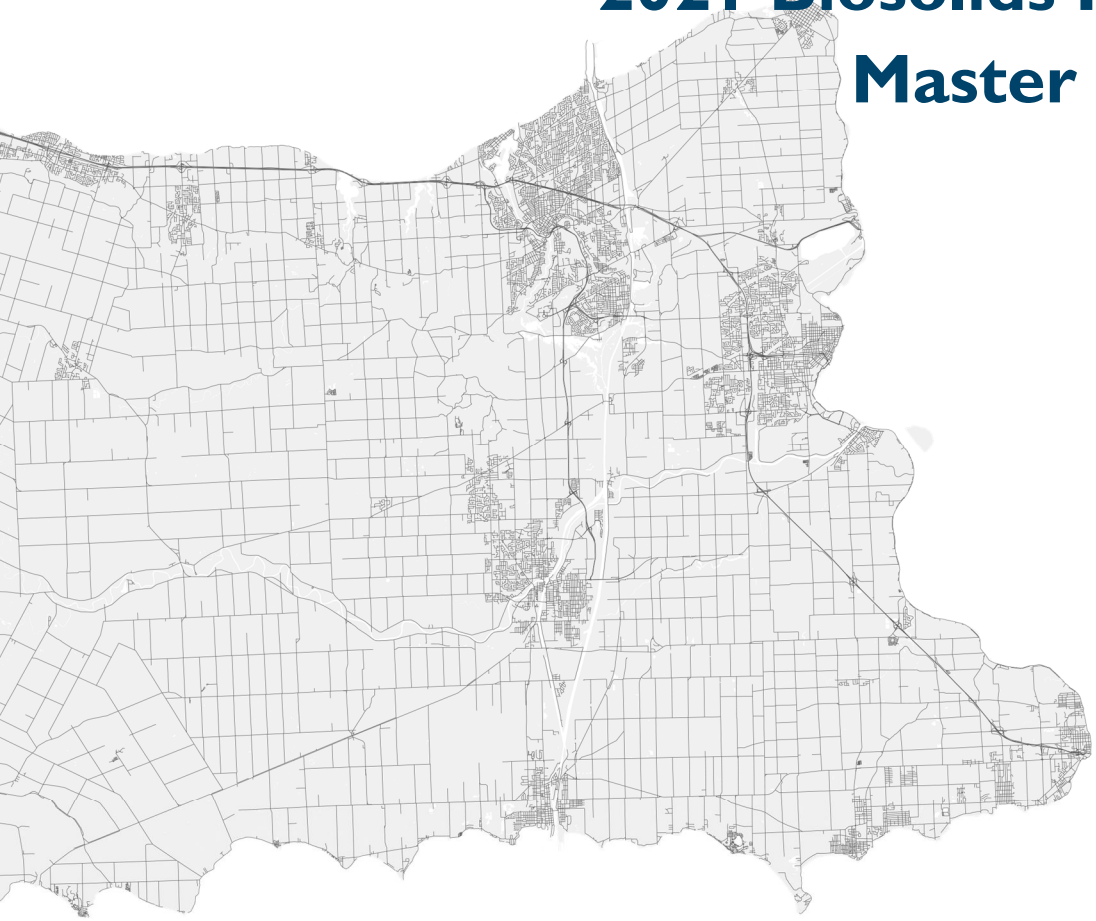
APPENDIX A8:
TM 8 – Water Treatment Residuals Alternatives

Technical Memorandum 8

Evaluation of Water Residuals Management Strategies

2021 Biosolids Management Master Plan Update

November 2023



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QA/QC - SIGN OFF SHEET

This report has been reviewed and approved by the undersigned.

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1.0 Introduction

1.1 Background and Purpose

Niagara Region has extensive water and wastewater infrastructure, with ten (10) wastewater treatment plants (WWTP) and six (6) water treatment plants (WTP). The majority of the solids generated at the WWTPs are anaerobically digested, and the resulting liquid biosolids are currently transported to the centralized Garner Road Biosolids Storage and Dewatering Facility (Garner Road Biosolids Facility) for storage prior to land application or dewatering and further processing. The solid residuals from the six water treatment plants are either transported to the Garner Road Biosolids Facility or discharged into sanitary sewers to be treated at the receiving WWTP and managed as part of the resulting wastewater solids. The WTP residuals generated at the Decew WTP and the Grimsby WTP are currently transported to the Garner Road Facility. The residuals generated at the Niagara Falls, Port Colborne, Rosehill, and the Welland WTPs are discharged into the sanitary sewer system.

As part of the Biosolids Management Master Plan Update, the Region is reviewing their current practices and long-term options for the management of the water treatment plant residuals. This Technical Memorandum 8 (TM 8) details current water residual management practices in the Region, compares these to practices at other Ontario municipalities and evaluates alternative management alternatives to address the water treatment residuals generated in the Region.

1.2 Technical Memorandum Outline

This technical memorandum (TM) is organized into the following sections:

1. **Introduction:** This section provides the background and propose of the TM and its outline.
2. **Review Water Residuals Management Practices in other Ontario Municipalities:** This section reviews current residuals management practices in other Ontario Municipalities as originally presented in TM 1.
3. **Existing Conditions and Future Needs:** This section describes existing water residuals disposal practices within the Region, and both existing and future quantity estimates. This section expands on existing conditions information presented in TM 1 and TM 4. This section also considers impacts of potential future regulations.
4. **Long List of Water Residuals Management Approaches:** This section describes available strategies to manage water residuals, including on-site treatment technologies.
5. **Screening of Long List of Water Residuals Management Approaches:** This section describes the screening criteria used to develop a short list of water residuals management approaches.

6. **Shortlisted Water Residuals Treatment Technologies Alternatives and Evaluation:** This section describes the short list of residual treatment technologies that will be carried forward and incorporated into the development of the preferred biosolids management strategies.
7. **Recommendations and Next Steps**

2.0 Water Residuals Management Practices in other Ontario Municipalities

As originally documented in TM 1 on "Background and Existing Conditions", Table 2-1 summarizes WTP residuals management processes in other Southern Ontario municipalities. Most of these municipalities manage their WTP residuals by discharging directly into the sewage system for treatment at the WWTPs. The Region manages residuals by directly discharging into the sewer system or by providing on-site gravity thickening and then hauling the thickened residuals to the Garner Road facility and discharging supernatant to the sewer, as described in the following section.

Table 2-1 WTP Residuals Management in Other Municipalities

MUNICIPALITY	RESIDUAL MANAGEMENT
Region of Halton	WTP residuals are directly discharged into sanitary sewers through a sanitary connection. When the sanitary connection is not available, the waste residuals are pumped out by a septic hauler from backwash holding tanks.
City of Barrie	WTP residuals are discharged into the sewer directly.
City of Toronto	WTP residuals are either hauled offsite for landfill or incineration.
York Region	Waste holding tanks are used to store residuals before pumping into sanitary sewers. The supernatant from the waste holding tanks is discharged into storm sewers or lakes.
Region of Peel	A settling process and tube clarifiers are used to treat water residuals. The residuals are discharged into sanitary sewers. The supernatant from the settling process is discharged directly into Lake Ontario.

3.0 Existing Conditions and Future Needs

The Region currently manages their water treatment plant residuals by either thickening and hauling to the Garner Road Biosolids Facility for blending with wastewater biosolids, or direct discharge to the local sewer system where the residuals are mixed with sewage and treated through the downstream wastewater treatment plants.

Table 3-1 summarizes current and future quantities of residuals from each WTP and current management practices.

Table 3-1 – Current and Future Residuals Quantities and Current Management Approach

WATER TREATMENT PLANT	RATED CAPACITY (ML/D)[1]	2019-21 RESIDUAL MASS, DRY KG/YEAR (DRY KG/D)	2051 ESTIMATED RESIDUAL MASS, DRY KG/YEAR (DRY KG/D)	CURRENT RESIDUALS MANAGEMENT APPROACH
Decew	227	685,790 (1,900)	896,148 (2,500)	Residuals are thickened then hauled to the Garner Road Facility for management, with larger quantities removed bi-annually during routine tank clean-out.
Niagara Falls	145	409,858 (1,100)	544,982 (1,500)	Residuals are thickened then hauled to the Garner Road Facility for management, with larger quantities removed bi-annually during routine tank clean-out.
Welland[3]	65	262,155[2] (720)	375,585 (1,000)	Discharge to the Welland WWTP sewershed.
Grimsby	44	185,500 (510)	311,491 (850)	Residuals are thickened and then hauled to either Garner Road (~10 – 20%) or Baker Road (~80 – 90%).
Rosehill[3]	50	123,897[2] (340)	169,725 (460)	Discharged to the Anger Ave WWTP sewershed
Port Colborne	36	53,820 (150)	62,853 (170)	Discharged to the Seaway WWTP sewershed.

Notes:

1. Future flows to 2051 are within existing rated WTP capacities, and no WTP capacities expansions are planned within this planning horizon.
2. The historical dry weight of residuals for the Rosehill and Welland WTPs are not recorded by the Region. As discussed in TM 1 and TM 4, the calculated residuals solids from the Rosehill and Welland WTPs are significantly higher than expected. Based on the average residual solids over treated flow ratio from the four WTPs (Decew, Grimsby, Niagara Falls, and Port Colborne), 30 kg residual solids / ML treated flow is used to estimate the residual solids from the Rosehill and Welland WTPs.

The Region initiated a pilot study in 2023 to dewater residuals from the Decew WTP during process clean-outs periods, where large quantities of residuals would normally be hauled to Garner Road in a short period. The Region intends to landfill dewatered residuals rather than sending them to Garner Road for blending with biosolids and eventually beneficial use. If this pilot is successful, the Region may also consider implementing this strategy at Niagara Falls WTP.

4.0 Long List of Water Residuals Management Approaches

Management alternatives for water treatment residuals include volume reduction by thickening or dewatering, disposal in landfills, or blended with biosolids for beneficial use.

4.1 Dewatering or Drying and Landfilling

Dewatering processes reduce the volume of the residuals to process or transport and increase the solids concentration to over 30 percent. Drying beds, either sand based for drainage or concrete based for freeze thaw sublimination, are used to achieve the highest solids concentrations in the range of 25 to 30 percent.

Dewatered or dried residuals can be disposed of in landfills or used as part of the landfill facility's daily cover. Landfills often require a total solids concentration above 20 percent for disposal or use, which can be achieved through dewatering or drying.

4.2 Dewatering or Drying and Incineration

Water treatment residuals can also be dewatered or dried, as described above, and blended with wastewater solids and incinerated.

4.3 Reuse by Blending with Wastewater Solids

Water residuals can also be blended and processed with wastewater solids. This allows the residuals to used in agriculture or horticulture activities and provides additional space at the landfills. The water treatment residuals generated in the Region are currently processed with biosolids.

4.3.1 Hauling to Centralized Facility

Water residuals can be hauled to the centralized Garner Road Facility for mixing with wastewater biosolid, and then managed as biosolids for different forms of beneficial reuse (refer to TM 7 for alternative biosolids management strategies). Thickening of the water residuals may be used prior to hauling to reduce hauled volumes.

4.3.2 Blending through Sewer System

Water residuals can be sent to the sanitary sewer system where they mix with raw sewage, and are treated through the downstream wastewater treatment plant. The residuals form part of the resulting biosolids produced by the plant, when can then be managed as biosolids for different forms of beneficial reuse (refer to TM 7 for alternative biosolids management strategies).

4.3.3 Hauling to Local Wastewater Treatment Plant (WWTP) for Dewatering

Water residuals could be hauled to a nearby WWTP to be blended with sewage biosolids prior to dewatering and hauling to an offsite processing facility. This alternative is only applicable for WTPs that are located close to WWTPs with dewatering capabilities.

5.0 Screening of Long List of Water Residuals Management Approaches

The use and disposal approaches to water treatment residuals management were compared and screened based on the sustainability of the practice and the availability of facilities in the Region. As shown on Table 5-1, the blending of water treatment residuals with biosolids and beneficial use of the product was the only alternative able to meet both criteria. As a result, this approach was carried forward for detailed evaluation.

Table 5-1 Screening of Water Treatment Residuals Management Approaches.

APPROACH	SUSTAINABILITY / LONG TERM RELIABILITY	AVAILABLE FACILITIES IN NIAGARA	SCREENING LEVEL RESULT
1. Dewatering/Drying + Landfill	✗	✓	FAIL Landfilling is not sustainable in long term. Although landfills are available, their capacity is declining.
2. Dewatering/Drying + Incineration	✓	✗	FAIL Incineration facilities are not available in Niagara Region.
3. Reuse by blending with wastewater solids a) Hauling to Centralized Garner Road Facility b) Through Sewer system c) Hauling to Local WWTP for dewatering	✓	✓	**PASS** **Facilities for blending with biosolids are available, and strategy can be maintained in long term.**

6.0 Shortlisted Water Residual Management Alternatives and Evaluation

It is recommended that the Region continue the current practice of combining the water treatment residuals generated in the Region with biosolids and beneficially using them, which is the only approach that passed the screening level evaluation. For each WTP, three alternatives for managing the water treatment residuals were considered.

Alternative 1: Haul thickened residuals to the Garner Road Biosolids Facility and blend with biosolids prior to beneficial use on land (either liquid land application or dewatering and transport to alkaline stabilization facility and distribution as a fertilizer product).

Alternative 2: Convey residuals to a WWTP through the wastewater collection system and treat the residuals along with the wastewater. Blended biosolids/residuals would then be hauled as liquid to Garner Road for either liquid land application or dewatering and transported to an alkaline stabilization facility and distribution as a fertilizer product.

Alternative 3: Haul thickened residuals to a WWTP with dewatering, and blend with biosolids prior to dewatering. Blended dewatered biosolids/residuals would then be transported to the N-Viro alkaline stability facility for distribution as a fertilizer product.

Key considerations when determining the preferred alternative for each WTP are:

- Potential for impacts to the downstream WWTP if residuals are sent to sewer which is influenced by:
    - Volume of residuals produced; a larger volume of residuals has a greater potential to overwhelm the local sewer system.
    - Ability of WTP effluent (including residuals) to meet current sewer use by-law.

- Proximity of WTP and closest WWTP to Garner Road Facility; this will impact hauling requirements. WTPs that are located closer to Garner Road than the closest WWTP would reduce total hauled distance by hauling their residuals directly to Garner Road.

- Availability of dewatering at the nearest WWTP; Alternative 3 above would only be feasible if a nearby WWTP has dewatering or plans to implement dewatering in the future.

6.1 Water Treatment Plants Currently Sending Residuals to Sewer

Three (3) of the six (6) water treatment facilities (Welland, Rosehill and Port Colborne) currently discharge their residuals into the sanitary collection system (Alternative 2). These three (3) facilities generate approximately 26 percent of the Region's water treatment residuals, by weight. Currently, discharge from these WTPs meets the sewer use by-law limits, with the exception of TSS from Welland WTP and Port Colborne WTP. However, the receiving WWTPs (Welland WWTP and Seaway WWTP) have the ability to accept these solids.

Liquid sludge from these two (2) WWTPs are hauled to the Garner Road Facility.

Although hauling of residuals could be considered for these WTPs, this would be a higher cost to the Region and increase truck traffic in these areas, particularly because liquid sludge from the two receiving WWTPs is also trucked to the Garner Road Facility. As the current operation is working well, there is no justification to change this approach to Alternative 1. Finally, none of the nearby WWTPs to Welland WTP, Rosehill WTP or Port Colborne WTP have dewatering. Therefore, Alternative 3 is not feasible. As long as the discharge of residuals into the sewer from these WTPs does not cause operational challenges at the downstream WWTP, it is recommended that Alternative 1 is continued for Welland, Rosehill and Port Colborne WTPs.

6.2 Water Treatment Plants Currently Hauling Residuals to Garner Road Facility

For the remaining WTPs, Decew, Niagara Falls and Grimsby, which currently have their residuals hauled to Garner Road, the potential impact on the wastewater treatment facility that could receive the residuals and the impacts of transporting the residuals to the Garner Road Biosolids Facility were considered. These three facilities generate approximately 74 percent of the Region's total water treatment residuals. Decew and Niagara Falls generate 60 percent of the total.

Historically, WTP residuals from Niagara Falls WTP were sent to the Niagara Falls WWTP sewershed. However, this resulted in process upsets at the WWTP, and the practice was discontinued.

Based on the potential impact of the larger volume of residuals on the Niagara Falls WWTP from both the standpoint of process upsets and cost, it is recommended that the residuals from Niagara Falls WTP continue to be transported to the Garner Road Biosolids facility for management with the biosolids. Furthermore, although Niagara Falls WWTP has dewatering, there is little benefit in hauling residuals first to Niagara Falls WWTP when the Garner Road facility is so close. Although it is not recommended as a primary strategy, the Region may consider dewatering residuals at Niagara Falls WTP and sending this material to landfill during process cleanout periods as a short-term contingency measure if available capacity is not available at Garner Road. It is not recommended that landfill disposal be implemented as part of normal operation.

Decew WTP is located within the Port Dalhousie WWTP sanitary catchment. Therefore, if residuals from Decew WTP were discharged to the local sewer, they would need to be conveyed approximately 14 km to Port Dalhousie WWTP. Once at the WWTP, they would be blended with biosolids and hauled 27 km to Garner Road. In contrast, if these residuals are hauled directly to Garner Road, the total haul distance is only 19 km. Furthermore, introducing residuals from the Region's largest WTP into the sewer would increase solids loading at the Port Dalhousie WWTP and reduce it's available capacity for treating sewage. As such, it is recommended that residuals from Decew WTP continue to be thickened and hauled to Garner Road directly. Similar to the

recommendation for Niagara Falls WTP above, a contingency plan for managing residuals during cleanout periods could be dewatering and sending to landfill if storage capacity is not available at Garner Road.

Residuals from Grimsby WTP are currently thickened and hauled to either Baker Road WWTP where they are discharged at the headworks (80 – 90% of residuals), or to Garner Road (10 - 20% of residuals). The addition of dewatering at Baker Road WWTP is suggested as an option to manage biosolids in the long term as well as dewatering at the Garner Road facility in TM 5.

It is recommended that Baker Road WWTP treat the residuals from the Grimsby WTP. If dewatering is eventually implemented at Baker Road WWTP, it is recommended that the Grimsby WTP residuals be discharged directly downstream of the anaerobic digester upstream of the dewatering facility, rather than at the head of the WWTP, to keep these non-digestible solids out of the main liquid treatment stream. This can be achieved by installed a holding tank to receive all Grimsby WTP residuals. Residuals from this holding tank will be gradually added to a mixing tank where they will be blended with digested sludge, followed by dewatering of the blended solids. This dewatered cake would then be hauled to the N-Viro facility by Walker Environmental. This configuration allows the residuals to be added to the biosolids at a controlled rate to help manage quality. Furthermore, the concentrations of regulated metals that would result from blending the residuals from Grimsby WTP and the biosolids from Baker Road WWTP meet the most stringent CFIA criteria, based on average historical solid generation rates and quality data available (2017 – 2021). Refer to Table 6-1. This indicates that solids produced from Baker Road WWTP will be of suitable quality to be hauled directly to the N-Viro facility while meeting the terms of the Region's contract with Walker Environmental. Residuals quality should be reassessed in the future if dewatering at Baker Road is pursued.

If dewatering is not pursued at Baker Road WWTP, it is recommended that residuals from Grimsby WTP continue to be transported to either Garner Road or to Baker Road WWTP and be discharged at the headworks.

It is not recommended to directly discharge Grimsby WTP residuals to the sewer to be conveyed to the Baker Road WWTP for treatment with the communities' wastewater, as it would require treating residuals through the WWTP and using up available capacity for sewage treatment. Further, the haul distance between Grimsby WTP and Baker Road WWTP is less than 5 km, so the reduction in hauling will be less significant.

Table 6-1 – Characteristics of Blended Solids from Grimsby WTP and Baker Road WWTP

	BAKER RD WWTP BIOSOLIDS		GRIMSBY WTP RESIDUALS		BLENDED		CRITERIA CFIA @4400 KG/HA/YR
Element	mg/kg	mg/d	mg/kg	mg/d	mg/d	mg/kg	mg/kg
Arsenic	5.742	39,102	53.644	27,895	66,997	9.14	75
Cadmium	1.013	6,897	1.966	1,022	7,919	1.08	20
Chromium	91.033	619,932	7.740	4,025	623,957	85.12	1,060
Cobalt	5.861	39,914	4.464	2,321	42,235	5.76	151
Copper	391.435	2,665,670	46.336	24,095	2,689,765	366.95	757
Lead	20.919	142,457	10.675	5,551	148,008	20.19	505
Mercury	0.186	1,266	0.019	10	1,276	0.17	5
Molybdenum	13.554	92,300	8.473	4,406	96,706	13.19	20
Nickel	30.039	204,565	8.718	4,533	209,098	28.53	181
Selenium	3.236	22,036	1.535	798	22,834	3.12	14
Thallium	-	-	-	-	-	-	5
Vanadium	-	-	-	-	-	-	656
Zinc	970.949	6,612,160	82.214	42,751	6,654,911	907.90	1,868

Notes:

1. The calculations above are based on average solids production from 2017-2021 as follows:
    a. Baker Road WWTP – 6.81 dt/d
    b. Grimsby WTP – 0.52 dt/d
    c. Blended Solids Quantity (calculated) – 7.33 dt/d
2. Thallium and Vanadium quality are not monitored by the Region. US EPA Part 503.13 criteria does not have criteria for Thallium and Vanadium, although CFIA regulation does.

6.3 Evaluation of Alternatives

A comparison of water treatment plants and proposed alternatives moving forward are presented in Table 6-2. The proposed approaches noted apply to normal operation, and do not apply to periodic clean-outs that result in higher volumes of residuals in a short time frame.

Table 6-2 Current and Proposed Approach to Convey Water Treatment Residuals

WATER TREATMENT PLANT	LOCAL WWTP	DEWATERING AT LOCAL WWTP	CURRENT APPROACH	RESIDUAL VOLUMES, HISTORICAL (2019-2021) / 2051 ESTIMATED (DRY KG/YEAR)	WTP RESIDUAL % OF TOTAL RESIDUAL PRODUCED AT ALL REGION WTP'S (2019-21 / 2051)	CURRENT ABILITY TO MEET SEWER USE BY-LAW	WTP DISTANCE FROM GARNER ROAD (KM)	LOCAL WWTP DISTANCE FROM GARNER ROAD (KM)	PROPOSED APPROACH	JUSTIFICATION
Decew WTP	**Port Dalhousie WWTP**	No	**Alternative 1**: Thicken and haul to Garner Road	685,790 / 896,148	40% / 38%	n/a	19 km	27 km	**Alternative 1**: Continue thickening and hauling to Garner Road	Significantly shorter haul distance from Decew WTP to Garner Road than from Port Dalhousie to Garner Road. Thickening equipment already in place.
Niagara Falls WTP	**Niagara Falls (Stanley Ave) WWTP**	Yes	**Alternative 1:** Thicken and Haul to Garner Road	409,858 / 544,982	24% / 23%	n/a	11 km	13 km	**Alternative 1**: Continue thickening and hauling to Garner Road	Distance is minimal and process upsets observed at Niagara Falls WWTP when sent to sewer.
Welland WTP	**Welland WWTP**	No	**Alternative 2:** Send to sewer (Welland WWTP)	262,155 / 375,585	15% / 16%	Discharged residuals are meeting sewer use by-law for TP and TKN, exceedances for TSS.	14 km	16 km	**Alternative 2:** Continue sending to sewer (Welland WWTP)	Welland WWTP has capacity to process the additional solids
Grimsby WTP	**Baker Road WWTP**	Recommended	**Alternative 1:** Thicken and Haul to Garner Road (~10 – 20%) or Baker Road WWTP (~80 – 90%) (and discharge into headworks)	185,500 / 311,491	11% / 13%	n/a	53 km	47 km	**Alternative 1:** Thicken and Haul to Baker Road WWTP headworks or Garner Road. Consider Alternative 3 in future if dewatering is added at Baker Road WWTP, by blending residuals with digested sludge and dewater blended solids before hauling offsite to N-Viro facility	Reduce total hauling by dewatering residuals with biosolids at Baker Road before hauling offsite. Reduces solids load on Baker Road WWTP by not sending to local sewer or head of WWTP.
Rosehill WTP	**Anger Avenue WWTP**	No	**Alternative 2:** Send to sewer (Anger Ave WWTP)	123,897 / 169,725	7% / 7%	Discharged residuals are currently meeting sewer use by-law	27 km	27 km	**Alternative 2:** Continue sending to sewer (Anger Ave WWTP)	Discharged residuals are currently meeting sewer use by-law. Volumes are small.
Port Colborne WTP	**Seaway WWTP**	No	**Alternative 2:** Send to sewer (Seaway WWTP)	53,820 /62,853	3% / 3%	Discharged residuals are meeting sewer use by-law for TP and TKN, exceedances for TSS.	23 km	23 km	**Alternative 2:** Continue sending to sewer (Seaway WWTP)	Seaway WWTP has capacity to process the additional solids. Volumes are small.

6.4 Water Treatment Plant Cleanout Operations

As has been previously noted, during WTP cleanout operations that occur intermittently through the year result in very high load of residuals for a short duration. For WTPs that directly discharge to the sewer system, these events can result in higher solids loading to downstream WWTPs. Historically, residuals from Niagara Falls WTP were discharged into the local sewer system and received by Niagara Falls WWTP. During clean-out events, this resulted in process upsets at the Niagara Falls WWTP, and the practice of sending Niagara Falls WTP residuals to the sewer was discontinued. Residuals from Niagara Falls WTP are now hauled to Garner Road to be mixed with biosolids and land applied.

The Region is currently using a portable centrifuge to dewater residuals at Decew WTP during cleanout operations. This approach is intended to reduce the cost of transporting the liquid residuals and reduce the operation and maintenance costs associated with processing the water treatment residuals at a WWTP before transport to the Garner Road facility.

A similar approach could be considered for the other WTPs if this pilot is successful to manage higher residuals loads produced during clean-out operations.

7.0 Recommendations and Next Steps

For management of water treatment plant residuals, it is recommended that:

- The three water treatment facilities that discharge their residuals to the local wastewater collection systems continue that practice;
- Decew and Niagara Falls water treatment facilities continue to transport their residuals to the Garner Road Facility for dewatering and management along with the Region's biosolids.
- If dewatering is added at Baker Road WWTP in the long term, blend Grimsby WTP residuals with digested sludge at the Baker Road Wastewater Treatment Facility upstream of dewatering. The blended dewatered biosolid and residuals would then be hauled to Walker Environmental or Garner Road.

There are no additional capital upgrades required to implement these recommendations, beyond those recommended in TM 5.