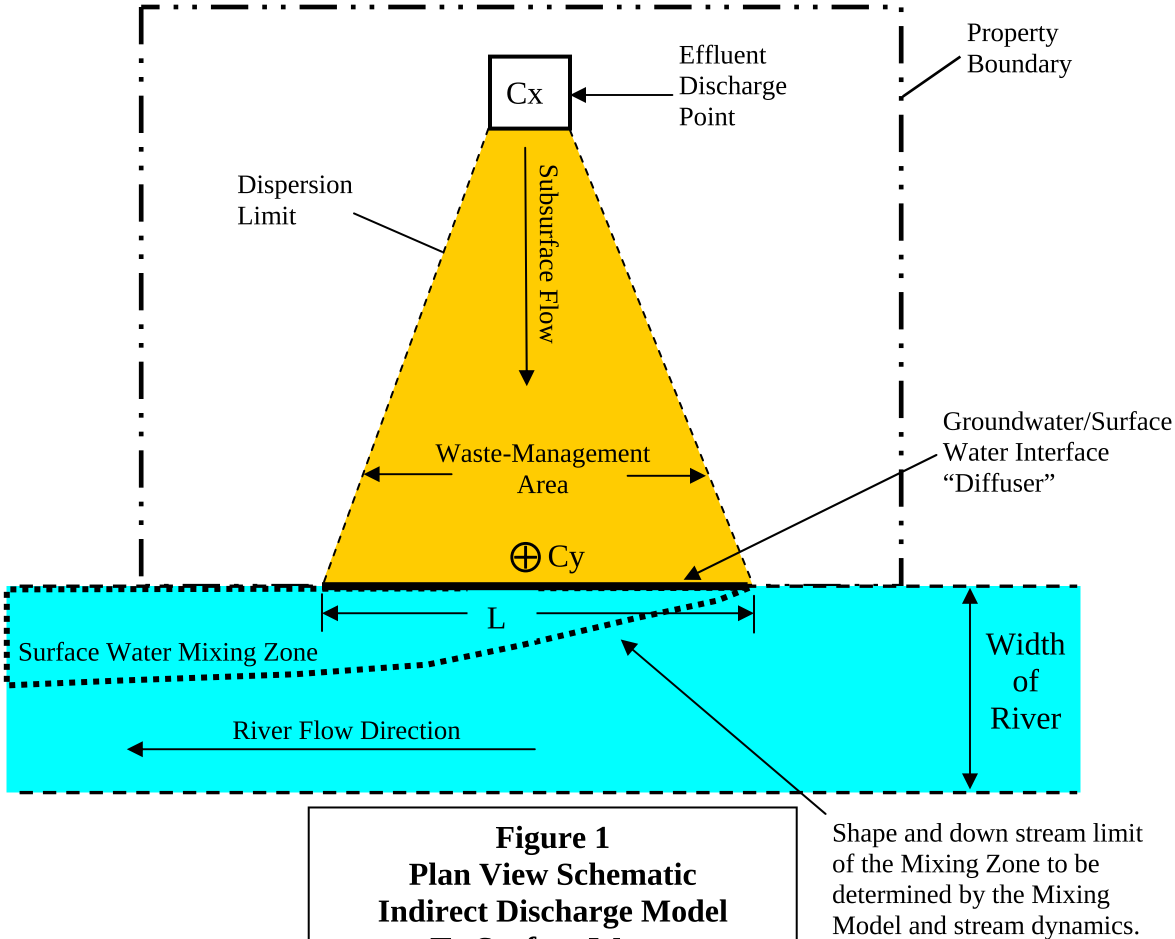

Figure 1
Plan View Schematic
Indirect Discharge Model
To Surface Water

Notes:
1. At L, provide groundwater volume, velocity and concentration of key water quality parameters for mixing zone model. These typically will be estimates based on calculations or modeling.
2. L functions as a surface water diffuser.
3. Effluent discharge in the Waste-Management Area can be in groundwater, hyporheic water, or both.
4. Limits of Waste-Management Area are determined by horizontal dispersion of the effluent in groundwater, hyporheic water or both.

Symbols:

⊕	Verification monitoring well location (i.e., *detection monitoring* well)
Cx	Concentration of key wastewater effluent parameters.
Cy	Concentration of key effluent parameters in groundwater or hyporheic water at transition to surface water for mixing zone analysis, e.g. concentration for diffuser at L.
L	Length of Waste-Management Area at receiving water body.

How to address where surface water is the downgradient edge of a waste management area

For sources covered by this IMD, Department staff are directed to address this situation in the following way:

- The indirect discharge systems should be designed and a permit issued with conditions so that effluent leaving the treatment system and entering surface water indirectly will meet water quality standards at the edge of the surface water mixing zone;
- If for some reason, no surface water mixing zone is allowed, then the indirect discharge system should be designed and a permit issued with conditions so surface water quality standards are met prior to groundwater entering the surface water channel. This is analogous to the waste management area being the mixing (and treatment) zone, and surface water quality standards would be met at "end of pipe," but the "pipe" in this case would be a diffuse groundwater to surface water discharge area;
- When surface water is the downgradient edge of a waste management area, groundwater compliance points (and subsequent concentration limits or variances) may be established at side-gradient edges of the groundwater waste management area to ensure the size of the area does not grow larger than contemplated in the design phase; and
- Groundwater monitoring within the waste management area at or near the discharge point to surface water may be included to confirm design assumptions are true, permit effluent limits are adequate, or for other operational purposes (i.e., *detection monitoring* instead of *compliance monitoring*).

The Department could determine an indirect discharge system is designed so no likely adverse groundwater quality impact could occur outside the waste management area boundaries. Typically, the design would include the following elements:

- The permittee owns or otherwise controls the property where the waste management area is located;
- DEQ has verified and the permit provides that water supply wells do not exist and cannot be placed within the waste management area; and
- The waste management area is configured to be limited in extent based on either a conservative design or on sufficient site-specific hydrogeologic data.

If the Department concludes that there will be no likely adverse groundwater quality impact outside the waste management area, establishing formal groundwater compliance points (and subsequent concentration limits or variances) is not required but remains an option. A source or the Department may elect to establish a concentration limit or concentration limit variance to set clear expectations and allow for limited change to groundwater quality as measured in detection monitoring wells or compliance monitoring wells if needed.

Applying OAR 340-040 to Indirect Discharges

If a system meets the definition of an indirect discharge, then the Department will apply the Groundwater Quality Protection rules in the following way:

- The groundwater inside the waste management area is considered part of the treatment system;
- If the Department determines that a discharge system established in accordance with this IMD does not have a "likely adverse impact to groundwater quality" outside the waste management area, groundwater and hyporheic water within the waste management boundary may exceed background groundwater quality while still satisfying the requirements of OAR 340-040;
- If a properly sited and designed system does not have a "likely adverse impact to groundwater quality" outside the waste management area, Department staff do not need to require formal groundwater *compliance points* (and subsequent concentration limits or variances);
- The permittee is required to meet any surface water quality or TMDL requirements that apply; and
- A groundwater monitoring plan is needed if groundwater monitoring within the waste management area at or near the discharge point to surface water is necessary to confirm design assumptions (i.e., *detection monitoring* points) or to ensure compliance with surface water quality permit conditions.

Under OAR 340-040, the waste management area boundary is established at the edges of the effluent waste management area. For an indirect discharge system, the downgradient boundary is a surface water body. Crossgradient boundaries may be surface water bodies or hydraulic boundaries.

Permitting Indirect Discharges

Overview

This section provides Department staff with the specific language and conditions that may need to be included in the permit evaluation report or the permit when permitting indirect discharge of treated municipal wastewater to surface water via groundwater.

The Department may receive proposals for disposal of municipal wastewater treatment plant effluent by indirect discharge to surface water via groundwater or hyporheic water with:

- A permit modification request;;
- A permit renewal for an expired or soon to be expired permit; or
- A new source permit application.

Given the increasing number of point sources subject to more restrictive effluent limitations for direct discharges to surface water, the Department expects that the majority of these proposals will be received as a permit modification or during the permit renewal process. Because the system is designed as an indirect surface water discharge system, the Department will require an NPDES permit.

A typical review team for indirect discharge system proposals will include a water-quality permit writer as lead, with an engineer and hydrogeologist in technical support roles.

Permit modification and renewal

Many recent NPDES permit modifications and renewals include new specific requirements to comply with more restrictive effluent limitations. Many of these permits also may include effluent temperature or nutrient limitations that reflect waste load allocations established in approved TMDLs. Because the newer permit requirements often require significant changes or upgrades to the permittee's treatment facility processes and equipment, the Department typically establishes a schedule within a modified or renewed permit that provides the permittee time to comply with the new limitations. Generally, the Department requires the applicant to comply within the 5-year term of the permit.

New permits

New indirect discharge systems are permitted in a similar way to a modification or renewal, except that the permit will not include a compliance schedule and the permittee will be required to achieve immediate compliance with permit conditions and effluent limitations.

Facilities plan

A wastewater facilities plan presents the results of a planning effort for new wastewater treatment systems or upgrades. The plan typically summarizes the wastewater collection service area and wastewater characteristics, identifies the components of the existing wastewater collection and treatment system, evaluates the performance of the treatment system with respect to water quality and regulatory standards, and analyzes alternatives to improve the system treatment effectiveness and capacity.

Department staff should discuss initial plans for an indirect discharge system with a permit applicant prior to beginning a facilities planning process. The facilities plan is typically where Department staff will find an applicant's formal proposal for disposal of municipal wastewater treatment plant effluent by indirect discharge to surface water via groundwater or hyporheic water.

For proposed indirect discharge systems, Department staff should review the facilities plan to make sure it:

- Provides a conceptual waste management and treatment system design, including the indirect discharge component;
- Characterizes the quality and quantity of treated wastewater;
- Describes the specific location and ownership of the area where indirect discharge is proposed; and

- Supports the technical appropriateness of the indirect discharge location (e.g., general setting, geology, hydrology, and relationship to the receiving stream).

Site characterization

The overall objective of any site characterization for an indirect discharge system is to establish that the indirect discharge is:

- Technically feasible (e.g., Is the site size and infiltration capacity such that the site will accept the expected flow volume as described in the facilities plan? Are there significant biological or wetlands resources that could be affected by the system?);
- Appropriately located (e.g., Is the site owned by the permittee larger than the estimated size of the waste management area? Are there any water supply wells nearby that could be affected by the future waste management area? Is the site appropriately zoned for indirect discharge uses?); and
- Cost effective and likely to succeed relative to other alternatives outlined in the facilities plan (e.g., Will the cost of the indirect discharge system outweigh any potential benefits?).

Because site characterization is expensive, Department staff can expect to see work plans proposing phased site characterization, with increasingly detailed investigation proposed as it becomes evident that the indirect discharge is technically feasible for a specific site.

Example: A city with a 2 million gallon per day discharge to a river was interested in removing a portion or all of their direct discharge to help meet the future, more stringent temperature standards. Because the area considered for land disposal was an undeveloped area on a gravel bench adjacent to the river, little existing information was available to estimate whether the soils and aquifer would accept a discharge of that magnitude. As a part of their pre-design work, the city installed monitoring wells, conducted a series of single well aquifer tests, conducted a long-term aquifer test, and finally conducted a large-scale infiltration test using river water in site characterization phases of increasing complexity and expense. The data they collected provided the city with the range of groundwater depths across the site, seasonal groundwater flow directions, aquifer hydraulic conductivities, and water-level response to actual infiltration. From these data, the city was able to use a numerical groundwater flow model to estimate the maximum infiltration capacity of the site, to estimate the maximum likely extent of groundwater impact (i.e., size of the *waste management area*), and likely concentrations of key parameters in groundwater at the rivers edge. The outputs from this modeling effort were used in the city's mixing zone analysis, and the data also were useful in designing the size and layout of the infiltration basins. The wells installed for the aquifer tests and to evaluate water-level changes in response to the infiltration test were located in such a way that they could also be used for longer term monitoring of the waste management area boundaries.

In many cases however, existing data and conservative design assumptions can be used to meet design needs in place of extensive site characterization and modeling.

> **Example:** A small community located near a river uses two post-treatment infiltration basins to dispose of their wastewater. Using readily available information on the worse case wastewater strength, geology, topography, property ownership, location of nearby wells, proximity to surface water, precipitation data, and using conservative assumptions on aquifer characteristics (some derived from Water Resources Department data), Department staff were able to estimate that the likely nitrate concentrations in groundwater would be 100 times less than ambient water quality criteria before groundwater discharged to surface water. In addition, staff compared the volume of groundwater discharging to the river was 1000 times less that the lowest typical summer stream flow volume. Staff concluded that adverse impact to groundwater or surface water outside of the waste management area was not likely at maximum permitted flows, and that groundwater monitoring was unnecessary for this site.

Groundwater modeling

A groundwater flow model may be necessary to evaluate technical questions such as how quickly wastewater might infiltrate, the extent of groundwater mounding, and the likely size of the waste management area.

A groundwater model is simply a mathematical equation or series of equations used to estimate the behavior of a groundwater system. Anderson and Woessner (1992) classify groundwater models in the following way: "Groundwater models can be divided broadly into two categories: groundwater flow models and solute transport models. Groundwater flow models solve for the distribution of head, whereas solute transport models solve for the concentration of solute as affected by advection (movement of the solute with the average groundwater flow), dispersion (spreading and mixing of the solute), and chemical reactions, which slow down or transform solutes." Either type of model can be solved analytically (e.g., calculations) or numerically.

As described in the two examples above, modeling (i.e., calculations) can be conducted in an inexpensive way if conservative assumptions are used. However, Department staff can expect that the larger indirect discharge system proposals likely will include more sophisticated methods of analysis, given the larger relative risk of an expensive failure. Because the type of model used must be selected based on the hydrogeology and geomorphology of the specific site, Department staff usually will recommend that applicants may need to hire an expert in modeling techniques.

Water quality parameters critical to the permitting process

If the location can accommodate the proposed system, the applicant should estimate the concentration of key parameters prior to discharge to surface water. The evaluation should be tiered in the following fashion:

- Can the system be designed so that in-stream water quality standards can be met in groundwater just prior to discharge to surface water? A groundwater contaminant fate and transport model (e.g., solute transport model) may be necessary in addition to a groundwater flow model to estimate key parameter concentrations prior to discharge to the surface water body. Key parameters should include, but are not limited to, those parameters that are likely to be set as effluent limits in the permit. These may include temperature[9], nutrients (including nitrogen compounds and phosphorus), and total metals (including mercury, copper and zinc).

- If in-stream water quality standards cannot be met in groundwater just before it discharges to the receiving stream, the applicant should evaluate whether establishing a mixing zone is allowable as outlined in the Department's Mixing Zone IMD. With regard to setting an appropriate mixing zone for indirect discharges, the mixing zone should include the width of the waste management area at the interface with the receiving water. This width could be viewed as the length of a diffuser for the purposes of evaluating a mixing zone extending into the flowing water.
- If the analysis demonstrates a mixing zone is not appropriate, the Department will not approve the proposed system. If the analysis demonstrates a mixing zone is appropriate, a Reasonable Potential Analysis (RPA) will need to be performed based on the fate and transport model and the mixing zone analysis.
- If in-stream water-quality standards cannot be met at the edge of the zone of initial dilution (for acute criteria) and/or mixing zone (for chronic and human health criteria), the Department will deny the proposed system unless the applicant can develop additional pollution controls to reduce pollutant concentrations.

Permit evaluation report

The permit evaluation report should:

- Describe the facility's classification as a system that discharges indirectly to surface water via groundwater. A statement (as below, for example) should be provided in the permit evaluation report if Department staff have concluded that an adverse groundwater quality impact outside the waste management area is not likely:

  "The (name of facility) facility has been determined to be system that discharges indirectly to surface water via groundwater according to the Internal Management Directive (name and date of this IMD) and, therefore, groundwater compliance monitoring and compliance limits or variances will not be required for this facility."

- Include reasons why groundwater or hyporheic water within a waste management area established under this IMD will not be used as an underground source of drinking water (especially in the case of a UIC facility in order to satisfy the UIC regulations):
  - The system is designed so that it will not impact existing groundwater beneficial uses such as water supply wells;

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[9] In 2005, DEQ contracted with Oregon State University to assess the cooling capability of hyporheic gravels. The final report for this modeling assessment indicates that hyporheic flow can indeed be a significant source of cooling. The models they used in their analysis included PetraSim and TOUGH2 (Lancaster et al, 2005).

- The system design and the permit conditions make it virtually impossible for new water supply wells to be placed in the waste management area and for effluent to leave the management area, except via surface water;
- The system placement and the wastewater treatment level is such that the permittee can demonstrate to the Department's satisfaction that there will be no lasting effects[10] on groundwater or hyporheic water quality, and that groundwater could potentially be used as a water supply if the disposal system were to be decommissioned; and
- Based on these factors, the Department can find that the permitted system will not be injecting municipal wastewater directly into an underground source of drinking water.

Permit conditions

There area several permit conditions that Department staff must include in the draft NPDES permit, including:

- A condition to prohibit the installation of water supply wells within the waste management area.
- A formal *groundwater quality protection program* [as defined in OAR 340-044-0030(2)] including groundwater monitoring, is necessary if the Department finds that there will be a likely adverse groundwater quality impact outside of a waste management area. However, if groundwater *detection monitoring* is being conducted to confirm design assumptions or for system operation needs, the permit must include a condition requiring a groundwater monitoring plan, and a condition for plan implementation. Specifics of the plan typically should include groundwater monitoring well locations, sampling parameters, concentrations limits, and monitoring frequency.
- The Department intends that adjustments to groundwater sampling frequency or groundwater parameters tested as referenced in the permit-required groundwater monitoring plan be made as necessary without modifying the permit, and language to that effect should be included in the permit. The exception is for any parameters required for compliance with in-stream water quality standards, and these parameters and their sampling frequency typically are included in Schedule B of the permit.

UIC registration

If the constructed system includes a subsurface fluid distribution system (e.g., an assemblage of perforated pipes), then the permittee must register the system with the Department as an Underground Injection Control system.

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[10] For example, technical reasons why a system may not have a lasting effect on groundwater quality could be that the system will be sited in an area with higher-than-average aquifer permeabilities and so would "flush" quickly following system decommissioning; the typical treatment system as outlined in the IMD would treat the water to a fairly high standard; and most of the compounds that survive through the wastewater treatment process will be soluble in water and will be removed from the aquifer quickly. Taken together, these reasons would allow the Department to conclude that any impacts would be shorter term, and that the aquifer could be returned to unrestricted use in a relatively short time period.

References

Anderson, M. P. and Woessner, W. W. (1992). *Applied Groundwater Modeling*. Academic Press, San Diego.

Lancaster, S., R. Haggerty, S. Gregory, K.T. Farthing, and S. Biorn-Hansen, 2005. *Investigation of the Temperature Impact of Hyporheic Flow: Using Groundwater and Heat Flow Modeling and GIS Analyses to Evaluate Temperature Mitigation Strategies on the Willamette River, Oregon*, Final Report to Oregon Dept. Environmental Quality, Oregon State University, Corvallis, 104 pp.